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Artificial Intelligence in Pulmonary Diseases: A New Frontier for Pakistan's Respiratory Care

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Artificial intelligence (AI) is significantly advancing the field of pulmonary medicine by enhancing diagnostic accuracy, facilitating informed clinical decision-making, and enabling more patients to receive targeted respiratory treatments. From various parts of the world, evidence suggests that AI outperforms doctors in tasks such as interpreting pulmonary function tests, classifying interstitial lung disease, detecting tuberculosis on chest X-rays, and identifying lung cancer at an early stage. By applying these technologies in Pakistan, where the burden of respiratory issues is high, they are very helpful to the health system. The AI-powered tools can address problems such as a shortage of specialists, delays in diagnosis, and limited resources, especially in remote areas. Nonetheless, effective adoption will necessitate strict checks on data quality, local population validation, ethical safeguards, and clinician training. If Pakistan adopts AI in a proper manner and creates its own datasets, it will not only be able to provide better respiratory care and tele-pulmonology services that are more widely used but also have a role in the advancement of global digital health innovation.

Keywords: Artificial Intelligence; Pulmonary Diseases; AI-Driven Technology; Pakistan

The rapid development of artificial intelligence (AI) has completely transformed all medical fields, while, in a sense, pulmonology has been at the core of this process. The AI application in this field is not only to increase the accuracy of pulmonary disease diagnosis and management by transforming the entire process, but also to lead us to a completely different understanding of these conditions. With the gradual advancement of AI, its use in clinical practice is becoming as common as the stethoscope was in the last century. In Pakistan, where the burden of respiratory diseases is still very high in terms of both morbidity and mortality, the significance of AI is not just theoretical; rather, it is direct, viable, and maybe even lifesaving.

The power of AI comes from its ability to analyze large amounts of complex data and uncover patterns that might not be noticed by the most skilled doctors. The use of AI in the interpretation of pulmonary function testing has already been demonstrated to surpass pulmonologists' performance in terms of accuracy and, to a great extent, reproducibility.[1] The same kind of progress is being made in HRCT image analysis, where deep learning algorithms can distinguish interstitial lung disease with an accuracy that is not much different from that of expert thoracic radiologists.2,3 These innovations are not only a sign of technological improvement but also a clear indication of the rise of equitable, consistent, and data-driven respiratory care.

AI is a great help to countries like Pakistan, where the burden of diseases like tuberculosis, COPD, asthma, lung cancer, and post-COVID respiratory diseases is very high. In areas with a high prevalence of TB, automated chest X-ray interpretation tools can quickly flag suspected cases, even when very little radiology expertise is available in the region.[4] The use of AI in spirometry interpretation can significantly reduce the instances of COPD and asthma getting misclassified, which is a problem that is commonly encountered in busy outpatient settings that are busy. In COPD, ML models can predict patient mortality and classify the condition, paving the way for precision management.[5,6] In addition to the area of lung cancer, where late diagnosis is almost always the case, AI-powered nodule detection and radiomics offer the possibility of earlier detection and risk stratification through patient engagement.[7,8] A bright tomorrow is not something we can only dream about; these tools already exist, have been internationally certified, and are just waiting to meet local requirements.

On the other hand, adopting AI must be slow and careful. The success of AI applications is mostly determined by the data used to teach them. Western data sets may lead to incorrect interpretations of images or clinical characteristics in South Asian regions, where disease patterns, environmental exposures, and genetic differences are very different. The population of Pakistan, which includes individuals with diverse respiratory risk factors such as exposure to biomass smoke, a high proportion of smokers, pollution, and TB, requires the use of localised datasets for precise AI predictions. The creation of such datasets involves teamwork among the specialists in pulmonology, radiology, data science, and public health organizations. In the absence of this, AI tools sourced from other countries may yield results that are either biased or untrustworthy.

Ethical considerations play an important role in this conversation. AI models handle highly sensitive patient information, and without established national rules, privacy, data ownership, and security issues could arise. There is a need for technological development to occur without violating human rights. Also, the doctors should always be in control. The technology can enhance human skills, but it will never be able to take over areas such as clinical judgement, empathy, or contextual understanding. It will be very important that the technology is regarded as a support only, not a replacement, to ensure a smooth, safe, and effective integration into respiratory care.

Pakistan has a noteworthy opportunity in AI-assisted telepulmonology, which is one of the best solutions in this field. With many patients in isolated villages far from specialized doctors, AI-enriched telemedicine can facilitate community-based screening, triage, and follow-up. Just think of a day when clinics in rural areas would be able to use AI for chest X-ray analysis in less than 5 minutes, where AI, together with a mobile-based spirometer, would be able to guide asthma therapy and where the digital tools would be able to forecast TB treatment failure risk even before it happens.[4,9] Such breakthroughs could change the landscape of lung health, eliminate diagnostic delays, and make the most of resources.

The post-COVID era is an additional field of enormous potential. Long COVID, persistent post-viral fibrosis, and increasing ventilator-related complications have led to new clinical dilemmas. AI tools that can measure the progression of fibrosis, predict future lung function, and indicate the need for advanced therapies would be of great help to clinicians in making follow-up strategies more efficient. There are already studies that have portrayed AI in CT-based models to show accurate detection and severity staging of COVID-19 pneumonia.[10,11] While Pakistan is still coping with the consequences of the pandemic, introducing AI could lead to the elimination of unnecessary imaging, the identification of high-risk patients for care, and the efficient consumption of scarce pulmonology services where required.

Though technology by itself would not be able to drive change. Capacity building is a must. The Pulmonologists need to get acquainted with AI fundamentals, not for the sake of becoming data scientists, but so they can judge and critique AI outputs, identify limitations, and point out

cases where human intervention is a must. Medical education must also transform itself. The younger generation of doctors will work in hospitals equipped with AI technologies, so it is better to train them early than to scare them.

In this broader perspective, Pakistan will have the opportunity not only to borrow AI from others but also to be a major contributor to global innovation. By hosting one of the world's largest TB, COPD, and post-infectious lung conditions patient populations, Pakistan could be an important supplier of high-quality datasets. Research institutes could team up with scientists from other continents to develop algorithms that mirror the various conditions in low- and middle-income countries. The implication of all this would be that, while clinical practice in Pakistan has made progress, it is also recognized worldwide as a digital health research country. The AI's entry into the field of pulmonary medicine is not merely a change in technology but a shift in perception of disease. The AI technology leads us towards precision medicine, where treatment is no longer determined by general guidelines but by the analysis of the unique patient situation using the most advanced calculations. By accepting AI, Pakistan is also accepting a future respiratory health scenario where the treatments are more exact, more available, and more fairly distributed. As this change nears its end, it is our responsibility to ensure that AI is incorporated in a responsible, ethical, and intelligent manner. Algorithms will not replace the future pulmonologist; rather, they will empower him or her. He or she will be provided with tools that increase understanding, process decisions more accurately, and eventually produce better patient outcomes. The time to act is now.

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