The Role of Artificial Intelligence in Enhancing Pulmonology Practice: A Systematic Review

Dr. Avirup Maiti[1], Dr. Soumya Mishra[2], Dr. Soumya Ray[3], Dr. Diptendu Dey[4]

[1]DTCD, DNB (Respiratory Medicine)

[2]DTCD

[3]MS, DNB (Ophthalmology)

[4]DNB - PGT (Respiratory Medicine)

Abstract: ***Artificial intelligence (AI) has emerged as a transformative force in healthcare, with growing applications in respiratory medicine. This systematic review evaluates current evidence on the use of AI in pulmonology, focusing on diagnostic accuracy, workflow efficiency, clinical decision - making, and patient outcomes. A comprehensive literature search of studies published between January 2015 and May 2025 was conducted. Findings suggest that AI significantly improves diagnostic accuracy in imaging and spirometry interpretation, facilitates early detection of lung diseases, and supports personalized treatment. However, challenges such as ethical concerns, data quality, and clinical integration remain. Interdisciplinary collaboration is essential for the successful implementation of AI in pulmonology.***

Keywords: Artificial Intelligence, Pulmonology, Machine Learning, Deep Learning, Chest Imaging, Spirometry, Sleep Apnea, COPD, Interstitial Lung Disease, Clinical Decision Support, Predictive Analytics, Respiratory Medicine

1. Introduction

Pulmonology is a rapidly evolving field that faces complex diagnostic challenges due to increasing patient loads, chronic respiratory diseases, and the need for precision in interpretation of diverse clinical data. Artificial intelligence (AI), particularly machine learning (ML) and deep learning (DL), is being employed to assist in diagnostic, prognostic, and therapeutic processes.

The objective of this systematic review is to evaluate and synthesize current literature on AI applications in pulmonology to understand how these technologies can enhance clinical practice.

2. Methods

Search Strategy
Databases including PubMed, Scopus, Embase, and IEEE Xplore were searched using keywords: "Artificial Intelligence, " "Machine Learning, " "Pulmonology, " "Respiratory Medicine, " "Deep Learning, " "Lung Diseases, " "Spirometry, " "Chest Imaging, " and "Clinical Decision Support. "

Inclusion Criteria
- Peer - reviewed articles published from January 2015 to May 2025
- Studies focused on AI applications in pulmonology
- Articles in English
- Clinical trials, cohort studies, retrospective analyses, and modeling studies

Exclusion Criteria
- Animal studies
- Editorials, opinion pieces
- Non - English publications

Data Extraction and Analysis
Two reviewers independently screened titles and abstracts. Full texts of eligible studies were assessed, and relevant data were extracted into a structured table. PRISMA 2020 guidelines were followed.

3. Results

1) Study Selection
Out of 726 initial records, 67 studies met the inclusion criteria after screening and full - text assessment.

2) Areas of AI Application in Pulmonology

Domain	Application	AI Technique	Performance Metrics	Reference
Chest Imaging	Lung nodule detection on CT	CNN	AUC: 0.96	Ardila et al., 2019 [1]
Chest Imaging	COVID - 19 detection on CXR	ResNet	Sensitivity: 93%, Specificity: 89%	Wang et al., 2020 [2]
Spirometry	Automated interpretation	Random Forest	Accuracy: 88%	Topalovic et al., 2019 [3]
Sleep Apnea	Home PSG scoring	LSTM	Sensitivity: 91%, PPV: 87%	Phan et al., 2019 [4]
COPD	Exacerbation prediction	Gradient Boosting	AUC: 0.84	Min et al., 2022 [5]
ILD	Pattern recognition on HRCT	Deep CNN	Accuracy: 90%	Walsh et al., 2018 [6]
Lung Cancer	Histopathology image analysis	SVM	Accuracy: 87%	Coudray et al., 2018 [7]
Asthma	Symptom prediction using wearables	Decision Trees	Precision: 85%	Wang et al., 2021 [8]
Tuberculosis	CXR screening in resource - limited settings	YOLOv3	Accuracy: 91%	Lopes et al., 2023 [9]
ARDS	Mortality prediction	XGBoost	AUC: 0.89	Liu et al., 2020 [10]

4. Discussion

Benefits

AI systems improve diagnostic accuracy, reduce time to diagnosis, and support predictive analytics. Automated spirometry interpretation, AI - based radiology tools, and predictive models for acute respiratory distress syndrome (ARDS) or COPD exacerbations can substantially reduce clinical workload.

Limitations

Despite promising results, most AI models are not externally validated. Data heterogeneity, algorithmic bias, and the "black - box" nature of deep learning models raise concerns. Integration into hospital systems and clinician training also pose challenges.

Ethical Considerations

Issues include data privacy, explainability, transparency, and accountability. Guidelines must evolve to ensure safe and equitable AI use.

5. Conclusion

AI offers significant potential in pulmonology, especially in improving diagnostics, supporting decision - making, and personalizing care. Future developments should focus on clinical validation, transparency, and integration into real - world workflows. Interdisciplinary cooperation between clinicians, engineers, and policymakers is essential.

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