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Advancing Global Low-Dose CT Screening for Lung Cancer

The implementation of low-dose computed tomography (LDCT) screening has significantly improved early lung cancer detection, leading to reduced mortality in high-risk populations. Early detection allows for timely treatment interventions. Many countries are moving toward national screening programmes, necessitating a structured and standardised approach to maintain screening effectiveness. Key challenges include harmonising technical aspects such as CT image acquisition and result interpretation. Integrating technologies like artificial intelligence and lung cancer biomarkers is vital for refining the process. These considerations were central to discussions at the international expert meeting of the Alliance for Global Implementation of Lung and Cardiac Early Disease Detection and Treatment (AGILE), which outlined the key requirements for the effective implementation of LDCT screening worldwide.

Standardisation of CT Image Acquisition and Interpretation

Ensuring uniformity in CT image acquisition and interpretation is fundamental to the success of LDCT screening programmes. Without standardisation, variations in CT scanners, imaging protocols and operator techniques may impact the accuracy and reproducibility of results, leading to inconsistencies in diagnosis. Calibration protocols are therefore critical, requiring daily, weekly and monthly quality control measures to maintain performance standards across different screening sites. These checks assess factors such as image noise, contrast resolution and equipment functionality, ensuring that CT scanners remain within the required parameters for accurate lung cancer detection.

For lung cancer screening, specific calibration techniques must be employed to ensure accurate lung nodule measurements, which are essential for tracking nodule growth and assessing cancer risk. Regular quality control assessments help to maintain consistency, particularly when using mobile CT scanners, which require additional calibration due to potential changes in performance during transportation. Additionally, reducing radiation exposure remains a priority, following the 'as low as reasonably achievable' (ALARA) principle. This approach ensures that radiation doses are minimised while maintaining sufficient image quality for reliable clinical interpretation.

Beyond lung cancer detection, LDCT screening can also provide valuable insights into other thoracic diseases, such as emphysema and coronary artery calcification. The ability to screen for multiple conditions within a single imaging session increases the overall utility of LDCT, offering broader health benefits beyond lung cancer screening alone.

Lung Nodule Protocol Management

Effective lung nodule assessment is a cornerstone of LDCT screening. The shift from diameter-based measurements to volumetric analysis has significantly improved accuracy, reducing the incidence of false-positive findings. However, challenges remain due to variations in imaging protocols across different scanner manufacturers and volumetric analysis software. AI-driven tools have the potential to improve consistency in lung nodule measurement and classification, though their widespread adoption requires further validation.

Risk assessment models are also being refined to optimise screening intervals. Most current screening programmes use an annual screening schedule, but emerging research suggests that biennial screening may be appropriate for individuals with no nodules or very low-risk nodules. Personalised screening intervals could reduce unnecessary follow-ups while maintaining screening effectiveness.

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Diagnostic follow-up of detected nodules often involves PET-CT or biopsy procedures. While PET-CT can provide additional information on nodule malignancy, it is not always definitive due to the risk of false-positive and false-negative findings. Similarly, biopsy procedures, whether percutaneous or surgical, carry risks and must be carefully considered. The challenge lies in balancing early detection with the need to avoid

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unnecessary invasive procedures, particularly in cases where nodules are benign. Optimising follow-up strategies is therefore essential in improving patient outcomes and minimising unnecessary interventions.

Integration of Technology and AI in Screening Programmes

Advancements in technology and AI are transforming LDCT screening processes, improving efficiency and diagnostic accuracy. AI-powered image reconstruction techniques enhance image quality while reducing radiation exposure, aligning with efforts to optimise screening protocols. AI also plays a role in lung nodule detection, segmentation and classification, helping radiologists to identify and assess nodules more effectively.

Different AI implementation strategies are being explored. AI can function as a companion to radiologists, assisting with nodule detection while requiring human verification. It can also act as a second reader, performing independent assessments alongside a radiologist, with discrepancies reviewed by an expert panel. A more advanced approach involves AI as a first-line screening tool, automatically ruling out negative cases and referring only indeterminate or positive cases for human review. While this approach has the potential to significantly reduce radiologists' workload, regulatory approval and large-scale validation remain key challenges.

In addition to AI, research into blood biomarkers and liquid biopsy techniques is ongoing. These biomarkers could complement imaging findings by providing additional diagnostic insights. However, further validation is required before they can be fully integrated into routine screening protocols. For now, LDCT imaging remains the primary tool for lung cancer screening, with biomarkers serving as a potential future addition.

The expansion of LDCT screening for lung cancer requires a carefully structured and harmonised approach to ensure accuracy, efficiency and accessibility. Standardisation across imaging protocols, risk assessment models and AI integration is essential in facilitating the successful implementation of large-scale screening programmes. Multidisciplinary collaboration among radiologists, technologists and researchers will be crucial in overcoming implementation challenges.

A global framework for LDCT screening, supported by rigorous validation and robust data security measures, will be instrumental in reducing lung cancer mortality and improving patient outcomes worldwide. By leveraging technological innovations and evidence-based practices, countries can establish effective screening programmes that not only detect lung cancer at an early stage but also contribute to broader public health benefits.

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