ISSN: 2572-3235

Ramirez L. Int J Radiol Imaging Technol 2025, 11:136
DOI: 10.23937/2572-3235.1510136
Volume 11 | Issue 2
Open Access

International Journal of Radiology and Imaging Technology

LITERATURE REVIEW

Best Methods to Reduce Unnecessary Radiation Exposure

Liliana Ramirez*

Radiologic Sciences, Midwestern State University, USA

***Corresponding author:** *Liliana Ramirez, 201 W. University Blvd., Odessa, Tx 79764, USA, Tel: 432-335-6449*

Abstract

The role of a radiographer is to create diagnostic quality images using different forms of radiation. Radiography uses x-rays to create radiographic images, which can cause biochemical changes. It is the ethical and legal responsibility of a radiographer to follow radiation protection practices and the concept of ALARA, as low as reasonably achievable, and protect the patient from unnecessary radiation. Radiographers used their professional judgement and knowledge and shielded patients from unnecessary radiation. Reports and statements by different organizations have caused significant changes in the practice of fetal and gonadal shielding, and the use of fetal and gonadal shielding are no longer recommended during all radiographic procedures. The Midwestern State University Moffett Library was used to access CINAHL and Medline articles to search for other radiation protection methods. Appropriate radiation practices were using proper collimation, selecting appropriate technical exposure factors, practicing image appropriateness to reduce unnecessary radiation to patients, creating a positive patient safety culture, and implementing reject and repeat analysis procedures. Gonadal shielding was a principal concept of radiation protection and radiographers should use their professional judgement, knowledge, and critical thinking and use all radiation protection methods to protect patients. Future research should explore other radiation protection tools implemented to protect patients from unnecessary radiation such as digital quantum efficiency of imaging receptors and collimation as dose reduction tool.

Introduction

The role of the radiographer is to create diagnostic quality images and to be an expert in radiation protection [1]. Based on the radiation protection concept of ALARA, as low as reasonably achievable, unnecessary radiation exposure should be avoided [2]. The American Association of Physicists in Medicine (AAPM) published a statement in April 2019 and recommended stopping the use of fetal and gonadal shielding during all radiographic imaging using ionizing radiation [1]. The position was later endorsed by the American College of Radiology (ACR) and other organizations [1]. The National Council on Radiation Protection and Measurement (NRCP) recommended that gonadal shielding should be discontinued for abdominal and pelvic imaging.1 In early 2021, the American Society of Radiologic Technologists (ASRT) published its own statement and acknowledged that shielding the fetus and gonads during abdominal and pelvic radiography imaging should be discontinued but should be continued during radiographic imaging when shielding is appropriate and aligned with minimizing radiation exposure [1].

Gonadal shielding was a principal concept of radiation protection, and conflicting statements have made it a challenge for radiographers [1]. Radiographers should use their professional judgement, knowledge, and critical thinking to implement all methods and tools designed to reduce unnecessary radiation exposure [1]. This new position of gonadal shielding has caused medical imaging professionals to re-examine best practices in reducing unnecessary radiation exposure. Methods and tools designed for radiographers and institutions to reduce unnecessary radiation exposure included applying proper collimation, selecting proper technical exposure factors, practicing image appropriateness, creating a positive patient safety culture, and implementing programs like reject and repeat analysis to reduce unnecessary radiation to patients. Further research is needed to explore other dose-reduction methods such as digital quantum efficiency of image receptors and how collimation can more efficiently reduce dose, especially scatter.

Citation: Imene B, Khaoula B (2025) Enhancing Pulmonary MRI Imaging through an Ann-Based Approach. Int J Radiol Imaging Technol 11:135. doi.org/10.23937/2572-3235.1510135

Accepted: July 25, 2025: **Published:** July 29, 2025

Methods

The Midwestern State University Moffett Library's academic databases were used to access CINAHL and Medline articles to search for the best methods to reduce unnecessary radiation exposure. The research topic was selected due to the recent changes made to the common practice of fetal and gonadal shielding. The following key words were used: gonadal shielding, collimation, technical exposure factors, radiation protection, radiation safety, patient safety, patient radiation exposure, and image appropriateness, repeat and reject analysis, unnecessary radiographs, unnecessary radiation exposure, radiation protection culture, and decreasing radiation exposure. Both the CINAHL and Medline search was limited to peer-reviewed articles in academic journals written in English within the past 6 years. The search resulted in 22 articles, and 19 articles were selected that were available in full text and relevant to the research question. Articles that did not contain any relevant information or that had duplicated information were eliminated.

Literature research was conducted to answer the question, "What are the best methods to reduce unnecessary radiation exposure". The following themes were identified: gonadal shielding, collimation, technical exposure factors, image appropriateness, reject and repeat analysis and patient safety culture.

Gonadal shielding

Gonadal shielding absorbs scatter radiation and prevents it from reaching radiosensitive organs [3]. The (NCRP) stated that gonadal shielding did not significantly contribute to reducing radiation exposure and instead may increase it or cause loss of diagnostic information and therefore should not be a routine radiation protection practice [3]. The AAPM also stated that gonadal shielding could interfere with the anatomy of interest and automatic exposure control (AEC) [3]. The ASRT Board of Directors published a statement concluding that gonadal shielding during abdominal and pelvic radiographic imaging increased the risk of repeat radiation exposure but supported the continued use of gonadal shielding when appropriate [1]. A study by Kaplan, et al. [4] concluded that gonadal shielding used with AEC during both male and female pelvic imaging increased patient radiation exposure to all organs within the path of the primary beam because of the intentional shadowing of the AEC sensors by the gonadal shields.

Collimation

According to the principles of ALARA, radiographers had the responsibility to reduce radiation exposure by limiting the size of the x-ray beam to the specific anatomy of interest, a practice known as collimation [5]. Satharasinghe, et al. [6] performed a study that focused on the use of collimation and radiation exposure and concluded that appropriate collimation was essential to reduce unnecessary radiation exposure. The causes of unnecessary radiation exposure during radiographic imaging to neonates in the neonatal intensive care unit have not been explored or identified until a retrospective cohort study conducted by Su, et al. [7] The result of the Su, et al. [7] study was that some of the reasons for unnecessary radiation exposure were improper positioning and improper collimation. The study identified possible solutions that included following protocols, proper training, and using immobilizers that minimized unnecessary radiation exposure [7]. A study conducted by Ploussi, et al. [8] provided an overview of radiation exposure in pediatric patients during interventional procedures. The study focused on the growing use of image guided interventional techniques like fluoroscopy for diagnosis and treatment and concluded that one of the main dose reduction techniques was collimation to limit the x-ray field size to the area of interest [8].

Technical factors

The selection of technical exposure factors affects radiographic image quality and interpretation, and radiographers must follow the principles of ALARA and select the lowest technical factors that are sufficient enough to create a diagnostic quality image [9]. Shahgeldi, et al. [9] aimed to reduce unnecessary radiation in digital pediatric chest imaging by varying exposure factors in pediatric phantoms and concluded that lower exposure factor settings could be used to reduce radiation exposure by 35% without decreasing image quality. Abbeyquaye, et al. [10] conducted a study that used computed radiography to determine if technical exposure factors affected radiation exposure when a phantom pelvis was exposed and technical factors that included focus to detector distance were adjusted. Abbeyquaye, et al. [10] concluded that exposure factors have a direct influence on dose. To decrease exposure dose, the authors used the same kVp and mAs but increased the focus to detector distance [10]. This, however, decreased image quality [10]. To reduce radiation exposure dose the authors recommended that measures that reduce patient dose should be taken unless they compromise image quality [10]. The study also highlighted the need for ongoing dose monitoring, quality control, and applying the principles of ALARA to reduce radiation exposure [10]. Technical factors influenced radiation exposure and radiographers needed to select the correct exposure factors that created a quality diagnostic image and reduced unnecessary radiation exposure [9].

Image appropriateness

Imaging exams that use ionizing radiation must be ordered based on certain clinical indications to protect the patient from unnecessary radiation exposure [8]. According to the ASRT Practice Standards, radiographers were responsible for verifying that correct and clinically

necessary images were ordered because image appropriateness was essential for radiation protection [11]. Unnecessary images created unnecessary radiation exposure and according to the principles of ALARA unnecessary radiation exposure should be avoided [2]. Ashikyan, et al. [2] looked at reducing unnecessary repeat knee radiographs during osteoarthrosis follow-up appointments and concluded that focused interventions decreased 50% of unnecessary repeat knee x-rays during routine follow-up visits which reduced unnecessary radiation. As one of their Choosing Wisely initiatives, the Critical Care Societies conducted a project that strived to decrease the use of daily chest x-rays on intubated patients in the pediatric intensive care unit [12]. The project included implementation of specific criteria for image appropriateness and concluded that some intubated patients in the pediatric intensive care unit receiving a daily screening chest x-ray did not need daily chest x-rays; through the development and implementation of other methods, to check lung issues, unnecessary exposure was reduced [12].

A retrospective cohort study conducted by Su, et al. [7] investigated the reasons behind unnecessary radiation exposure during radiologic examinations in neonatal intensive care units [7]. One of the findings was the discrepancy between the imaging orders and the procedures carried out [7]. The study concluded that following protocols or using ultrasound as the first option as an imaging tool could reduce unnecessary radiation exposure in neonatal intensive care infants [7]. After conducting a study looking into the perceptions of imaging appropriateness among radiographers, Moore [13] concluded that radiographers needed to work with one another to enhance the appropriateness of imaging orders and suggested using clinical decision support mechanisms to reduce unnecessary radiation exposure. Radiographers had the responsibility to ensure the proper exams were ordered and needed to be involved to ensure image appropriateness and decrease unnecessary radiation exposure to patients [11].

Reject and repeat analysis

Repeat radiographic images increased radiation exposure and radiographers must limit repeats to reduce unnecessary radiation exposure to patients [14]. Reject and repeat analysis should be implemented in imaging departments to identify imaging mistakes, incorrect practices, and sources of errors [14]. Radiology departments generate large amounts of data including repeat and reject rate analysis data to be used to increase internal examinations of radiographic quality [15]. To reduce unnecessary radiation exposure to patients, a data driven approach could be used for continuous improvement and to establish a quality and safety committee to define and track metrics [15]. Both radiographers and the institutions had the responsibility to reduce unnecessary radiation exposure, and implementing a system to track and reduce repeats would help accomplish this [15].

Radiation safety culture

The Health and Safety Commission defined the safety culture of an organization as the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to and the style and proficiency of an organization's health and safety management [16]. For optimal radiation safety practices in the field of radiology, the correct culture is necessary to support safety initiatives and create accountability in the field, empowering technologists to lead continual quality improvement efforts [17].

Azyabi, et al. [18] analyzed data from the 2018 Agency for Healthcare Research and Quality Hospital Survey on Patient Safety Culture and found that a positive safety culture had a significant influence on the overall perception of patient safety and concluded that fostering a positive safety culture can improve healthcare outcomes. Hesgrove, et al. [16] (2024) concluded that workplace safety culture and patient safety culture were connected, and strong leadership and adequate resources were integral to enhance a strong and healthy culture of safety. Azyabi, et al. [18] retrospective study used a sample from the Agency for Healthcare Research and Quality HSOPSC 2081 database and determined that a positive patient safety culture significantly influenced safety outcomes and overall perceptions of patient safety. In 2023, Moore [17] concluded that perceptions of radiation safety were different among the different imaging modalities and interdisciplinary teamwork needed to be considered to advance modality-specific radiation safety actions. Moore and Bruno [19] concluded that leadership must place a greater emphasis on cultivating and maintaining the safety culture in their organization along with consistent messaging and teamwork-building and in-service education on radiation safety.

Conclusion

The role and responsibility of a radiographer is to protect the patient from unnecessary radiation exposure. For years, gonadal shielding was a central concept of radiation protection. The recent changes have created a significant change in gonadal shielding but not in the practice of protecting the patient from unnecessary radiation. Radiographers must continue to practice radiation protection by understanding and implementing the best methods to reduce unnecessary radiation exposure which include proper collimation, proper gonadal shielding, selecting proper technical exposure factors, and practicing image appropriateness to reduce unnecessary radiation to patients. Institutions also have a responsibility to protect patients from unnecessary radiation by creating a positive patient

safety culture and implementing programs like reject and repeat analysis culture. Future research is needed to determine what other methods can further reduce patient dose. Although beyond the scope of this paper, digital quantum efficiency of image receptors could be a method to reduce patient dose and should be investigated. Also, more evidence of how collimation works to filter the primary beam and clean up scatter should be gathered as a method to reduce patient dose.

Acknowledgements

The author wishes to express sincere gratitude to the faculty and staff of the Radiologic Sciences program at Midwestern State University for their support and guidance throughout this research. Special thanks to the Moffett Library for providing access to academic resources and databases essential to the literature review.

There are no conflicts of interest to declare, and all research complied with applicable institutional and ethical guidelines.

References

1. Bryan W, DeMaio D, George C, Moore GK, Moore QT, et al. (2022) Update on the elimination of fetal and gonadal shielding during abdominopelvic radiography. Radiol Technol 94:143-150.
2. Ashikyan O, Buller DC, Pezeshk P, McCrum C, Chhabra A (2019) Reduction of unnecessary repeat knee radiographs during osteoarthrosis follow-up visits in a large teaching medical center. Skeletal Radiol 48: 1975-1980.
3. Stearns BK, Seitz K, Folck QM (2023) Exploring past to present shielding guidelines. Radiol Technol 95: 84-93.
4. Kaplan SL, Strauss KJ, Magill D, Felice MA, Francavilla ML, et al. (2020) Quantification of increased patient radiation dose when gonadal shielding is used with automatic exposure control. J Am Coll Radiol 17: 1698-1704.
5. Toussant K, Khan T, Velez CK, Alicea C (2023) Importance of collimation for image quality and radiation exposure. Radiol Technol 94: 206-207.
6. Satharasinghe D, Jeyasugiththan J, Jeyasuthan M, Amalaraj T, Abeyweera AL, et al. (2021) Impact of collimation on radiation exposure in adult and paediatric digital x-ray imaging. Radiat Prot Dosimetry 197: 19-27.
7. Su YT, Chen YS, Yeh LR, Chen SW, Tsai YC, et al. (2023) Unnecessary radiation exposure during diagnostic radiography in infants in a neonatal intensive care unit: A retrospective cohort study. Eur J Pediatr 182: 343-352.
8. Ploussi A, Brountzos E, Rammos S, Apostolopoulou S, Efstathopoulos EP (2021) Radiation exposure in pediatric interventional procedures. Cardiovasc Intervent Radiol 44: 857-865.
9. Shahgeldi K, Sjöberg T, Nordström J, Lesanu R, Svahn TM (2019) Optimizing image quality, radiation dosage to the patient and to the detector in pediatric chest radiography: A phantom study of a portable digital radiography system. Radiat Prot Dosimetry 185: 414-420.
10. Abbeyquaye D, Inkoom S, Hammond NB, Fletcher JJ, Botwe BO (2021) Patient dose assessment and optimisation of pelvic radiography with computed radiography systems. Radiat Prot Dosimetry 195: 41-49.
11. Moore QT (2022) Radiologic technologists' perceptions of imaging appropriateness in radiography, CT, and mammography. Radiol Technol 93: 437-453.
12. Malin SW, Maue DK, Cater DT, Ealy AR, McCallister AE, et al. (2023) A quality improvement initiative to reduce unnecessary screening chest radiographs in a pediatric ICU. Respir Care 68: 1377-1384.
13. Moore QT (2022) Radiologic technologists' perceived reasons for inappropriate imaging. Radiol Technol 93: 532-543.
14. Spence B (2023) Using a repeat analysis project in radiography education. Radiol Technol 94: 294-295.
15. Anaskevich LK, Kanal KM, Zhang J (2022) Data-driven quality and safety programs in radiology. Radiol Technol 93: 566-572.
16. Hesgrove B, Zebrak K, Yount N, Sorra J, Ginsberg C (2024) Associations between patient safety culture and workplace safety culture in hospital settings. BMC Health Serv Res 24: 568.
17. Moore QT (2023) Perceptions of radiation safety culture among radiography, computed tomography, and mammography technologists. Radiol Technol 95: 17-25.
18. Azyabi A, Karwowski W, Hancock P, Wan TTH, Elshennawy A (2022) Assessing patient safety culture in United States hospitals. Int J Environ Res Public Health 19: 2353.
19. Moore QT, Bruno MM (2023) Effects of work shift or shift length on radiation safety perception. Radiol Technol 94: 409-418.