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The Role of Artificial Intelligence in Lung Cancer Screening: A Systematic Review

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Abstract

Background

Traditional screening methods, such as low-dose computed tomography (LDCT), have limitations, including high false positives and suboptimal sensitivity. AI, with its ability to analyze large datasets and detect subtle patterns, offers a promising solution for improving lung cancer detection rates. Convolutional Neural Networks (CNNs) and other deep learning techniques are particularly useful in image analysis, while machine learning models integrate clinical data for risk prediction.

Methods

We systematically reviewed studies published from 2015 to 2023 on AI in lung cancer screening. Eligible studies involved AI algorithms (machine learning, deep learning), specifically CNNs for image analysis and support vector machines (SVMs) for risk stratification. Meta-analysis was used to assess pooled sensitivity, specificity, and predictive values (PPV, NPV), with statistical significance determined by p-values <0.05.

Results

The pooled sensitivity of AI-based tools was 90% (95% CI: 86%-94%), with specificity at 85% (95% CI: 80%-90%). In comparison, LDCT showed sensitivity of 75% and specificity of 80%. The positive predictive value (PPV) for AI tools was 78%, significantly higher than the 68% for LDCT. CNN-based methods demonstrated sensitivity of 92% (95% CI: 88%-96%) and specificity of 87% (95% CI: 83%-91%), higher than other AI techniques. The p-value for CNN-based methods compared to LDCT was <0.01, indicating statistical significance in enhancing early-stage lung cancer detection. AI methods also demonstrated a higher negative predictive value (NPV) at 95%. The overall p-value for all comparisons was <0.05, confirming the statistical significance of AI-based methods.

Conclusion

AI tools, particularly CNNs, significantly improve the accuracy of lung cancer screening, with CNNs showing higher sensitivity and specificity compared to traditional methods. These findings suggest that AI has the potential to enhance clinical practice and reduce lung cancer mortality.

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