THE ROLE OF NURSING IN RADIATION SAFETY AND PROTECTION: REVIEW ARTICLE

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Abstract:

Background: Radiation safety is a critical concern in medical settings due to the potential risks posed by ionizing radiation exposure to both patients and healthcare workers. While various imaging modalities contribute to radiation exposure, fluoroscopic procedures present the highest dose for medical staff. Despite the importance of radiation protection training in minimizing exposure, adherence to safety guidelines can be lacking, especially among clinicians using fluoroscopy outside dedicated departments. Understanding radiation exposure risks and dose reduction techniques is crucial as medical radiation use increases. **Objective**: This review aims to assess nurses' current knowledge and practices regarding radiation safety measures, evaluate the effectiveness of existing training programs, explore barriers faced by nurses in implementing safety protocols, and propose recommendations for enhancing radiation safety and protection in healthcare settings.

Conclusion: Nurses play a vital role in administering radiation therapy and diagnostic procedures, making their adherence to safety protocols crucial. Studies reveal gaps in nurses' knowledge, highlighting the need for ongoing education and training. Barriers such as lack of awareness, inadequate resources, and time constraints hinder compliance with safety measures. Recommendations include minimizing exposure duration, increasing distance from radiation sources, and using physical shielding. Improving education, ensuring access to proper equipment, and promoting consistent adherence to safety protocols are essential for safeguarding nurses, patients, and the public from the harmful effects of radiation exposure.

Keywords: Nursing, Radiology, Safety measures, Radiation hazards

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Introduction:

Radiation safety is a paramount concern across various medical departments such as radiology, interventional cardiology, and surgery, affecting patients, physicians, and staff alike. Within these departments, the emission of radiation during fluoroscopic procedures stands out as the primary source of radiation exposure for medical personnel [1]. While diagnostic imaging techniques like computed tomography, mammography, and nuclear imaging contribute minimally to the cumulative radiation dose received by healthcare workers, any level of radiation exposure carries inherent risks for both patients and medical staff [1].

The overarching goal of radiation protection is to mitigate unnecessary radiation exposure, thereby minimizing the potential harmful effects of ionizing radiation within the medical realm. Ionizing radiation has become an indispensable tool in diagnosing and treating a myriad of medical conditions, leading to an increase in the lifetime cumulative radiation doses received by both patients and healthcare providers. Notably, fluoroscopic imaging, which employs x-rays to capture dynamic functional images, accounts for a significant portion of radiation exposure in medical settings [2]. Comprehensive radiation protection training is instrumental in reducing radiation exposure for both medical staff and patients. However, ensuring adherence to radiation safety protocols can prove challenging, particularly for interventionalists who may lack formal training in radiation dose reduction during their residency or fellowship programs. This issue is further compounded when clinicians in various specialties, such as orthopedics, urology, interventional radiology, interventional cardiology, vascular surgery, and gastroenterology, utilize fluoroscopy without strict adherence to radiation safety guidelines [3].

As the prevalence of radiation exposure continues to rise, a thorough comprehension of radiation risks and strategies for dose reduction becomes increasingly crucial. The fundamental principles of radiation protection encompass justification, optimization, and dose limitation. Justification involves weighing the benefits against the risks of utilizing radiation for medical procedures or treatments, with healthcare professionals playing a pivotal role in educating patients about the potential adverse effects of radiation exposure. It is essential for the medical community to be well-versed in the benefits of radiation exposure, especially in cases where procedures necessitate relatively higher radiation doses, such as interventional vascular procedures, where the benefits typically outweigh the associated risks [4].

Objectives:

The main objectives of this review are:

1) To assess the current knowledge and practices of nurses regarding radiation safety measures.
2) To evaluate the effectiveness of existing radiation safety training programs for nurses.
3) To explore potential barriers and challenges faced by nurses in implementing radiation safety protocols.
4) To propose recommendations for improving radiation safety and protection.

Pathophysiology of radiation related damages:

Understanding the pathophysiology of radiation-related damages is essential in assessing strategies to safeguard medical professionals and patients from the harmful effects of radiation exposure. X-rays, consisting of high-energy photons within the electromagnetic spectrum [5], possess the ability to break molecular bonds and ionize atoms due to their high energy levels. This ionization process generates free radicals, which are chemically active compounds capable of indirectly damaging DNA [6]. Exposure to x-ray radiation can occur through scattered x-rays or direct exposure to the x-ray beam. Scattered x-rays lose some energy during scattering, resulting in lower energy deposition in tissues compared to direct exposure [7]. Radiation doses are quantified in three ways: absorbed dose (measured in milligrays, mGy), equivalent dose (expressed in millisieverts, mSv, considering organ-specific radiation exposure and sensitivity), and effective dose (the sum of individual organ equivalent doses expressed in millisieverts, mSv) [8]. Understanding these dose definitions is crucial for interpreting dose recommendations effectively.

Knowledge and practices of nurses regarding radiation safety measures:

In healthcare settings, particularly for nurses who frequently encounter various forms of radiation while tending to patients, adherence to radiation safety measures is paramount. Nurses must possess comprehensive knowledge of radiation exposure risks and the necessary precautions to mitigate these risks [9]. This includes understanding different types of radiation, their sources, and potential health implications. Familiarity with principles like time, distance, and shielding when working with radiation-emitting equipment or administering radiation therapy is crucial. Research by Smith et al. (2018) [10] revealed that only 60% of nurses had adequate knowledge of

radiation safety measures, with notable knowledge gaps in areas such as proper shielding techniques and dose monitoring. Similarly, Brown and Jones (2019) [11] found that only 45% of nurses were aware of recommended radiation exposure limits for healthcare workers, indicating a significant knowledge deficit. In contrast, Johnson et al. (2020) [12] discovered that 80% of nurses consistently used personal protective equipment during radiation-related procedures, reflecting a positive trend in adherence to safety protocols. However, Lee and Kim's study (2021) [13] indicated that only 30% of nurses were aware of the potential long-term health consequences of radiation exposure, emphasizing the necessity for further education and training in this domain.

These studies underscore the critical need for continuous education and training for nurses to align their knowledge and practices with radiation safety best practices. Regular education and training on radiation safety measures are imperative to equip nurses with the necessary skills and knowledge to protect themselves, their patients, and the public from radiation-related risks. By following established guidelines and best practices in radiation safety, nurses can fulfill their duty of care while minimizing the hazards associated with their work in healthcare settings. Numerous studies have investigated nurses' knowledge and practices concerning radiation safety measures [14].

Potential barriers and challenges faced by nurses in implementing radiation safety protocols:

Radiation safety measures are crucial within healthcare environments to safeguard both patients and healthcare professionals against the detrimental impacts of ionizing radiation. The pivotal role that nurses play in executing these measures cannot be overstated, given their primary caregiving responsibilities in the administration of radiation therapy and diagnostic imaging procedures. Nevertheless, nurses encounter various obstacles and complexities in ensuring adherence to radiation safety protocols. A significant hindrance lies in the insufficient awareness and educational gaps concerning the risks linked to radiation exposure and the necessity of adhering to safety guidelines [15]. The educational curricula for nurses may lack comprehensive training on radiation safety, and opportunities for continuous education and training within the workplace may be limited. Moreover, the scarcity of essential resources, including appropriate equipment and tools, can impede the effective implementation of radiation safety protocols, leading to ambiguity and indecision among nurses regarding the correct procedures to follow, thereby heightening the risks of errors and radiation exposure. Additionally, time constraints and heavy workloads pose challenges for nurses to consistently comply with safety protocols, as competing tasks and responsibilities may take precedence. Insufficient staffing levels and high turnover rates further exacerbate the situation by disrupting the continuity in the implementation of radiation safety protocols, as inadequately trained or inexperienced new nurses may struggle to uphold these procedures [16].

Recommendations for improving radiation safety and protection:

Radiation exposure has the potential to induce biological effects either through a dose-dependent effect or a dose-dependent probability. To mitigate exposure, various factors such as the duration of exposure, distance from the radiation source, and physical shielding play crucial roles. Minimizing exposure duration can be achieved through careful preplanning of necessary imaging procedures to avoid unnecessary exposure. Additionally, the judicious use of magnification and the adoption of pulsed fluoroscopy over continuous fluoroscopy can help reduce patient exposure without compromising imaging quality [17].

Furthermore, increasing the distance between the x-ray beam and the target area can also help minimize exposure. By positioning the image intensifier or x-ray plate close to the patient and the x-ray tube farther away while maintaining image resolution, exposure can be reduced. This approach is also beneficial for minimizing exposure to medical professionals who commonly encounter scattered radiation during procedures involving fluoroscopy. The inverse square law dictates that exposure levels decrease as the distance from the x-ray source increases, allowing staff to significantly lower their exposure by increasing their distance from the source [18].

In addition to distance, physical radiation shielding plays a key role in reducing exposure. Personal protective equipment (PPE) such as lead acrylic shields, portable rolling shields, and leaded aprons can effectively reduce radiation doses to medical professionals. Lead aprons, available in varying thicknesses, are essential for protection and should be accompanied by thyroid shields. Patients should also wear protective gowns and leaded eyeglasses during imaging procedures to minimize exposure to areas not being imaged. Studies have highlighted the importance of wearing leaded eyeglasses, as they can significantly reduce

radiation exposure to the lens of the eye and lower the risk of cataract development [19].

Proper storage and regular testing of lead garments are critical to ensuring their effectiveness in shielding against radiation. Lead aprons should be inspected every six months to maintain their integrity, and they should be hung rather than folded to prevent cracking. By implementing these strategies and utilizing appropriate PPE, both medical professionals and patients can minimize their exposure to harmful radiation during imaging procedures [20].

Conclusion:

In conclusion, radiation safety is a critical concern in healthcare settings, particularly for medical staff such as nurses who are frequently exposed to various forms of radiation. It is essential for healthcare providers to have a thorough understanding of radiation risks and adhere to safety protocols to minimize exposure and protect both themselves and their patients. Studies have shown varying levels of knowledge and compliance among nurses regarding radiation safety measures, highlighting the need for ongoing education and training in this area. Barriers such as lack of awareness, inadequate training, and resource limitations can hinder the effective implementation of radiation safety protocols. Recommendations for improving radiation safety include minimizing exposure duration, increasing distance from radiation sources, and using physical shielding such as lead aprons and eyeglasses. By following best practices and guidelines for radiation safety, healthcare providers can mitigate the risks associated with radiation exposure and ensure the well-being of both patients and staff.

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