Opinion Article

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Evaluating Radiation Exposure and Risk Assessment in Pediatric Radiology

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Description

Pediatric radiology is an essential ield in medical imaging, where radiographic techniques aid in diagnosing and monitoring various conditions in children. However, due to the inherent vulnerability of children to ionizing radiation, the evaluation of radiation exposure and effective risk assessment are important. Children's tissues are more sensitive to radiation than adults and they have a longer life expectancy, raising the potential for radiation-induced effects to manifest over time. Understanding how to manage and mitigate these risks is vital for healthcare professionals to ensure the safety of young patients. Radiology in pediatric care includes diverse imaging modalities, including X-rays, Computed Tomography (CT), nuclear medicine scans and luoroscopy. All of these involve varying degrees of radiation, with CT scans generally emitting higher levels compared to conventional X-rays. Due to their smaller body size and higher metabolic rate, children are at a greater risk for radiation-induced biological damage, making it vital to limit their exposure. Furthermore, research suggests that children who undergo multiple imaging procedures may accumulate signi icant radiation doses over time, increasing their susceptibility to long-term risks, such as malignancies. Consequently, implementing risk assessment strategies and adopting radiation protection principles like ALARA (As Low As Reasonably Achievable) are critical in pediatric imaging. These occur randomly and their probability, not severity, increases with dose. Examples include cancer and genetic mutations. Since children have a longer post-exposure life expectancy than adults, the cumulative risk of stochastic effects is higher. These effects have a threshold below which they do not manifest. Above this threshold, their severity increases with dose, potentially leading to conditions like skin burns or cataracts. Although deterministic effects are less common in diagnostic radiology, they remain a risk during procedures like prolonged luoroscopy.

Radiation dosage in pediatric imaging

Radiation dose in pediatric imaging is measured in various units, including millisieverts (mSv) and Grays (Gy), depending on the type of procedure. A child's radiation dose depends on multiple factors such as body part, technique, equipment settings and frequency of imaging.

Radiographic imaging: X-rays are widely used but have relatively low doses. Techniques such as digital radiography help minimize exposure compared to traditional methods.

CT scans: These scans provide high-resolution, cross-sectional images but are a major source of radiation exposure. Children's CT protocols are often modified to reduce radiation while retaining image quality.

Fluoroscopy: Used for real-time imaging, luoroscopy involves continuous X-rays, increasing radiation dose. Careful technique, shielding and modern digital advancements have reduced dose levels in pediatric cases.

Nuclear medicine: This involves the administration of radioactive tracers, with doses customized based on the child's weight and the diagnostic requirement.

Interventional radiology: This technique can involve extended luoroscopy and higher doses, so steps to minimize radiation are essential.

Optimization of imaging techniques

Optimization focuses on maintaining image quality while reducing the radiation dose. Techniques such as dose modulation in CT scanning and using low-dose protocols in luoroscopy are essential steps. Advances in technology have led to:

Automatic exposure control: AEC systems adjust radiation dose based on the patient's body part, thus reducing unnecessary exposure.

Iterative reconstruction in CT: This technique improves image quality even at low radiation doses, making it bene icial for pediatric patients.

Digital radiography: Digital imaging techniques offer better quality at lower doses than traditional ilm-based radiography.

Use of protective shielding: In pediatric imaging, physical shielding, such as lead aprons or thyroid collars, is used to protect sensitive organs not in the direct imaging path. Recent recommendations advocate using shielding only when absolutely necessary and ensure that it does not interfere with the quality of the diagnostic images.