

Large Language Models in Diagnostic Pulmonology and Predictive Care

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Introduction

The advent of Artificial Intelligence (AI) has heralded a new era in medical diagnostics and patient care. Among the most transformative innovations in this space are Large Language Models (LLMs), such as GPT-4, which have demonstrated remarkable capabilities in natural language understanding, pattern recognition and context-driven reasoning. These models are increasingly being explored in a range of clinical applications, from medical documentation and triage to diagnostics and prognostic modeling. In the realm of pulmonology, which encompasses complex respiratory diseases such as asthma, Chronic Obstructive Pulmonary Disease (COPD), interstitial lung diseases and lung cancer, LLMs offer the potential to revolutionize how clinicians interpret data, deliver diagnoses and predict disease trajectories. By integrating vast volumes of unstructured medical data-including Electronic Health Records (EHRs), radiologic reports, patient notes and real-time sensor inputs-LLMs enable a new paradigm of precision medicine tailored to the individual patient [1].

LLMs significantly reduce administrative burden by automating clinical documentation. They can transcribe physician-patient conversations, generate SOAP notes and summarize patient encounters. In pulmonary clinics, this translates to more time for patient interaction and less time spent on charting. These models also enable intelligent summarization of longitudinal patient data, highlighting key events such as exacerbations, medication changes, or hospitalizations, which are vital for chronic disease management [2].

Description

Pulmonary medicine is inherently data-intensive and interdisciplinary. Accurate diagnosis often requires the integration of clinical symptoms, imaging studies, Pulmonary Function Tests (PFTs), laboratory data and histopathological findings. Moreover, many respiratory conditions present with overlapping symptoms such as cough, dyspnea and wheezing, which complicates diagnosis and increases the burden on healthcare providers. Traditionally, pulmonologists rely on a combination of clinical expertise and diagnostic tools to arrive at a diagnosis. However, the increasing volume of medical information has surpassed the cognitive load any individual clinician can manage. This is where LLMs, trained on vast medical corpora, can provide critical support by synthesizing complex information and offering probabilistic diagnostic insights [3].

LLMs can process diverse clinical inputs and assist in generating differential diagnoses. For example, by analyzing patient symptoms, imaging reports and lab results, an LLM can suggest a ranked list of potential conditions such as

sarcoidosis, pulmonary embolism, or idiopathic pulmonary fibrosis. This tool is especially useful in emergency settings where rapid triage is essential. Clinical decision support systems powered by LLMs have shown promise in reducing diagnostic errors and enhancing diagnostic accuracy. These models can also be fine-tuned with local clinical data to align with regional epidemiology and institutional protocols. While LLMs do not directly interpret radiographic images, they can parse radiology reports to extract relevant findings and match them with clinical data. When combined with computer vision models, such as Convolutional Neural Networks (CNNs), LLMs can contribute to the analysis of chest X-rays, CT scans and PFT graphs. For instance, a hybrid AI system can identify ground-glass opacities on CT, interpret their clinical significance using an LLM and correlate them with systemic symptoms to differentiate between COVID-19 pneumonia and non-infectious interstitial lung disease.

One of the most powerful applications of LLMs is in predictive care. By integrating structured and unstructured data from EHRs, wearable devices and environmental data, LLMs can forecast disease progression, hospitalization risk and response to therapy. For example, in COPD management, LLMs can analyze spirometry results, exacerbation history and social determinants of health to predict the risk of future exacerbations and recommend preventive strategies. Similarly, in lung cancer, LLMs can assist in identifying high-risk patients based on genetic profiles and longitudinal health data. The use of LLMs in clinical settings raises important ethical, legal and operational questions. LLMs may inherit biases present in training data, potentially leading to disparities in diagnostic accuracy across different populations. Continuous auditing and model retraining with diverse datasets are necessary to ensure equity. Clinicians may be hesitant to rely on "black-box" algorithms. Enhancing model transparency through explainable AI (XAI) techniques is crucial for fostering trust and facilitating clinical adoption. To be effective, LLMs must be seamlessly integrated into existing electronic medical record systems and clinical pathways. User-friendly interfaces, clinician training and ongoing support are essential for successful implementation [4].

The future of LLMs in pulmonology is promising but contingent on overcoming current limitations. Areas of ongoing research and development. Combining text, imaging and sensor data for holistic patient assessment. Enabling LLM training on decentralized data without compromising privacy. Empowering patients through conversational agents that provide education, symptom tracking and early warnings. Developing standards for validation, certification and ethical deployment of LLMs in healthcare [5].

Conclusion

Large Language Models are poised to transform diagnostic pulmonology and predictive care. By augmenting clinician capabilities, automating routine tasks and enabling early intervention, these models promise to enhance patient outcomes and optimize healthcare delivery. However, realizing this potential requires a multidisciplinary effort that combines technological innovation with ethical rigor, clinical expertise and system-level planning. As we stand at the intersection of AI and medicine, LLMs offer a unique opportunity to rethink how respiratory diseases are diagnosed, monitored and managed. The integration of these models into pulmonology heralds not just a technological shift but a paradigm change toward more intelligent, personalized and proactive care.

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Received: 02 April, 2025, Manuscript No. jprm-25-167384; **Editor assigned:** 04 April, 2025, PreQC No. P-167384; **Reviewed:** 18 April, 2025, QC No. Q-167384; **Revised:** 23 April, 2025, Manuscript No. R-167384; **Published:** 30 April, 2025, DOI: 10.37421/2161-105X.2025.15.731

Acknowledgement

None.

Conflict of Interest

None.

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How to cite this article: Profita, Carreras. "Large Language Models in Diagnostic Pulmonology and Predictive Care." *J Pulm Respir Med* 15 (2025): 731.