Exploring Past to Present Shielding Guidelines

Bethany K Stearns, MS, R.T.(R)(MR)(CT), CHEP
Kristin Seitz, BSMI, R.T.(R)(MR)(CT), MRSO(MRSC)
Quest M Folck, BS, R.T.(R)(CT)

Purpose To explore the data and supporting evidence for the 2019 statement by the American Association of Physicists in Medicine (AAPM) that recommends limits to the routine use of fetal and gonadal shielding in medical imaging.

Methods Three researchers searched 5 online databases, selecting articles from scholarly journals and radiology trade publications. Search results were filtered to include literature published from January 1, 2016, to August 9, 2022, to ensure relevance and provide historical background for the 2019 AAPM statement.

Results The use of patient shielding during medical imaging did not reduce dose, and in certain instances, increased dose received by patients during computed tomography, fluoroscopy, or dental imaging. The use of shielding interfered with technology designed to reduce patient dose, including automatic exposure control and dose modulation. Research showed that errors in shield placement were common and that shields can act as sources of infection or carriers of harmful lead dust.

Discussion In each article reviewed, a compelling case was made for discontinuing routine patient shielding during radiographic procedures. Serious opposition to the discontinuation of the shielding practice was not found. Opportunities exist for further study into technologists' and the public's understanding of the effects of radiation and technologists' compliance with new shielding policies.

Conclusion The challenges with properly using shielding, paired with recent technological advancements and a new understanding of radiation protection, have negated the need for contact shielding. This legacy practice can be discontinued in clinical settings, and educational materials for technologists and students should be updated to reflect these changes.

Keywords | *gonadal shielding, patient shielding, dose reduction, automatic exposure, patient shielding recommendations*

Patient shielding, specifically gonadal shielding, was first introduced in the 1950s to protect patients from risks associated with exposure to ionizing radiation during diagnostic imaging.[1] Patient shielding is composed of lead, or a lead-equivalent material, in various shapes and is used to help absorb the scatter radiation and prevent it from reaching radiosensitive organs (see **Figure 1**).[2] When the practice of shielding was introduced, hereditary risks were the primary concern, so the emphasis was placed on gonadal shielding and little mention was made of other tissues.[1] The practice of gonadal shielding was further popularized when recommendations for gonadal shielding were added to the U.S. Code of Federal Regulations in 1976.[3] Shortly after that, the International Commission on Radiological Protection (ICRP) published weighting factors representing stochastic risks for specific tissues from whole-body radiation.[1] The ICRP assigned the gonads the highest weighting factor at 0.25. At that time, no weighting factor was assigned for sensitive organs such as the stomach or colon.[1,3,4] By this point, shielding had become standard practice in the field of radiology, to the point that when surveyed, 86% of technologists stated that they would continue to shield patients even if it violated the policy of the facility in which they were employed.[3]

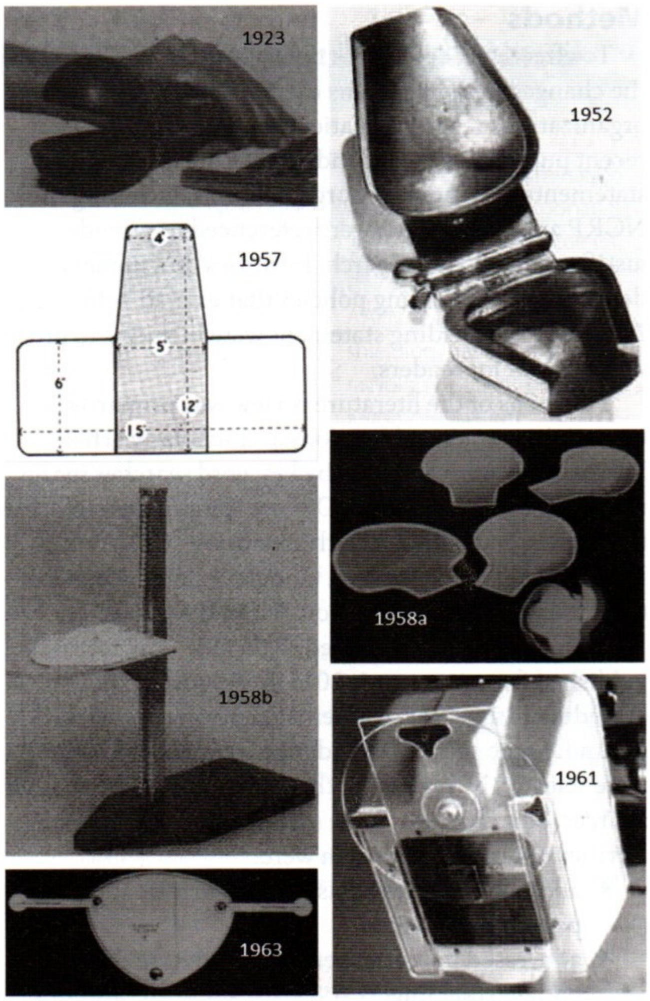

Figure 1. *Examples of gonadal shields used in diagnostic imaging with the year they were described in the literature. Reprinted under the Creative Commons Attribution 4.0 International license. Jeukens CRLPN, Kütterer G, Kicken PJ, et al. Gonad shielding in pelvic radiography: modern optimised x-ray systems might allow its discontinuation.* Insights Imaging. *2020;11(15). doi:10.1186/s13244-019-0828-1. creativecommons.org/licenses/by/4.0/*

Modern research, however, has called the practice of shielding patients into question. One reason is an overall reduction in radiation dose because of improvements in imaging technology. Technological advancements have helped decrease the amount of radiation needed to create quality images, reducing patient radiation doses by as much as 25 times (compared with those received at the time shielding was introduced).[1] These low overall doses also mean that gonadal dose is far less than when shielding was introduced.

In addition, recent studies have found no significant correlation between gonadal radiation doses received during radiography studies and heritable effects in humans.[5] Compared with the gonads, the stomach and colon are at 3 times higher risk for stochastic effects.[1] Considering these findings, in ICRP Publication 103, published in 2007, the ICRP decreased the weighting factor for the gonads to 0.08 and added weighting factors for the stomach and colon of 0.12 each.[1,3,4] With this increased knowledge of the radiosensitivity of the gonads and abdominal structures, researchers concluded that shielding the gonads is not as important as previously believed.

Gonadal shielding also is far more effective at blocking scatter radiation in male patients than in female patients, reducing its utility for women and girls. This is because the ovaries are not located in the same place in all patients, presenting challenges in positioning gonadal shields, while the testes can be correctly located and a shield properly placed over them. Placement of shielding reduces the dose to the testes by up to 95%, and gonadal shielding placed over the ovaries reduces dose by up to 50%.[4,6] However, if the shield is not properly centered over the ovaries, the shield does not protect them, and the radiation dose to the ovaries increases.[4,6]

Another key factor is that modern imaging equipment has precise collimators and dose optimization, which help to decrease patient dose. Improvements in collimation, increased requirements for beam filtration, and decreased exposure times help reduce radiation dose and maintain image quality.[3,7,8] Dose optimization predetermines the dose needed for high-quality images and terminates when the detectors have reached that dose.[1,3,4,6] Shield placement also is a concern when using dose optimization. If part of a lead shield is in the primary x-ray beam, the patient dose increases because the detectors are not receiving radiation and, therefore, the exposure will not terminate, thus increasing the patient dose.[1,3,4,6]

These findings led 2 prominent industry organizations, the National Council on Radiation Protection and Measurements (NCRP) and the American

Association of Physicists in Medicine (AAPM), to recommend that the practice of patient shielding be ended. The NCRP statement dated January 12, 2021, stated that "gonadal shielding does not contribute significantly to reducing the risks from exposure and may have the unintended consequences of increased exposure and loss of valuable diagnostic information, and therefore the use of gonadal shielding is not justified as a routine part of radiologic protection."[5] The AAPM in 2019 also recognized that lead shielding can interfere with anatomy and the use of dose optimization, specifically automatic exposure control (AEC).[9]

Because patient shielding has been a staple in radiology for decades, there is an uneasiness among the public about why shielding is not being used during imaging and a reluctance from technologists to change longstanding practices.[10] The NCRP acknowledged these concerns in a statement, noting that shielding might help ease patient concerns about radiation dose; however, it should be used after the patient has been informed of policy changes and if the shield will not obscure anatomy.[5] Technologists should educate patients about the technological advancements that have occurred in the industry and led to a reduction in patient doses. Technologists also need to explain how shielding can increase the radiation dose to the patient if the lead shield is in the primary beam. Until technologists have a firm understanding of the new shielding guidelines and can communicate the reasons for the change, the public will continue to question and have concerns about why shields are not being provided.[3,4] Even after discussion, patients might still ask to be shielded, and the technologist should do so to psychologically comfort the patient.[4,7]

This article aims to clarify the new shielding guidelines for technologists. The research that spurred changes in gonadal shielding practices is synthesized and the ways in which that research is affecting industry standards are discussed. Emphasis is placed on how shielding placement, in field and out of field, can substantially affect the radiation dose to the patient. Modalities included in this review include radiography, computed tomography (CT), fluoroscopy, and dental radiography.

Methods

To effectively determine the factors that led to the changes in the positions of prominent industry organizations regarding patient shielding, a review of recent publications was conducted. Official position statements from advisory organizations, including the NCRP and the AAPM, were referenced to provide justification for the research. Historical documents describing the shielding policies that existed before the 2019 AAPM shielding statement were included to provide context for readers.

The focus of the literature review was primarily on radiology trade publications and scholarly articles. Publications were accessed by keyword searches in the following databases: EBSCO Host, Cumulative Index to Nursing and Allied Health Literature (CINAHL) Plus, Elsevier, PubMed, and Google Scholar. Details of the database searches are provided in the **Table**.

Search results were filtered to include only research published from January 1, 2016, to August 9, 2022, excluding historical documents referenced for background. Some sources outside the filtered date range were selected by reviewing the reference lists from other sources. Search results were screened for duplicates. Further criteria for inclusion were:

- addressed implications for pediatric or adult patient populations
- addressed potential benefits or adverse effects of patient shielding
- discussed application in medical radiography, dental radiography, CT, and fluoroscopy

Nuclear medicine, radiation therapy, and nonionizing imaging modalities were excluded from the literature review. Publications that met the criteria were compiled and relevant data were extracted for the results section of the literature review. Conclusions drawn from the research and recommendations by the researchers were noted.

Results

Based on the literature search, 21 pertinent sources were selected. Of the sources identified, 10 mentioned patient shielding practices in medical radiography, 7 discussed CT, 4 referenced fluoroscopy, and 2 discussed dental radiography.

Table

Database Search Criteria Used for the Literature Review[a]

Researcher	Database(s)	Keywords
1	EBSCO Host, Google Scholar	AAPM shielding, elimination radiation shielding, gonadal shielding, radiation dose CT, radiation dose imaging
2	Elsevier, Google Scholar, PubMed	AAPM shielding, gonadal shielding, patient shielding radiology, patient shielding recommendation, radiation shielding
3	CINAHL Plus	Automatic exposure and patient shielding, patient shielding, patient shielding in radiology, dose reduction in radiology, dose reduction in CT, patient shielding in fluoroscopy, history of patient shielding in diagnostic imaging

[a] *Search results were filtered to include only research published from January 1, 2016, to August 9, 2022, excluding historical documents. Abbreviations: American Association of Physicists in Medicine, AAPM; Cumulative Index to Nursing and Allied Health Literature, CINAHL; computed tomography, CT.*

Findings from the literature review are presented by imaging modality. For each modality, findings regarding dose reduction or increase, shield placement, secondary considerations (eg, cross-contamination), and patient considerations that affect findings (eg, region of interest, age) are examined.

Radiography

Multiple publications have explored the efficacy of patient shielding during routine radiographic procedures.[3-6,10-12] In-field shielding, which involves placing a shielding device in the primary radiation beam, is 1 of the evaluated practices. In-field shielding usually is placed over the reproductive organs with the intention of reducing the dose to these structures. More than half of the selected studies on radiography explored the effect of in-field shielding during radiographic imaging.

A prominent concern among these publications was that improper in-field shield placement could obscure pertinent anatomy and lead to increased repeat studies, particularly for shields placed over the gonads (see **Figure 2**).[6] One study found that key pelvic landmarks were obscured in 43% of images obtained in the hip region when in-field shielding was used, resulting in repeat exposures.[3] A separate study showed that in-field shielding was often improperly placed during abdominal shielding, with improper placement noted in 91% of pelvic examinations on female patients and 66% of pelvic studies performed on male patients.[6] Even when in-field shielding was properly positioned based on current practice standards, shields did not protect the gonads in 85% of female patients and 52% of male patients because of anatomical variations.[5] Another study found ovarian shielding less than 20% effective because of the same anatomical variations.[4] Another author concluded that in-field shielding was mispositioned frequently because of technologist error or unpredictable anatomic variation, which rendered the shielding ineffective or detrimental.[10]

In-field shielding also was shown to increase radiation dose when used in conjunction with AEC devices. Researchers at Cincinnati Children's Hospital Medical Center noted that most radiography performed on pediatric patients uses AEC devices, which are designed to terminate the exposure after an optimal level of radiation reaches the sensors. Results showed that in-field shielding blocked these detectors, leading to an

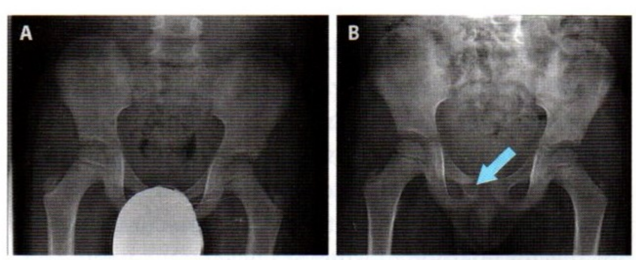

Figure 2. *Pelvic radiograph demonstrating a lead shield obstructing pathology (A). The pathology is visible once the shield is removed (B). Reprinted under the Creative Commons Attribution 2.0 Generic license. Frantzen MJ, Robben S, Postma AA, et al. Gonad shielding in paediatric pelvic radiography: disadvantages prevail over benefit.* Insights Imaging. *2012;3:23-32. doi:10.1007/s13244-011-0130-3. creativecommons.org/licenses/by/2.0/*

increased exposure time and higher radiation dose to the patient.[4] A study was performed using phantoms that had in-field shielding placed over the pelvic area during exposures made with AEC. This experiment found that because the shields partially obscured the ionization detectors of the AEC, the dose area product increased by 147% for the adult phantom.[1] Another study demonstrated that when in-field shielding was used, a 51% increase in dose to the radiosensitive organs surrounding the shield (eg, breast, colon) was seen in pediatric patients, and a 100% increase was seen in adult patients.[5]

When in-field shields were placed properly over the gonads and did not interfere with AEC devices, the benefit was marginal. Researchers found that internal scattering contributes the largest gonadal dose to patients and is not affected by the shield.[4]

The effectiveness of out-of-field shielding also was discussed in several publications. A long-held belief in the industry was that the organs, particularly the gonads, that lie outside the collimated field of view would be protected from exposure when out-of-field shielding was used. However, researchers found that most doses to these out-of-field organs resulted from internal scatter, which was not absorbed by the contact shield.[3] Another author noted that out-of-field shielding often was positioned improperly because of technologist error, leading to the shield interfering with the study and rendering the shield ineffective.[10] Samara et al stated that out-of-field shielding on head, neck, shoulder, and extremity examinations could safely be eliminated because of the distance between the primary beam and radiosensitive organs.[11]

Aside from the findings regarding dose, researchers also noted the potential for in-field shielding and out-of-field shielding to serve as reservoirs for pathogenic organisms. In 1 study, 15 lead aprons used for patient shielding were swabbed to determine the degree of microorganism contamination. All aprons tested were positive for microorganisms; *Staphylococcus aureus* and fungal spores were among those identified.[12] Concerns were raised that shields could transmit disease from patient to patient or technologist to patient.[11]

Computed Tomography

Unlike with radiography, shielding all patients during CT examinations is not a routine practice. However, research into the effectiveness of shielding during CT is warranted because many facilities shield patients who are pregnant and pediatric patients during CT because of the increased radiosensitivity of children and fetuses.[13]

The effectiveness of in-plane shielding (the equivalent of in-field shielding in radiography) was discussed in multiple resources that explored shielding practices in CT. One finding on the use of in-plane shielding during CT examinations was that using shielding often resulted in artifacts on the images that were obtained.[11] Another study found that when in-plane shielding measuring 0.25 mm (approximately 0.01 in) lead equivalent was placed over the abdomen of a pregnant phantom, the radiation dose to the fetus increased substantially, and the dose to the pregnant patient was increased by 47%.[13] The authors of the pregnant phantom study also noted that in-plane shielding could result in image artifacts. In-plane shielding over the sensitive breast tissue during CT coronary angiography resulted in a dose increase of 67.8% to the breast and 103.4% to the lung tissue.[14] In contrast, in the same study, when shielding was forgone and tube current modulation was applied alone, the dose to those tissues decreased, suggesting that the practice of shielding was detrimental. Thyroid dose reduction was negligible when in-plane shielding was used.[11] The AAPM recommended against the use of in-plane bismuth shielding and encouraged facilities to consider adopting other techniques for reducing patient dose such as scan protocol optimization.[11]

The effectiveness of out-of-plane shielding also was explored. One study showed that during CT examinations of the head and neck, the dose to the radiosensitive organs of the abdomen and pelvis was nearly imperceptible (measuring approximately 1 μGy) regardless of whether gonadal shielding was used, which rendered shielding useless.[7] One study found that dose reduction to the lens of the eye during CT was better accomplished using gantry tilt and dose modulation rather than shielding or leaded goggles.[15] Another study found that the dose reduction to the thyroid gland was insignificant when out-of-plane shielding was used and recommended that the practice be discontinued.[11] A study performed using pediatric phantoms did note a marginal decrease in dose to the patient when out-of-field shielding was used but stated that the dose reduction was not significant enough to justify the potential risks of artifacts.[16]

Researchers also found that the contact shields used during CT could serve as a reservoir for infection.[16] Because of the prevalence of nosocomial infections and the increasing occurrence of antibiotic-resistant bacterial strains, concern regarding this risk is growing.[11]

Fluoroscopy

Studies also have been performed to evaluate the effectiveness of patient shielding during fluoroscopic procedures.[3,8,11] Fluoroscopic procedures have long been considered to provide a sizeable radiation dose to patient and radiographer, so routine shielding is common. Recent research sought to evaluate whether the practice is beneficial.

In-field shielding was discussed in numerous studies. One notable finding was that when in-field shielding was used during fluoroscopy studies, the added high density of the shield could interfere with the function of the automatic brightness control system. This caused the system to drastically increase the radiation output from the tube to penetrate the shield, resulting in a significant dose increase for the patient.[3]

Out-of-field shielding also was explored in multiple articles. Phelps et al sought to determine whether out-of-field shielding would result in a reduction in the dose patients received from leakage and scatter radiation during fluoroscopy studies.[8] There was no measurable dose difference to the patient when shielding was used or not used, and the only effective measure for reducing out-of-field radiation dose was collimation.[8] Another study showed a marginal reduction in dose to the organs when out-of-field shielding was used but noted that the surrounding tissues received an increased dose.[11] Researchers emphasized that despite the small reduction in organ dose, keeping the shield in place and outside the exposure field was challenging because of the length of fluoroscopy studies and patient motion, making shielding impractical. Yet another study noted that out-of-field shielding during fluoroscopy increased entrance skin exposure, increasing the risk of radiation effects.[8]

Another factor evaluated by researchers was the possibility of the spread of hospital-borne infections via contact shields placed on patients during fluoroscopy. One study showed that shields acted as fomites, and even when proper cleaning protocols were followed, the risk of disease transmission persisted.[8]

Dental Radiography

Considerations for patient shielding during dental radiography were explored in 2 of the selected articles but no clear findings were produced.[7,17] Among the topics discussed were out-of-field shielding and potential dangers posed by the shields used during dental radiography.

One author explained that out-of-field shielding is routinely used during dental radiography in an effort to protect the thyroid.[7] Because of the difficulty of keeping thyroid shields in place during panoramic dental radiography, the shield could enter the field of view and compromise image quality; thus, some professional organizations suggest the practice be discontinued.[7] The author did state that thyroid shielding is recommended during other dental radiography procedures, particularly for pediatric patients. Lead aprons used during dental panoramic and cone-beam procedures were shown to decrease dose by less than 1 μGy and less than 5 μGy, respectively, calling their efficacy into question.[17] Shielding in the form of leaded glasses was shown to be potentially unnecessary because dental procedures resulted in doses below the 5-year dose threshold recommended by the ICRP.[7] Out-of-field shielding of the thyroid during dental CT also was discussed and recommended, despite concerns that the shield could interfere with the study.[7]

Other topics discussed were potential detrimental effects of lead shielding during dental procedures unrelated to dose. One study found that when lead shields were tested, 88% had lead dust contamination.[17] Because of the potentially harmful qualities of lead when ingested, the authors recommended further evaluation.

No articles were located that explored infection risk associated with the use of contact shielding in dental radiography specifically. However, shields composed of the same materials and used in a similar fashion as other modalities, such as radiography, CT, and fluoroscopy, were reservoirs for infection.[8,11,12,16] Therefore, although conclusive data were not obtained, infection risk from shielding can be assumed in the dental modality as well. The authors of both studies that explored dental radiography noted areas where future research was needed.

Discussion

When the AAPM issued its position statement recommending limits to the routine use of fetal and gonadal shielding in medical imaging in April 2019, many people in the medical imaging community were left with questions. For technologists, shielding was an ingrained part of clinical practice for their entire careers. Patients expected to be shielded to protect them from the harm radiation could cause. Educators instructed students about the perceived benefits of shielding, even making shielding mandatory on required competency examinations. Educational institution accrediting organizations required schools to teach shielding as a best practice, and the American Registry of Radiologic Technologists (ARRT) included shielding as part of its certification exams.

Three months after the AAPM statement, the American Society of Radiologic Technologists (ASRT) responded to its members' mounting questions regarding shielding. The organization issued its own statement recommending technologists continue shielding patients because more research was needed.[18]

By December 2019, the AAPM created the Communicating Advances in Radiation Education for Shielding (CARES) committee and published a list of frequently asked questions[9] in an effort to improve communication and reduce confusion. The CARES committee included representatives from stakeholder organizations such as the American College of Radiology, ASRT, and the Association of Educators in Imaging and Radiologic Sciences. The AAPM has since devoted a section of its website to the CARES committee and education for patients and professionals on discontinuing the practice of shielding.

By January 2021, ASRT issued a second statement agreeing that the discontinuance of fetal and gonadal shielding during abdominal and pelvic imaging was appropriate if the imaging was performed by a registered radiologic technologist.[19] In its *Spring Educator Update* that year, the ARRT issued a statement indicating that changes in shielding cannot be referenced specifically in ARRT documents because they could be adopted in varying degrees at state and institutional levels.[20] The ARRT also stated that student education on shielding and the effects of radiation should continue; however, the instruction might be more detailed than that on the ARRT examination for certification and registration.[20]

Research shows that the long-held practice of lead shielding during radiographic examinations often causes harm with no benefit. Many factors have contributed to this change, including changes in tissue weighting factors, advances in technology, and improvements in equipment performance.

Radiosensitive Tissues

Tissue weighting factors for the gonads have decreased from 0.25 in 1977 to 0.08 in 2007, making the gonads one-third as sensitive as originally thought, whereas organs such as the stomach and colon, which originally were not given weighting factors, are currently weighted at 0.12 each.[1,3,4] Therefore, providing patient shielding for the perceived radiosensitive gonads can increase radiation exposure to organs that are much more sensitive to radiation. These organs were not considered in the past because the original focus was on the perceived hereditary effects of radiation on the reproductive organs.[3]

In-Field Shielding

In-field shielding, which has been taught as a best practice for decades, provided no patient benefit, and potentially increased dose in each modality investigated. In radiography, proper placement of the shield was challenging for technologists to determine. Anatomical variations in the location of the ovaries make shielding them without obscuring the pelvic anatomy being examined almost impossible, with a success rate of between 15% and 20%.[4,5] One of the same studies found that shielding the testes was successful in 48% of examinations.[5] The widespread use of AEC increased the risk that shielding presents to patients because the lead shield might be positioned over the photocell controlling the termination of the exposure. AEC technology was not available when shielding was introduced in the 1950s. In CT, automatic dose modulation, which is designed to customize dose to the size and shape of the anatomy being imaged, makes the use of in-plane shielding ineffective. Fetal dose increased by 47% when a shield was used over the abdomen of a patient who was pregnant.[13] Shielding over breast tissue resulted in an increased dose of almost 68% to the breasts and doubled the dose to the lungs.[14] Scanning through lead shields frequently caused artifacts.[11] This could result in undiagnostic examinations, repeat imaging, and an avoidable 2-fold increase in radiation dose.

In fluoroscopy, a modality that produces larger amounts of radiation dose due to the extended time of radiation exposure, in-plane shielding also resulted in an increase in dose. Shielding was found to interfere with automatic brightness control, which was interpreted by the equipment as underexposure. To compensate, the amount of radiation was automatically increased to improve the image on the monitor.[3] These results counter the thought that in-field shielding is beneficial for the patient for each of the radiation-generating modalities studied.

Out-of-Field Shielding

Research on out-of-field shielding during radiography, performed to provide protection to organs outside of the collimated area of interest, demonstrated that it had no appreciable benefit. Studies found that much of the dose to tissues close to, but outside of, the collimated beam resulted from scatter inside the patient's body. The application of a lead contact shield has no effect on internal scatter. Improvements in beam collimation also made shielding gonads during head and extremity radiography examinations unnecessary.[11] Likewise, improvements in beam collimation in CT have made out-of-field shielding unnecessary. Dose reduction from the shielding was not significant, and the risk of artifacts from the shield accidentally sliding into the field of view and resulting in repeat imaging made the practice more unnecessary. Dose to sensitive organs like the lens of the eye can be better achieved by other means such as tilting the CT gantry or using dose modulation. In fluoroscopy, the risk of the shield slipping into the field negated the marginal dose reduction found in 1 study.[11] Collimation was the only effective method of dose reduction for fluoroscopy.[8] In dental radiography, out-of-field thyroid shields were challenging to keep out of the area of interest, so some professional dental organizations recommend discontinuing use for all adult patients.[7] Lead aprons also were unnecessary due to the minimal dose to the patient's torso from improved technology in dental radiography equipment.

Infection Control

Although most research focused on radiation dose, a relationship between lead shields and infection control also was explored. Several studies found that lead shields harbor pathogens. Studies of shields used in radiography and CT found that shields tested positive for microorganisms, including *Staphylococcus aureus* and fungal spores.[12] This raises concern for nosocomial infections in the current environment of antibiotic-resistant bacteria. In addition, a study of shields used in dental radiography found lead dust surface contamination on most of the samples.[17]

Findings

There were discrepancies between the perceived benefits of lead shielding and the actual effects of shielding. In all studies, doses were unaffected or increased by using shielding. Several factors contributed to these outcomes. Modern technological advancements (eg, AEC, dose modulation) increased x-ray tube shielding, and CT gantry tilt were more effective in reducing dose than was shielding. In addition, data used to justify the AAPM decision were not communicated clearly to imaging professionals when its statement was released. This resulted in confusion when they recommended changes to a legacy of medical imaging processes.

Gaps in Research

To be thorough, attempts to search for studies that supported the continuation of the practice of shielding were made. The authors were unable to find scientific studies and found 1 point–counterpoint debate article that supported the continuation of shielding.[10] However, the physicist in opposition to discontinuing shielding was an author of other articles recommending the practice be discontinued. This brought into doubt his opposition, which might have been performative or debate for debate's sake. The difficulty in finding literature supporting shielding might be because opposition to the change does not exist, or because researchers in opposition are not willing to publish their thoughts or findings.

Findings also might have been skewed by using sources primarily from the United States, where these guideline changes originated. Regulatory organizations outside of the United States could have different positions. If there was opposition, it was not identified in the literature.

Opportunities for Further Study

There are several opportunities for further research on shielding. As front-line staff tasked with discontinuing lead shielding, technologists must be aware of the justifications for the change. Research will be needed to determine the level of understanding technologists have and whether this understanding affects the level of compliance with agency recommendations. Inconsistent adherence to the guidelines will perpetuate confusion among the public. As demonstrated by the research, shielding for the psychological benefit of patients has the potential to cause harm through increased radiation dose and spread of infection. Technologists also must understand the reasoning behind the decision so the information can be communicated to patients. This could be cumbersome at first but should get easier with time. Inconsistent adherence also could make future studies into patient radiation dose challenging. Results could be inflated artificially by the continued improper use of unnecessary shielding and lack of standardized processes.

The current generation of radiography students will be the first to be taught new shielding practices during their educational experience. Discovering how these new technologists deal with patients who have become accustomed to being shielded by current technologists might be useful. As future generations of patients without the expectation of shielding seek care, technologists will be able to rely on skills and technological advancements to decrease dose, rather than physical shielding.

There also is opportunity for research into the public perception of radiation and its effects. Unfounded fear of radiation is common, with the public equating the radiation used in medical imaging with the radiation used in nuclear warfare. Improved education for the public should help ease concerns about the effects of radiation, making the experience with medical imaging procedures more positive. This could help to ease some of the burden on technologists in explaining why shielding is no longer necessary.

Conclusion

Standardization is needed among technologists, medical facilities, and educational institutions about the new shielding recommendations. Although some facilities are changing policies to reflect the new recommendations by not shielding patients, they are not educating the staff. Other facilities are not updating shielding policies, and technologists shield patients for every examination. Although ARRT has instructed educational institutions to continue instructing students about gonadal shielding, many students are told not to shield when at clinical sites. Technologists, medical facilities, and educational institutions need to agree to adopt the same policy to reduce confusion.

Bethany K Stearns, MS, R.T.(R)(MR)(CT), CHEP; Kristin Seitz, BSMI, R.T.(R)(MR)(CT), MRSO(MRSC); and Quest M Folck, BS, R.T.(R)(CT); are graduate students in the Master of Science Radiologic Sciences program at Southern Illinois University in Carbondale.

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