To shield or not to shield? A cross-sectional survey exploring radiographers’ perceptions and knowledge about patient lead shielding in Greece and Cyprus.

Abstract

Purpose: To explore radiographers’ knowledge, clinical practice, and perceptions regarding the use of patient lead shielding in Greece and Cyprus.

Method: An online Qualtrics survey was distributed through the Hellenic and Cypriot Societies of Radiologic Technologists, and the researchers’ networks, using purposive sampling. The survey was launched on June 18, 2022, and terminated on July 18, 2022. Data analysis was performed on SPSS, using descriptive and inferential statistics to compare variables. Qualitative data was analyzed using conceptual content analysis and through the classification of findings into themes and categories.

Results: A total of 216 valid responses were received. Most respondents reported not being aware of the patient shielding recommendations issued by the American Association of Physicists in Medicine (67.1%) or the guidance issued by the British Institute of Radiology (69.4%). Relevant training was generally not provided by radiography departments (74%). Most of them (84.7%) said that they need specific guidance on lead shielding practices. 81.8% of the respondents said that lead shielding should continue to be used outside the pelvic area when imaging pregnant patients. Paediatric patients are the most common patient category to which lead shielding was applied.

Conclusions: Significant gaps in relevant training have been identified among radiographers in Greece and Cyprus, highlighting the need for new protocols and provision of adequate training on lead shielding practices. Radiography departments should invest in appropriate shielding equipment and adequately train their staff.

Keywords: Radiography; Shielding; Lead; Radiation protection; Greece; Cyprus

Introduction

Radiation protection has been central to medical imaging and radiotherapy professionals. Lead (Pb) shielding has been a widely established strategy to achieve a reduction in patient radiation exposure, and for good reason. The use of lead shielding for gonadal and fetus protection has been considered for many decades as best practice, being also consistent with the ALARA (As Low As Reasonable Achievable) principle. However, shielding use has been recently reconsidered [1,2]. Specifically, recent guidance documents issued by the British Institute of Radiology (BIR) and the American Association of Physicists in Medicine (AAPM) [3,4] have advised that lead shielding may interfere with the image, or be misplaced, and result in increased radiation exposure. In addition, recent findings corroborate the cessation of lead shielding use in diagnostic imaging [5]. However, a vast number of papers have indicated that lead shielding reduces the dose to the patient and that radiation remains a harmful carcinogen [6-9].

Arguments have been made that, nowadays, doses are lower due to improved x-ray equipment. Automatic Exposure Control (AEC) systems are widely embedded in medical imaging equipment. Thus, optimal radiation exposure can be achieved by reaching a pre-determined air kerma threshold [10]. However, AEC may cause increased radiation dose if highly attenuated objects like lead shielding interact with the primary x-ray beam [11]. Some novel technological developments can lead to a massive reduction in radiation exposure for patients. It has been documented that these technological changes have achieved a breakthrough in radiation protection [12]. Recent research has shown a significant decrease in the gonadal tissue burden factor, and the latest data on radiation exposure risk has led to a reevaluation of lead shielding use in clinical practice. However, although the individual doses may have decreased per individual examination, far more examinations are being carried out, often involving more complex, longer procedures.

Another major issue at play in this document is the undermining of the linear no-threshold model. The International Atomic Energy Agency accepts the linear no-threshold model, and it is a fundamental concept in the European Basic Safety Standards. The evidence supporting the linear model continues to increase. A recent paper demonstrated continued ongoing effects from radiation for sixty-seven patients at doses as low as 7.5 mSv [13].

Despite the effects that ionising radiation exposure can have on health outcomes, medical imaging and radiotherapy are now one of the most developed and widely used disciplines in clinical practice. The benefits of these health services to the patient far outweigh the potential risks of radiation exposure. Therefore, it is imperative to ensure that the best radiation practices are employed while also maximising the benefits for the patient.

In Greece, no research has been conducted regarding the use of lead shielding; this lack of research, in conjunction with some inconsistencies and different opinions related to lead shielding in other countries [14,15] has justified the need for this study.

This study aims to map out all employed practices in Greece and Cyprus related to lead shielding use and radiographers' perceptions and experiences on this sensitive topic.

Methods

This is a cross-sectional observational study; therefore, reporting of the results follows the STROBE and CHERRIES checklists [16,17].

Participants

All radiographers working in Greece or Cyprus were invited to participate in this survey. No inclusion/exclusion criteria were applied depending on sub-specialisation of the participants or any demographic characteristics.

Instrument

This study used a questionnaire on Qualtrics (Qualtrics, Provo, UT). This was an exact replication of an already validated survey from a similar study in Ireland after carefully translating all elements into Greek. The questionnaire consisted of 32 closed and two open-ended questions. It was piloted among radiographers and researchers (n=4) to ensure face validity and optimal survey flow.

Data collection

The survey was launched between June 18, 2022, and July 18, 2022. It was distributed via e-mail, using the official membership list of the Greek Society of Radiologic Technologists (STAAE). It was further distributed through social media, with regular posts on the Society's and the researchers' pages on LinkedIn, Twitter and Facebook. For Cyprus, the survey was kindly distributed through the local Society of Radiographers members. Regular reminders were also sent to increase the response uptake.

Data analysis

Quantitative data was analysed on the SPSS software, version 26 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics was used to analyse data, and the chi-square (x^2) statistical test was employed to examine possible relationships between important variables. Cramer's V was used as a measure of the effect size between significant associations, and when V>0.25, the effect size was very strong; when it was >0.15, it was strong; and when >0.10 moderate [18]. Graphs and tables were used to visualise the results, where they seemed appropriate. The level of statistical significance was set at $p<0.05$.

A conceptual content analysis was employed to analyse the qualitative part of the data since this is a well-established method to analyse written text and quantify phenomena [19]. The researchers classified all data into codes, and then these codes formed the basis to develop themes with a common content.

The coding of data was manually performed using the colour-coding technique [20].

Ethics

Ethical approval was obtained by the XXXXX Ethics Committee (ref: CT-SREC-XXXX-XX). STAAE was the gatekeeper of the study. Informed consent was sought from all participants at the beginning of the survey. All participants were adequately informed about the aim and objectives of the study and the anonymity of their responses. All data was securely stored according to local research protocols.

Results

In total, 216 valid responses were received. It should be noted that not all survey questions achieved the same number of responses; hence, reported percentages have been calculated with regard to the actual number of responses received for each question.

Demographics

Of all radiographers included in the sample of this study, 70.4% originated from Greece and 29.6% from Cyprus. Table 1 depicts the main demographic characteristics of the respondents.

Table 1. Main demographics	
Age of the respondents	
20-25 years old	8.3%
26-31 years old	24.5%
32-42 years old	32.9%
>42 years old	34.3%
Years after graduation	
<5 years	18%
6-19 years	54.7%
20-26 years	18%
>27 years	9.3%

Shielding guidelines

Regarding lead shielding guidelines, the majority (67.1%) of the respondents reported not being aware of the recommendations issued by the AAPM, compared to those who were aware of this document (32.9%). Similarly, 69.4% of them did not know about the guidance issued by the BIR, compared to those who did (30.6%). Of those who were aware of the BIR guidance, the majority (62.2%) said that they agree that shielding may interfere with the image and, if not optimally placed, cause an increased radiation dose to the patient, 25.8% agreed to a certain degree, 6% disagreed, and 6% were not sure. Of those aware of the AAPM recommendations, 40.8% said that they agree only to a certain degree that shielding should not be used for medical imaging examinations on a regular basis, 31% of them did not agree at all, and only 19.7% agreed with the above statement. A further 8.5% of them were not sure.

The x^2 test showed a statistically significant association (p= 0.049, V= 0.210) between BIR guidance awareness and years after graduation. In addition, shielding-related training was statistically associated with BIR guidance awareness (p= 0.000, V= 0.304) (Fig.1).

Many respondents (45.1%) were not sure if they agreed that shielding should not be used during fluoroscopic procedures, 34.5% of them did not agree, and only 20.4% agreed with that. Regarding the use of lead shielding during CT examinations, 40% of them did not agree with shielding being discontinued, 31.6% were unsure, and 28.4% agreed with not using shielding for CT scans. Concerning the notion that shielding can interact with the AEC system, thus resulting in increased radiation dose in CT scans, almost half of them (44.8%) said that they were not sure about that, 42.5% of them agreed, and 12.6% did not. For mammography examinations, 43.7% of the respondents agreed that lead shielding should not be routinely used, 29.3% were unsure, and 27% did not agree.

Lead shielding practices

Respondents were also asked to report if they use lead shielding in the primary beam, and almost half of them (46.5%) said this is situation dependent. In addition, 36.2% said they routinely use shielding in the primary beam, while 17.3% do not. Of those who do not use shielding in the primary beam, 29.7% have received shielding-related training and 70.3% have not, thus resulting in a statistically significant association between training and use of shielding in the primary beam (p= 0.000), with a very strong effect size (V= 0.589) (Fig.2).

Regarding lead shielding outside the primary beam, again almost half of them (47.2%) said that this depends on the situation, 37.4% of them routinely use lead shielding, and 15.4% do not. The training was once again statistically significant to using lead shielding outside the primary beam (p= 0.000), with a very strong effect size (V= 0.414). In addition, years after graduation were strongly (V= 0.196) associated with the use of shielding outside the primary beam (p= 0.016) (Fig.3).

According to the respondents, most patients (63.3%) rarely ask for lead shielding. Almost a quarter of them (22.3%) occasionally ask for shielding, and 6% never ask for this. Only 8.4% of them said that patients regularly ask for lead shielding.

Three quarters of radiographers (75.8%) said that they allocate time to explain in detail the rationale for lead shielding use to the patients, compared to 24.2% who do not. This was found to be statistically significant (p= 0.042, V= 0.193) to years after graduation of the respondents (Fig.4), and to training of the respondents (p= 0.000, V= 0.719).

Over a third (36.9%) of the respondents said that they clearly explain the risks and benefits of lead shielding to the patients, compared to 10.1% who do not. Most of them (53%) reported providing such explanations only occasionally. Explanation of risks/benefits were again statistically significant (p= 0.000, V= 0.588) to training and to years after graduation (p= 0.036, V= 0.185).

Respondents were asked to report in what types of examinations they regularly use lead shielding, and x-rays of the pelvis was the most prevalent response (56.6%), followed by chest x-rays (41.9%).

Over a third of the respondents (38.7%) said that they would use lead shielding as a means of reassurance to a patient that requests it, even if it is not the best practice to be used, 36.7% said this is situation dependent, and 13% of them would use it only if the patient denied being examined. A further 11.6% would not use lead shielding in any case. This was again very strongly (V= 0.592) associated with shielding-related training (p= 0.000).

With regards to the COVID-19 pandemic, most of the respondents (52%) said that the pandemic did not question the application of lead shielding due to using the same material on all patients.

Training and protocols

Regarding lead shielding training, most respondents (74%) said that the departments they work at do not provide such training. A further 23.2% said that they had received such training at a departmental level, and 2.8% of them said that, although the department provides such training, they have not received it. Of medical imaging departments located in Greece, 82.8% do not offer such training to radiographers, compared to 53.1% for departments in Cyprus (Fig.5). The x^2 test showed a statistically significant association between the two countries and the provision of training (p-value= 0.000), with a very strong effect size (V= 0.321).

In addition, 71.6% of the respondents said that there is no specific protocol for the optimal positioning and application of lead shielding in their department, compared to 28.4% who have developed such protocols. Chi-square tests showed a statistically significant association between countries and protocols for lead shielding (p-value= 0.000, V= 0.337), since 51.5% of the departments in Cyprus have such protocols, compared to medical imaging departments in Greece (18.4%).

Most of the respondents (84.7%) said that it would be helpful to have specific guidance in their departments to guide radiographers on the optimal use of lead shielding, 12.5% of them thought that it might be useful, and 2.8% of them said that it would not be helpful at all. Two out of three of the respondents (67.5%) think that the application of lead shielding should continue to be taught to radiography students in all cases, 18.1% of them believe that the education on this must be changed, and 14.4% of them were not sure about that.

Perceptions on lead shielding

Almost half of the respondents (48.9%) said their decision on whether to ask for shielding or not as patients would be situation dependent, 30.7% said that they would ask for lead shielding, and 20.4% of them would not.

Most of them (66%) think that lead shielding is an effective strategy for radiation protection, 22.4% of them needed clarification, and 11.6% of them answered negatively. Most of the respondents (84.5%) said that the effective use of collimators could significantly contribute to radiation dose optimisation, 11.8% were not sure about it, and 3.7% said no. Also, 78.5% said that lead shielding is not the primary dose reduction strategy in conventional radiography, compared to 21.5% who said yes.

Most of them (65.8%) think that lead shielding can interfere with the AEC system, compared to 34.2% who do not. With regards to the potential risk of injury, most of them (70.7%) think that the application of lead shielding has no risk of injury for them as radiographers, followed by 23.7% of them who consider it as a low risk, and 5.1% who think there is a moderate risk of injury. Only 0.5% answered that lead shielding could be a high risk of injury for them. Their perceptions of potential risk of injury were strongly associated with years after graduation ($p = 0.032$, $V = 0.180$) (Fig.6).

Regarding paediatric patients, most respondents (86.9%) said that all the procedures related to lead shielding should be different from those for adult patients, 11.5% said that children should be approached in the same way as adults, and 1.6% of them were not sure. In addition, 81.8% of the respondents said that lead shielding should continue to be used outside the pelvic area when imaging pregnant patients, compared to 9.8% who said that its use should be discontinued, and 8.4% who were unsure about that.

Due to a significant decrease in gonadal tissue weighting factor, 61.4% of the respondents think that caution should be paid to other tissues and organs with higher tissue weighting factors, 21.4% of them felt unsure, and 17.2% said that no caution should be paid to other tissues. Regarding different projections, over half of the respondents (52.9%) did not agree with the notion that radiation dose is higher in posteroanterior projections compared to anteroposterior, 28% of them agreed, and a further 19.1% were not sure about that.

Given that the younger the age of exposure the greater the risk for malignancy at older ages, respondents were asked at which age lead protection should be re-evaluated for children. Almost a third (29.5%) of them were not sure about that, followed by those who believe that lead shielding should be re-evaluated between 0-5 years old (26.4%), over 18 years old (22.5%), and 6-17 years old (21.6%).

Respondents were asked to report their perceptions of patients' worries when exposed to radiation. Most of them (70.7%) said that the patients are concerned about the risk of developing malignancies, followed by worries about gonads (21.4%), and concerns about hereditary risks (7.9%).

Finally, over half of the respondents (57.6%) were unsure if the AAPM guidance can be easily implemented, 22.4% said no, and 20% felt that it would be easily implemented in practice. Among the reasons for a challenging implementation were radiographers being hesitant to adopt new practices (49.5%), patients insisting on lead shielding use (31.9%), and other causes (18.6%). Similarly, most of the respondents (57%) were not sure if the BIR guidance can be easily implemented in practice; 24.3% of them said no, and 18.7% yes. Again, the main reasons for this could be radiographers being hesitant to adopt these guidelines (45.4%), patients insisting on lead shielding use (33.3%), and other reasons (21.3%).

Finally, most of the respondents (61.6%) said that the culture of their working environments had not influenced their practices on lead shielding, compared to 38.4% who said yes. The following graph (Fig.7) demonstrates the main themes and corresponding categories which emerged from the content analysis and highlights the factors that influence radiographers' practices the most.

Table 2 demonstrates some representative quotes from radiographers, which reflect their perceptions on lead shielding use and their recommendations for future practices.

Table 2. Representative quotes from radiographers
''There have been times that we used shielding, missed important anatomy, and repeated the x-ray. If no shielding had been used, this would not have happened''. *''Let the industry train radiographers on how to reduce the dose depending on their equipment''.* *''It should not be discontinued, but we must buy new lead protection and be educated about their optimal use at university''.* *''All stakeholders should cooperate to apply these guidelines and to inform patients regarding this practice change''.* *''We must convince the patients''.* *''Education, so we can all keep up with the changes''.* *''Radiation protection begins outside the x-ray room. It is first necessary to reduce the number of x-rays procedures. Lead shielding is the last attempt to reduce dose''.* *''Global guidelines should be issued''.* *''Shielding needs appropriate maintenance, it is heavy, and not comfortable''.* *''A bad lead maintenance is dangerous both for the radiographer and the patient. I think we must stop using it''.*

''We must convince our patients and prove that there is no need to use it anymore. We must make them trust us''.

Discussion

The poor awareness of the above major lead shielding guidelines (AAPM/BIR) noted among Greek and Cypriot radiographers clearly shows an urgent need for streamlined and coordinated information provided to these professionals. The Greek Atomic Energy Commission has aligned with the already published lead shielding guidelines [21], and radiographers should refer to them for guidance. Radiographers in this study are far less informed about the AAPM/BIR guidelines compared to a similar study recently conducted in Ireland. The Irish Institute of Radiography and Radiation Therapy and Irish Association of Physicists in Medicine have issued relevant guidance on patient lead shielding [22], and this is also true for the Society and College of Radiographers in the UK [23]. Therefore, all respective professional bodies in Greece and Cyprus must consider their position in the light of evidence, radiographer opinions, and patient needs. This is also strengthened by recent findings suggesting a European consensus statement on lead shielding, due to inconsistencies and/or lack of guidelines noted among European countries [24].

In addition, a great degree of uncertainty was noted about lead shielding cessation in CT and fluoroscopic examinations, highlighting the reluctance of radiographers to accept such practice changes on the basis that they do not optimally protect their patients and that they wish to have the choice of using the most appropriate tools. Recent research corroborates lead shielding cessation, except when its application does not affect the procedure's performance and reassures patients and carers regarding radiation protection [25]. This is strengthened by our study, as most radiographers supported its use for psychological purposes and highlighted that lead shielding approaches should be individualised. Results from clinical trials have also warned about an increased radiation dose to patients under trans-radial interventions [26]. However, caution should be paid to specific cases where the application of lead shielding in conjunction with other techniques (e.g., breast displacement) has proved beneficial for radiation dose reduction [27].

Relevant training was proven vital for optimal lead shielding practices, which justifies the importance of training/education on certain professional practices [28,29]. The significant variance that was noted between Greece and Cyprus in terms of shielding-related training raises serious concerns about optimal training in Greece at a departmental level. A significant heterogeneity in shielding education has been confirmed among radiography educators, while nowadays, it is widely accepted that radiographers are highly influenced by clinical colleagues' practices [30]. Substantial heterogeneity in radiography education in Europe [31] might have further exacerbated inconsistencies in lead shielding practices. Since most radiographers in this study have prioritised specific guidance for optimal clinical practice, radiology managers in Greece should develop specific educational strategies and protocols to ensure that all colleagues receive optimal training on lead shielding practices.

The application of lead shielding has some already reported potential risks, such as the risk of injury to radiographers or patients. Radiographers have already reported physical demand from prolonged time wearing lead shielding as an important risk [32]. In addition, recent research findings have cautioned on lead shielding use due to increased lead concentrations in hair samples of radiographers (measured with plasma mass spectrometry) working at general hospitals, compared to concentrations on administration staff [33]. Hence, thoughtful consideration should be made regarding benefits and risks when using lead shielding.

Patient age was the most frequently reported reason to influence radiographers' decision on whether to use lead shielding or not, with most of them using shielding on paediatric patients. However, caution should be paid when applying lead shielding to children since recent findings have shown that the benefits may not outweigh the potential risks of infection and image artefacts [34]. Some have argued that there is mispositioning of lead, although there is limited evidence for this [35]. Training on appropriate positioning would seem a better response to mispositioning than removal of protection. Optimal collimation must also be applied by all radiographers as an effective strategy to reduce the radiation dose to the patient [36].

High workloads and time constraints might have influenced the shielding practices followed by radiographers in this sample. Increased physical and mental demand is a global phenomenon exacerbated after the pandemic, with the healthcare workforce trying to recover from severe staff and resource shortages. However, since radiographers should always act in the patient's best interest, patient safety and care should not be compromised due to any circumstances. Finally, specific caution should be paid to the lack of lead shielding equipment that many radiographers reported, and also its suboptimal maintenance that can be hazardous both for the patient and the staff.

Limitations

This study has several limitations which can affect the interpretation of the results. First, this survey was electronically administered; hence, radiographers with limited or no access to social media might have been inadvertently excluded from this study. Also, the sample size is highly heterogeneous regarding country of origin since it mainly consists of Greek radiographers. In addition, some Cypriot radiographers are likely to have received training in Greece, whilst some Greek radiographers might have received only vocational education. Therefore, it should be noted that safe inferences cannot be made about the differences between these countries. All these may affect the generalisation of the results. Further studies with larger samples are required to confirm or reject these results. Patients should be asked their opinions and receive clear explanations about the risks and benefits of its use.

Conclusion

This study highlights the great need for an evidence-based discussion on lead shielding practices established by medical imaging departments in Greece and Cyprus. A significant heterogeneity exists between the two countries in terms of training; hence, Greek professional bodies and radiography educators should develop rigorous shielding-related training packages at academic and departmental levels. Radiographers should be better informed about recent guidance on lead shielding use and align their practices with research findings.

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