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DERLEME / REVIEW

Solunum Sistemi Hastalıklarıyla Mücadelede Yapay Zekâ
Artificial Intelligence in Management of Respiratory Disease

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ÖZET

Bu çalışma, solunum yolu hastalıklarının yönetiminde yapay zekanın rolünü literatür ışığında özetlemeyi amaçlamaktadır. Yapay zeka, makine öğrenmesi, derin öğrenme ve veri analizi yöntemlerini kullanarak hızlı ve etkili sonuçlar elde eden, gelişen bir teknolojidir. Yüksek özveri gerektiren, karmaşık ve hızlı karar alma mekanizmaları gerektiren durumlarda kullanılması faydalıdır. Dünya çapında giderek artan, mortalite ve morbidite riski yüksek olan solunum yolu hastalıkları hem sağlık sistemi hem de sağlık çalışanları için büyük bir yük oluşturmaktadır. Literatür, solunum yolu hastalıklarının yönetiminde bu yükün azaltılması, kritik kararların alınması, hastalara ve sağlık profesyonellerine fayda sağlanması amacıyla yapay zekanın kullanımını desteklemektedir. Karmaşık görüntüleme yöntemleri, semptomların izlenmesi, olası durumların ve yan etkilerin tahmin edilmesi yapay zekanın bu alanı etkileyeceği yönlerdir.

Anahtar Kelimeler: Yapay zeka; Solunum sistemi hastalıkları; makine öğrenme; derin öğrenme

ABSTRACT

This study aims to summarize the role of artificial intelligence in the management of respiratory diseases in the light of the literature. Artificial intelligence is a developing technology that achieves fast and effective results using machine learning, deep learning and data analysis methods. It is useful to use in situations that require high dedication and complex and fast decision-making mechanisms. Respiratory diseases, which are increasing worldwide and have a high risk of mortality and morbidity, pose a great burden to both the healthcare system and healthcare professionals. The literature supports the use of artificial intelligence in the management of respiratory diseases to reduce this burden, make critical decisions, and benefit patients and healthcare professionals. Complicated imaging methods, monitoring symptoms, and predicting possible situations and side effects are the aspects where artificial intelligence will influence this field.

Keywords: Artificial intelligence; respiratory disease; machine learning; deep learning

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INTRODUCTION

Artificial intelligence (AI) technology is the realization of complex issues that require information processing skills, such as decision-making through data, speech recognition, and interlingual translation, by imitating human consciousness and using methods such as machine learning, deep learning and data analysis (1,2).

Machine learning (ML), a sub-branch of artificial intelligence, is an algorithm that predicts, classifies and makes decisions using pre-prepared data, or online data to determine the course and complete assigned tasks. ML techniques range from simple logistic models to complex neural network models with thousands of parameters (3). Deep learning is a recently developed model of artificial neural networks and processes sequentially transferred data in a way that is both abstract and linear (4).

The use of artificial intelligence in the medical field has tended to increase in recent years for reasons such as fast data processing and decision-making. The basis of modern medicine lies in making evidence-based decisions based on available data (5). This process is solved by creating models with the data and using statistical analysis expressed using mathematical methods. AI, on the other hand, can establish complex and advanced relationships with data beyond the human brain. In this way, it provides supporting conclusions about the current situation by considering the evidence in a similar way to the clinician. By learning more from each new case, it can process more data in minutes than a human can (6).

The rapid increase in respiratory diseases and high mortality rates causes great concern to health authorities. Difficulties in the management of increasing chronic respiratory diseases can arise from delayed and incorrect diagnoses. The abundance of data in health management has facilitated the applicability of AI-based methods. The potential of AI to support accurate and timely predictions, precise monitoring, and accurate diagnosis has been reported (7). Therefore, the aim of the current study is to summarize the place of artificial intelligence-supported applications in respiratory diseases in the literature.

APPLICATTION OF ARTIFICIAL INTELIGENCE IN RESPIRATORY DISEASE

While all diseases can benefit from artificial intelligence, respiratory diseases such as COPD, asthma, idiopathic pulmonary fibrosis, bronchiectasis and sleep apnea can be included. Respiratory diseases are common conditions around the world and place a great burden on the healthcare system in terms of mortality and morbidity rates. The supportive use of AI in this field will make positive contributions both economically and in terms of workload (8). Increasing air pollution in the globalizing world is directly proportional to deaths from respiratory diseases and the increase in the need for outpatient treatment. It is reported that 3 million people die from COPD every year. It is known that approximately 235 million people have asthma (9,10). Although significant advances have been made in the management of chronic respiratory diseases, new research is still needed due to the dense disease population (8).

Diagnosis and evaluation

Diagnosis of respiratory diseases is usually made by respiratory function test (PFT). With PFT, forced vital capacity (FVC) and forced expiratory volume expelled in 1 second (FEV1) are measured (11). In addition, portable devices that measure peak flow rate (PEF) are used in clinics. Thanks to the developments in recent years, devices with wireless connections have been produced. In addition to PFT, biomarkers are also used in respiratory diseases. These diagnostic methods can be easily implemented with the help of AI in the form of smart monitors or home test kits (8).

Imaging methods have a major role in the diagnosis and management of respiratory diseases. High-resolution computed tomography in combination with chest X-ray is already used in the diagnosis of respiratory diseases. Prediction models have been created to distinguish atypical lesions such as ground glass opacity, honeycomb appearance and nodules in the lung lobes seen in bronchiectasis, pneumonia and interstitial lung diseases from other diseases with the help of AI. In this way, it has been reported that disease diagnosis becomes easier with non-invasive methods (3).

The use of mechanical ventilation (MV) is vital in intensive care units. In addition to saving the lives of patients in critical care, incorrect use of MV can worsen the current condition of the lung and prolong the duration of MV use. Additionally, as the risk of infection increases, a process that results in death may begin. In this process, AI can determine the intubation needs of patients by analyzing clinical parameters and laboratory results in critical situations (12).

Prediction of infections in intensive care units is vital to reduce the risk of mortality and morbidity. Sepsis and septic shock are also life-threatening problems in severe infections. AI applications can be used to predict, prevent, evaluate and clinically manage these risks. It is of great importance to manage sepsis in its early stages, as every hour delayed increases the risk of death. This management is carried out by collecting and analyzing vital signs at the bedside. In a study conducted in 2018, a sepsis-determining artificial intelligence program was created with data from more than 42 000 intensive care patients. Thanks to the data combined with electrocardiogram, blood pressure and heart rate, sepsis prediction was successfully achieved with high accuracy (3).

Cough detection

Cough is one of the main symptoms of many respiratory diseases. Monitoring cough frequency and severity can play an important role in the early diagnosis of diseases. With the help of smartphones, AI systems can be programmed to recognize the acoustic characteristics of cough (18). Widespread use of smartphones can offer AI systems the ability to collect and analyze data about the general population and create a population-based surveillance network. Data obtained from the general population can help control conditions such as the COVID-19 pandemic by monitoring the clinical course of the individual as well as the cough (19).

Asthma and COPD

Diagnosis of chronic respiratory diseases such as asthma and COPD includes patient history, clinical symptoms, pulmonary function testing and imaging methods. Although

pulmonologists can perform these evaluations, AI may support other field physicians or physicians with limited experience in the field of respiratory diseases (14).

Airway obstruction is common to asthma and COPD. When the definition of COPD is examined, there is irreversible airflow limitation, which can also be seen in long-term asthma patients. Access to spirometry is limited in clinics providing primary healthcare services. Therefore, it is difficult to make a differential diagnosis between the two conditions. Moreover, even clinics that provide secondary health care may fail to distinguish between the two diseases in people over 40 years of age and smokers. Underdiagnosis of 20-70% and overdiagnosis of 30-62% have been reported for asthma and COPD in primary care clinics (15,16). Misdiagnosis, failure to distinguish between asthma and COPD, and inadequate treatment can lead to poor outcomes. Therefore, many auxiliary methods, including AI combinations, are needed (14).

Pulmonary fibrosis

In a study on pulmonary fibrosis, AI was used to diagnose and classify using computed tomography according to current guidelines. In the first stage, the accuracy of the algorithm was reported as 76.4%. The time required to analyze 150 images was reported as 2.31. According to the artificial intelligence results compared with radiologists in the second stage; The accuracy rate of the radiologists was 70.7%, while the accuracy of the AI algorithm was 73.3%. Additionally, the algorithm can distinguish between diffuse pulmonary pneumonia and non-common pulmonary pneumonia in a manner comparable to that of a radiologist. According to the study authors, AI is a rapid and feasible method for classifying pulmonary fibrosis using high-resolution CT imaging. Currently, AI has great potential and ability to transform many aspects of respiratory disease management (3).

Pandemic

The COVID-19 pandemic, which has recently affected the whole world, has placed a great burden on healthcare workers and healthcare systems. In this disease caused by the SARS CoV-2 virus, symptoms such as severe respiratory symptoms, acute respiratory failure, septic shock and multiple organ failure were observed. In this process that required effective decisions in a short time, methods were needed that would both save time and reduce the cost burden. Thanks to a study combining biological systems and artificial intelligence, the effects of pirfenidone and melatonin on this infection were confirmed. It was also stated that it predicted the possible effects of various drug combinations on the disease and the respiratory system (13). There is always the risk of facing new pandemics in the future. Therefore, AI will provide a great advantage in clinical decision-making during critical periods.

Management and rehabilitation

Human error in disease management is associated with financial losses and poor clinical outcomes. Human errors made especially in respiratory diseases and intensive care units can have irreversible consequences. Preventing or reducing these errors is possible with AI and ML techniques. In a study, it was reported that a 10-18% decrease in mortality rates and a 5.9-8.4 day decrease in the length of stay in intensive care unit were achieved thanks to diuretics used

in the management of ML (20). Especially in cases where there is no definitive evidence, AI is beneficial in decision-making.

It is important to access quality and gold standard data to create relationship-based models in respiratory diseases. Additionally, large-scale and integrated computational algorithms are needed to identify and treat individual-specific symptoms in various diseases. There are AI applications that process data from both adults and children, which help determine more successful diagnostic and treatment approaches specific to the individual with biomarkers emerging in diseases (21). Considering the complex pathophysiology underlying different types of respiratory diseases, processing different data for everyone can produce successful results within the scope of cause-effect relationships.

According to a review published in 2023 on the rehabilitation of respiratory diseases, it was reported that there is no practice that evaluates respiratory system health holistically and completely (22). Currently used monitoring applications collect low numbers of data such as heart rate and respiratory frequency to indicate cardiac and respiratory health. The scarcity of this data collected does not fully reflect the respiratory system health of individuals. For this reason, the factors that determine respiratory system health in a broader context need to be determined and analyzed (22).

Pulmonary rehabilitation (PR) is a valid and evidence-based method used in the treatment of respiratory diseases, based on breathing exercises, secretion clearance techniques, exercise training and patient education (23-25). Monitoring vital signs during exercises performed within the scope of PR and providing feedback to the patient and clinician are important for treatment success. In studies conducted on this subject, measuring respiratory frequency using Wi-Fi signals and more accurate evaluation of oxygen saturation with the help of pulse oximeter and artificial intelligence will be beneficial in terms of disease management and exercise (26,27). In addition, evaluating the exercise environment, precipitation, humidity rate and moving objects with the help of sensors is a complicated situation. AI can be used to process a lot of data from medical devices or sensors in a short time and create feedback (22).

Besides these benefits, there are some situations that need to be considered regarding the use of AI in the management of respiratory diseases. Non-medical devices that claim to contain artificial intelligence may cause AI to be questioned and unreliable in the decision-making phase of healthcare services due to their ability to process incorrect data. To prevent such situations, it is necessary to determine the expectations of the health sector well, to obtain quality and gold standard data, to make good cost calculations, to be aware that AI is a still developing technology and to not rush the applications (8).

CONCLUSION

It is not possible to avoid the use of artificial intelligence in the globalizing and developing world. The use of AI applications in the diagnosis and treatment of respiratory diseases is promising. It plays a supporting role in the health industry in dealing with respiratory diseases. Since AI is an emerging technology, it is essential to access large-scale and high-quality data. Considering the shortcomings and dangerous aspects mentioned in the literature, the use of AI

algorithms will be beneficial in obtaining fast and effective results. It is obvious that more studies on this subject are needed in the coming periods.

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