Investigating Reduced Use of Shielding in Radiologic Imaging

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Purpose To investigate if there has been an elimination of gonadal and fetal shielding during routine abdominal and pelvic imaging compared with other radiologic examination types such as torso or extremity examinations.

Methods This original, mixed-methods, pilot research study used an anonymous 22-question survey to collect data. Respondents drawn from social media groups, cold calls, and current colleagues of the author were asked to complete the survey during a 31-day period. Questions were focused on the responding technologists' demographics and when they shield patients based on examination type, age, and sex.

Results Of the 38 survey respondents, 36 stated they would not shield during pelvis imaging; 15 stated they would not shield during torso imaging; 31 stated they would not shield during lumbar imaging; and 10 stated they would not shield during extremity imaging. The survey results also showed that patients' age, sex, and risk of covering anatomy have a vital role in current shielding practices. However, 25 respondents stated that their employer does not have a different shielding protocol for male and female patients. Of the respondents, 89% reported having a rolling lap shield available for use during upright imaging studies. Findings showed that many technologists do not shield during various examinations.

Discussion This study provides a starting point for future research and acknowledges a shift in shielding practices. The findings of this study can be used by administrators and other professionals when examining their current shielding protocols.

Conclusion The results from this pilot survey show that, in addition to patient radiation dose, other important factors, such as examination type and patient age, influence a technologist's decision to shield.

Keywords | *shielding, lap shield, radiologic technology, x-ray, protocol, radiology*

X-rays were first discovered in 1895 by Wilhelm Conrad Roentgen.[1] Roentgen showcased his discovery by taking a radiograph of his wife's hand.[1] This scientific discovery quickly became a multiuse invention used in fields other than science and medicine. For example, shoemakers used radiation to check if a shoe fit.[2] After a direct connection was made between skin burns and nausea and radiation exposure, regulations were implemented to monitor radiation exposure and to protect individuals against adverse effects.[3]

Biological Effects of Radiation

The first discovered biological effects of radiation were skin burns and hair loss. These reactions were used to promote the use of radiation for cosmetic procedures such as hair removal.[4] In 1905, a decade after the discovery of x-rays, shielding for radiation was investigated. That same year, researchers found that when rabbits were irradiated, their ovaries became highly radiosensitive.[4] As research continued throughout the early 1900s, further studies were conducted on technology and radiation effects. For example, in 1926, Muller showed that radiation could induce genetic mutations that also could be inherited.[4] Radiation disasters such as Hiroshima in 1945 and Chernobyl in 1986 allowed for further research on radiation injury.[5] The effects of such injury were found to include subcutaneous tissue lesions, skin atrophy, ulceration, skin necrosis, scarring, pain, and

cancer.[5] Researchers used these disasters to further their knowledge of the stages of cutaneous radiation injury, acute radiation sickness, and possible treatments.[5]

There are 4 stages of acute radiation sickness: prodromal stage (hours after exposure), latent stage (1 to 2 days after exposure), manifest illness stage (days to weeks after exposure), and recovery or death (weeks to years after exposure).[5] However, with larger radiation doses, these stages can progress quickly. Radiation's effects on the nervous system extend beyond radiation dose to include factors such as age, sex, and genetics. Radiation starts to produce effects at levels as low as 0.05 Gy, which is the occupational exposure limit per year.[5] Exposure of 2 to 10 Gy in a short time frame is considered lethal in 50% of patients.[5] A single dose of 10 Gy is lethal to the central nervous system. For the respiratory system, 0.7 Gy is needed to produce symptoms such as respiratory distress, coughing, chest pain, and shortness of breath.[5] After initial symptoms develop, respiratory infections, pulmonary fibrosis, and lung cancer may develop as possible latent effects.[5] Radiation can produce symptoms in other areas of the body as well such as bone marrow, leading to the inability to produce more red blood cells; the gastrointestinal tract, causing vomiting and diarrhea; and the skin, causing telangiectasis and skin atrophy.[5] Recent technologies, such as improved radiation beam filtration, allow for a substantial decrease in the radiation dose needed for imaging examinations compared with that needed in the early 1900s before the development of filtration. Therefore, a modern examination that uses radiation is less harmful and of better quality than those used historically.[6]

Radiation might be used precisely and in moderation as part of a patient's treatment plan for certain diagnoses in which the benefit of radiation exposure outweighs the potential adverse effects. Radiation is directed therapeutically to destroy cancer cells. During the planning phase of radiation therapy, the pathway to the tumor must be identified to protect other organs as much as possible.[5] Because of the amount of radiation to which these patients are subjected, they do experience radiation effects. These patients usually develop radiation fibrosis syndrome, which causes them to produce excess collagen and extracellular matrices and increases their risk of developing other cancers.[5] Skin damage often results from radiation therapy. Some patients might experience more severe skin effects such as skin atrophy, ulceration, scarring, pain, and skin cancer.[5] Thus, radiation therapy is used cautiously due to the risks of short- and long-term adverse effects.

Shielding Factors and Types

Shielding is 1 of 3 factors (ie, time, distance, and shielding) that affect lower radiation doses. Shields come in many materials, colors, sizes, thicknesses, and shapes. Each shield is measured by its thickness. Lead is the most common type of material used and sets the standard for radiation absorption with the standard lead equivalence used for other materials.[7] The most common thicknesses of lead products are 0.25 mm, 0.35 mm, and 0.50 mm.[8] There are assorted shield sizes available for patients with different body habitus and for examinations of specific body parts. Technologists and other staff members wear different shields than do patients, often consisting of full body coverage and thyroid shielding when they are exposed to ambient radiation during a patient examination.

In 2019, the American Association of Physicists in Medicine (AAPM) recommended the discontinued use of gonadal and fetal shielding for all routine x-ray-based diagnostic imaging.[9] In 2021, the National Council on Radiation Protection and Measurements (NCRP) recommended ending routine gonadal shielding during abdominal and pelvic radiography.[10] These changes were recommended because of improved technology for reducing radiation exposure such as improved beam filtration, decreased exposure time, and automatic exposure controls. In addition, the change in recommendations aims to eliminate the possibility of incorrect shield placement and accidental covering of important anatomy, which would result in repeat imaging and additional radiation exposure.

In consideration of the recent AAPM and NCRP recommendations, this study aimed to determine if there has been a shift in shielding practices used by radiologic technologists.[9,10] This study explored the types of shields available, the use of shielding during specific examinations (eg, an extremity examination), and shielding practices based on age and sex. The goal of this study was to evaluate current shielding practices

during radiography examinations to determine any changes based on the updated recommendations.

Methods

This mixed-methods, pilot research study investigated the elimination of shielding used by radiologic technologists with an anonymous survey produced via SurveyMonkey, which was accessed through a subscription held by Southern Illinois University Carbondale. The survey was approved for use by the university's institutional review board (No. 24115). Based on the American Society of Radiologic Technologists (ASRT) statement on shielding guidelines, which supported the NCRP recommendations, the survey was designed to be a pilot study for future research and health care protocol determination.[10,11]

Instrument Design

Survey questions were designed to discover when technologists choose to eliminate shield use. The survey consisted of 21 multiple-choice questions and 1 comment box. The multiple-choice questions were formatted to consist of a single correct answer, multiple correct answers, or a 3-point Likert scale. Questions included:

- 3 multiple-choice questions for demographic information
- 5 questions on employer protocols and availability of shields
- 9 yes-no questions on shielding practices used during specific examinations
- 3 questions asking technologists their opinion on shielding and its effects on radiation dose and patient comfort
- 2 questions (1 yes-no question and 1 open comment box) to obtain their opinion on shielding

All responses were reviewed and accepted except for responses of no to the final 2 questions asking for the respondent's opinion. The information provided in the comment boxes was evaluated for topic relevancy and included in the report. The first comment box was a part of a multiple-choice question used to evaluate potential reasons for not shielding, and the second box was used by respondents to comment on shielding practices in general or as discussed in the survey. The opportunity for respondents to type in open-ended answers allowed for qualitative data collection to better support the overall research goal.

Participants and Procedure

Data were collected via a clickable link embedded in an email sent to respondents. Respondents were asked to read a consent statement before starting the survey; continuing with the survey was taken as consent to participate in the study. No incentive or compensation was offered for participation. The study required that respondents be employed as radiologic technologists in radiography and aged 19 years or older. The survey was sent by mass email to the author's coworkers and colleagues, the members of 3 online public radiologic technologist Facebook group pages, members of public LinkedIn pages, and those on the call lists of hospitals included in the 2023-2024 U.S. News National Best Hospital and Best Children's Hospital rankings. This survey was open from May 15, 2024, until June 14, 2024. Members on LinkedIn and the call lists were contacted once because the likelihood that they would be available for conversations was low. Three days before the survey closed, the public Facebook group members were contacted again to remind them of the close date.

Data Analysis

For this dataset, all responses (N = 38) were used. This sample size was sufficient because this research was a pilot study. There was an unknown response rate as the survey was sent anonymously to members of multiple groups with an unknown total. This study used a 2-tailed, 95% confidence interval with a P value of .05 to determine statistical significance

The statistical analysis equation used for the confidence interval for population proportion was:

$$\hat{p} \pm z_{\alpha/2} \sqrt{\frac{\hat{p}\,(1-\hat{p})}{n}}$$

The sample proportion was defined as $\hat{p}$ equals x/n, with x defined as the number of successes in n observed trials (ie, total number of answers). Furthermore, α equaled .05; z was determined by a

standard normal cumulative probability table using α divided by 2, where the result was a critical value of 1.96. The confidence interval formula was used to highlight a range of values for questions that were compared to determine a sample proportion for an unknown population group. The program R was used for data calculations and as a quality control mechanism to verify data. Percentages were used to show sample size. Whole and statistical analyses were performed on questions related to shielding for specific body parts and groups of body parts to determine the level of population confidence.

Results

A total of 38 respondents completed the survey during the 31-day survey window. Nineteen of the questions garnered responses from all 38 respondents. For some questions, respondents were instructed to skip the next question depending on their answer. Values for all statistics and analytics were based on the response rate for each individual question—not the survey as a whole—to better evaluate instances of not shielding. However, the questions that were skipped did not affect the overall study as they were optional for completion, and all responses were included in the results. Of the 38 respondents, most reported having more than 10 years of experience, having an associate degree, and working at an outpatient imaging center (see **Table**).

Table

Respondent Demographics (N = 38)

Variable	n (%)
Experience, y	
0-2	4 (10.5)
3-5	6 (15.8)
6-10	4 (10.5)
> 10	24 (63.2)
Education level	
Certificate	3 (7.9)
Associate	21 (55.3)
Bachelor's	12 (31.6)
Master's or higher	2 (5.3)
Work setting	
Community hospital	11 (28.9)
Outpatient imaging	13 (34.2)
Trauma hospital	8 (21.1)
Other	6 (15.8)

Employer Protocols

Respondents were asked if their current employer has a shielding protocol in place for employees to follow. Of the 38 respondents, 28 said yes and 10 respondents said no. Respondents were then asked if that protocol differs between male and female patients. Six responses affirmed protocol changes between men and women, 25 responses denied the presence of protocol changes based on sex, and 7 nonresponses to the question.

Respondents were asked if they would disregard their employers' protocol and shield the patient if the patient requested a shield. Most respondents (n = 25) said they were very likely to shield a patient on request; 11 respondents said they were somewhat likely to do so, and 2 respondents said they would never disregard employer protocols.

Shielding Availability

In response to the question regarding available shield options for patient use during imaging, most respondents (n = 34) said they had a rolling lap shield to place in front of patients during upright examinations, and 4 respondents said they did not have access to such a shield. For examinations not conducted in an upright position, respondents reported contact lap shields were available for use. A total of 4 respondents said they only had 1 size contact lap shield, 22 respondents said they had 2 or 3 different sizes of contact lap shields available, and 12 respondents said they had 4 or more different sizes.

Shielding Practices

The next set of yes-no questions asked respondents when and if they would attempt to shield during certain examinations regardless of the patient's sex (see **Box**). Regarding pelvic imaging, 2 respondents said they would attempt to shield the patient, and 36 respondents said they would not attempt shielding ($\bar{x}$ = 0.95; 95% CI, 0.88-1.02). Regarding torso imaging (eg, posterior

anterior chest radiograph), 23 respondents said they would attempt to shield the patient, and 15 respondents said they would not attempt shielding ($\bar{x} = 0.61$; 95% CI, 0.45-0.76). For lumbar imaging, 7 respondents said they would attempt to shield the patient, and 31 respondents said they would not attempt to shield the patient ($\bar{x} = 0.82$; 95% CI, 0.69-0.94). During extremity imaging, 28 respondents said they would attempt to shield the patient, and 10 respondents said they would not attempt to shield the patient ($\bar{x} = 0.74$; 95% CI, 0.59-0.88).

Respondents also were asked if they would shield during specific examinations when the shield lies inside or outside the field of view. A total of 5 respondents said they would attempt to shield the pediatric patient for abdominal and pelvic imaging, and 33 respondents said they would not ($\bar{x} = 0.87$; 95% CI, 0.76-0.98). For torso and extremity imaging, 29 respondents said they would attempt to shield the patient, and 9 respondents said they would not ($\bar{x} = 0.76$; 95% CI, 0.63-0.90).

Technologists' Perceptions

Respondents were asked if they believed that they shield pediatric patients (ie, ≤ 18 years) more often than they do patients older than 18 years; 27 respondents said they shield pediatric patients more often than they do adults, and 11 respondents said they did not feel they shield pediatric patients more often than they do adults.

Respondents also were asked whether shielding might be considered for men and women who are in childbearing years (ie, ≤ 50 years) compared with patients older than 50 years; 25 respondents said they shield women younger than 50 years more often than they do those older than 50 years, and 13 respondents said they do not believe there is a difference in their shielding practices for women in regard to age. Likewise, 23 respondents stated they shield men younger than 50 years more often than they do men older than 50 years, and 15 respondents stated they do not believe there is a difference in the shielding practices they use for men in regard to age.

Respondents were asked whether they believe abdominal and pelvic shielding affects repeat imaging rates. Twenty-nine respondents believed shielding for abdominal and pelvic imaging increases the repeat imaging rate, and 9 respondents stated shielding for such images does not increase the repeat imaging rate.

Box

Survey Questions Regarding Shielding Practices

1. Would you attempt to shield gonads during pelvis imaging (regardless of sex), for example anterior posterior (AP) pelvis?
2. Would you attempt to shield gonads during torso imaging (regardless of sex), for example posterior anterior (PA) chest?
3. Would you attempt to shield gonads during lumbar spinal imaging (regardless of sex), for example AP lumbar spine?
4. Would you attempt to shield gonads during extremity imaging (regardless of sex), for example PA hand?
5. Would you attempt to shield gonads during pelvis or abdominal imaging, in which the shield lies inside the field of view, if the patient is pediatric (ie, aged 0-18 years)?
6. Would you attempt to shield gonads during torso or extremity imaging, in which the shield lies outside the field of view, if the patient is pediatric?

To elaborate on respondents' opinions about not shielding, the survey asked respondents why they would choose not to shield a patient. Respondents could choose more than 1 answer; answers included:

- help control the spread of infection (n = 8)
- patient's age (n = 18)
- patient needs urgent care (n = 9)
- patient refuses a shield (n = 12)
- shielding could potentially cover the patient's anatomy (n = 35)
- too much patient movement (n = 10)

The survey also contained a comment box for respondents to provide an open-ended answer to this question. Three respondents said they may decide not to shield because the shield could cover the patient's anatomy and result in the need for repeat imaging. A patient having experienced severe trauma was noted by 1 respondent as a reason for not shielding, and 1 respondent explained in further detail:

> *Based on the nature of scatter, shielding is only appropriate when it benefits the patient. Usually, a brief explanation is satisfactory for most patients, but we accommodate any patient that insists on shielding.*

In addition, although the shielding recommendations were made by the AAPM and the NCRP, one respondent skipped the multiple-choice questions and wrote the comment, "ASRT and ARRT no longer recommend shielding patients, even if pregnant." The AAPM recommended the discontinued use of gonadal and fetal shielding for all routine x-ray-based diagnostic imaging, whereas the NCRP recommended ending routine gonadal shielding during abdominal and pelvic radiography.

The last formal question asked respondents if they had read the ASRT's statement supporting NCRP's recommendation to discontinue shielding for abdominal and pelvic imaging.[10,11] Of the respondents, 25 said yes, 12 said no, and 1 skipped this question. The last question of the survey consisted of a comment box that allowed respondents to leave feedback or other comments about the survey. Five feedback comments were left. Two were responses regarding appreciation for the survey and topic of research, and 3 were responses suggesting that more educational resources be made available to technologists to reduce misinformation and confusion about shielding because some technologists misinterpret the NCRP's recommendations and discontinue shielding for all examinations instead of discontinuing shielding only during abdominal and pelvic imaging.

Discussion

This survey's results provide an overview of radiologic technologists' current shielding practices. This survey aimed to evaluate if a change occurred in shielding practices after the NCRP recommended for the elimination of shielding during abdominal and pelvic imaging.[10] The majority of the sample group reported having more than 10 years of experience, having an associate degree, and working in outpatient imaging centers. Most of the respondents reported being employed by a company with a shielding protocol in place and that the protocol did not differentiate between male and female patients. Regarding the types of shields available for use, most respondents said they have a rolling lap shield available for use in upright examinations. Most respondents also stated they had 2 or 3 different sizes of contact lap shields available for patient use.

This study's findings show that most technologists do not shield when there is chance of covering the patient's anatomy, which supports the NCRP's recommendations.[10] This study found a statistically significant difference between technologists who would not shield a patient's gonads during pelvic and lumbar imaging but would shield a patient for torso and extremity imaging. The reason for eliminating gonadal shielding during abdominal and pelvic radiographic imaging is because the genetic effects are lower than previously estimated, and shielding might mask important anatomical findings. This comes after a reduction of the gonadal dose weighting factor from 0.25 to 0.08.[4] Studies such as Jeukens et al have shown that shielding for pelvis and abdominal imaging increases the likelihood of covering important patient anatomy, leading to an increase in repeat imaging and overall patient dose.[4] This study showed that many radiologic technologists agree that the occurrence level of repeat imaging increases in a statistically significant manner due to the incorrect placement of shields. Years of research and hospital protocols support the argument that shielding is necessary. Changing this long-standing, research-defined practice will take time and continued research supporting new protocols. Although this study shows there has been a shift in current practices since the recommendation to eliminate shielding during abdominal and pelvic imaging, more information and guidance is needed to supersede established shielding practices.

Literature from Jeukens et al, Karami et al, and Stearns et al showed that shields should no longer be used during patient imaging, which is in line with recommendations from the AAPM.[4,6,7,9] Many reasons have been given to support these recommendations. For example, the amount of radiation needed to produce 1 image has been reduced substantially compared with that needed previously.[3,4,6,12] Although the current study did not find evidence of technologists' perceptions or practices that aim to end shielding altogether, the findings demonstrate that shielding practices are changing in current procedures. Most of the respondents in the current study agreed that examination type, patient age, and reason for examination (ie, trauma or urgent care) have a bigger role in the technologist's choice to shield than does the amount of radiation being delivered.[6]

This study also found that many technologists wish more information was available to help inform patients of the decreased use of shielding during radiographic imaging. The ASRT created a task force that aims to share and spread information about radiation protection.[13] When the author performed the survey, the task force had informational videos as well as educational posters available for downloading and printing from their webpage. As of January 2026, the webpage is under construction, pending an upcoming shielding update from the NCRP.

To better answer patients' questions and understand why patients are no longer being shielded during certain examinations, technologists should read the current NCRP recommendations and closely monitor for updated recommendations.[10] When patients ask about shielding, technologists should kindly explain the reasons for the change in practice and offer patients an opportunity to read the recommendations or ask questions before the examination. Consent for imaging should happen regardless of the shielding practice used.

As increasingly more information supports eliminating abdominal and pelvic shielding, technologists and facilities should watch for supporting research or new protocols put in place by their administrations. Shielding still should be used when necessary (eg, to shield gonadal anatomy positioned outside the imaged body part or for patient comfort). For example, technologists should shield during an extremity examination on a patient who is pregnant or use a rolling lap shield during a chest examination. Until larger-scale research studies and changes in hospital protocols occur, shielding should be used when possible to reduce unnecessary radiation exposure. Technologists should continue to follow their facility's protocols to maintain standards until more research and legislation provide further information about the changes needed to support more effective shielding.

Limitations

This study has several limitations. First, a sample size of 38 is a small number to represent an estimated population of 221 000 radiologic technologists.[14] Due to the small sample size, the current study only can be used as a pilot study demonstrating that the elimination of certain shielding practices has begun. A larger sample size would allow for a better understanding of current shielding practices. Second, the data collected via the survey were self-reported, which could allow for inaccurate results due to the misinterpretation of questions or response bias. Third, there was an unknown response rate as the survey was sent anonymously to members of multiple groups with an unknown total. Fourth, shielding practices used for pediatric patients can differ greatly from those used for adult patients. Therefore, including respondents from a pediatric hospital and a hospital that treats adults and pediatric patients could have affected the results. In addition, this survey included questions that only asked what shielding the technologist would attempt to do in generic situations, rather than asking questions about specific imaging scenarios or providing specific case examples.

Future Research

Future research studies could include larger sample sizes and more in-depth questions regarding specific examination types compared with those used in the current study. This study focused mainly on the decision-making process for shielding during a few select examination types. Future research could aim to include a wider range of hospital shielding protocols or differences in shielding protocols at pediatric hospitals and adult hospitals.

Conclusion

This study aimed to understand the current shielding practices used by radiologic technologists during radiography. The findings showed that most technologists have shields available for patient use and that they choose whether to shield based on the examination type. However, many responses showed that the patient's age is a factor in choosing whether to shield. Based on the findings, some radiologic technologists still use shields during abdominal and pelvic examinations. This study also found that most technologists agree with the NCRP recommendations and that shielding during abdominal and pelvic imaging increases the repeat imaging rate. Although examinations involving radiation exposure should follow the principle of as low as reasonably achievable, shielding should be

used responsibly. The data used in the current study could be used as a basis for future research to determine shielding practices and their effects. Although some technologists have begun to move away from shielding a patient's gonads during abdominal and pelvic imaging after the 2021 recommendations from the NCRP, some facilities will require more specific research and legislation to change their protocols. Shielding during abdominal and pelvic imaging has decreased in prevalence but has not been eliminated in current practices.

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