Enhancing Patient Safety in Interventional Radiology: Advances in Radiation Dose Optimization

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Background

- Radiation exposure remains a key safety concern in interventional radiology (IR).
- Innovations in imaging, AI technologies, and real-time monitoring have improved dose management.
- Quality improvement strategies (DRLs, ALARA, standardized protocols) help ensure safe practice.
- Patient-centered approaches are crucial for vulnerable populations (e.g., pediatrics, oncology patients).
- Future efforts focus on global standardization and emerging AI-based dose optimization.

Methods

- Comprehensive review of peer-reviewed studies (2018–2024) in dose optimization technologies.
- Evaluated:
    1. Low-dose imaging techniques (LDCT, PCD-CT).
    2. AI-driven dose monitoring and noise mitigation tools.
    3. Real-time dose monitoring systems.
    4. Quality improvement measures (DRLs, ALARA, training programs).
- Special focus on patient-specific protocols for sensitive groups.

Results

- Low-dose CT (LDCT) and photon-counting CT (PCD-CT) reduce radiation exposure without compromising image quality.
- AI-powered tools improve real-time dose tracking and noise reduction.
- Adoption of DRLs, ALARA protocols, and dose audits led to a 20–25% reduction in radiation doses.
- Patient-specific protocols effectively reduced exposure in pediatrics and oncology groups.

Figure 1. Radiation Dose Reduction Post-Optimization

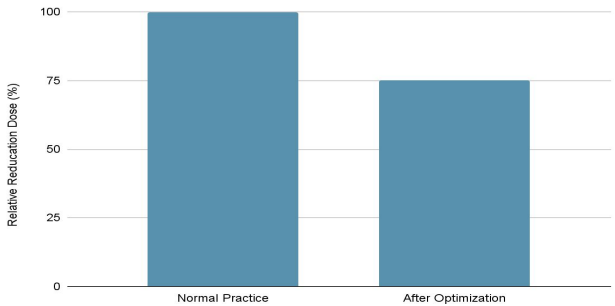
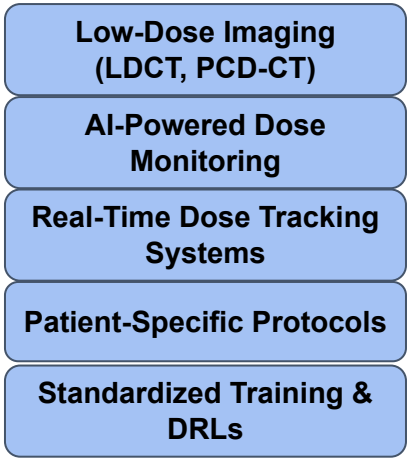


Figure 2. Strategies for Radiation Dose Optimization in Interventional Radiology



Conclusion

- Technological advances and standardized protocols have enhanced radiation safety in IR.
- Regional variability in DRLs and challenges in individualized dose tailoring remain barriers.
- Emerging technologies like AI-based optimization, automated dose-tracking, and spectral imaging hold promise for further improvements.
- A multidisciplinary collaboration (physicians, physicists, engineers, and AI experts) is needed to drive safer and more patient-centered interventional radiology practices.