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REVIEW
DERLEME

Artificial intelligence applications in pulmonology and its advantages during the pandemic period

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ABSTRACT

Artificial intelligence applications in pulmonology and its advantages during the pandemic period

Artificial intelligence, with its increasing data volume, developing technologies, more information processing power and new algorithms, has a wide usage area in all sectors. In the field of health, these technologies is gaining an increasing place every day. Artificial intelligence methods can act as a simulation of the human mind and intelligence, resulting in the analysis and classification of complex data in a short time. Thus, by separating the small differences in the images examined, it can help diagnosis, detect preliminary signs of the disease and predict how the disease will develop. Computer based programs; diagnostic algorithms, surgical support and robotic systems developed on the basis of patient data are increasingly used in the drug development industry. In this study, artificial intelligence applications in the field of health and its use in pulmonology, the place of wearable technologies in our department and the advantages they provide us during the pandemic period were discussed in the light of the literature.

Key words: *Artificial intelligence; pandemic; pulmonology; wearable devices*

ÖZ

Göğüs hastalıklarında yapay zeka uygulamaları ve pandemi döneminde sağladığı avantajlar

Yapay zeka; artan veri hacmi, gelişen teknolojiler ile daha fazla bilgi işleme gücü ve yeni algoritmalar sayesinde tüm sektörlerde geniş bir kullanım alanına sahiptir. Sağlık alanında da bu teknolojiler kendisine her gün daha da artan bir yer edinmiştir. Yapay zeka yöntemleri, insan zihninin ve zekasının bir simülasyonu gibi davranarak karmaşık verilerin analizini ve sınıflandırmasını kısa sürede sonuçlandırabilir. Böylece incelenen görüntülerde küçük farklılıkları ayırarak tanıya yardımcı olabilir, hastalığın ön belirtilerini tespit edebilir ve hastalığın nasıl gelişeceğini tahmin edebilir. Bilgisayar tabanlı programların; hasta verilerine dayanarak geliştirilen tanı algoritmaları, cerrahi destek ve

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robotik sistemler, ilaç geliştirme sektöründe kullanımı gittikçe yaygınlaşmaktadır. Bu çalışmada sağlık alanında yapay zeka uygulamaları ve göğüs hastalıkları özelinde kullanımı, giyilebilir teknolojilerin branşımızdaki yeri ve pandemi döneminde bize sağladığı avantajlar literatür eşliğinde tartışılmıştır.

Anahtar kelimeler: *Giyilebilir cihazlar; göğüs hastalıkları; pandemi; yapay zeka*

Artificial intelligence applications and usage areas in the field of health

Artificial intelligence has revolutionized the field of health and all areas of human life in the last century. Artificial neural networks are logical systems that aim to perform these operations automatically by modeling various features such as learning, producing, understanding, classification, generalization, and analyzing, considering that the human brain can perform, are applied in many branches of science, and have the ability to solve complex situations that are difficult to solve. That is, artificial intelligence is a simulation of the human mind and intelligence.

Digital health technologies include fields such as telemedicine applications, robotic interventions, wearable technologies, sensors, artificial intelligence, and biotechnology. It is unfeasible to separate these applications that provide data exchange between each other. These technologies, especially artificial intelligence, have been used more and more every day to combat preventive health services and diseases. Moreover, healthcare services are significantly affected by this change worldwide. Machine learning and artificial intelligence are affecting doctors, hospitals, and all other health-related areas.

Artificial intelligence and its subcomponents have taken place in every subunit in the field of health. Working on innovation in health, wireless health applications, and genomic medicine, Dr. Eric Topol, in a *Nature* journal article, mentioned that artificial intelligence benefits clinicians, healthcare systems, and patients such as faster image interpretation, reduced workflow and medical errors, and the ability to process own data to improve health.

Computers can look beyond what the human eye can see and distinguish small differences in the images examined, aid diagnosis, detect signs of disease, and predict the development of disease. Machine learning involves a continuous process of learning and improvement. This area continuously develops rapidly; however, there is still much that has not been discovered.

Accurate detection of diseases requires years of medical training. Even after training, making a diagnosis is difficult and time-consuming. In various fields of medicine, the demand for experts has exceeded the supply, which creates an excessive workload for doctors and delays may occur in the diagnosis of diseases. Machine learning and deep learning algorithms have recently made great progress in the automatic diagnosis of diseases, making the diagnosis process cheaper, easier, and accessible, and helping physicians with the decision support systems created.

The working principle of machine learning algorithms is based on learning to see particular patterns in the same way as doctors. The only difference is that algorithms require a large number of instances to learn and must be digitized meticulously. Artificial intelligence is used in areas where the information used by clinicians for disease diagnosis is transferred to digital media and decision support systems can be created in this way (1). For example, one of the first and most frequently used fields of these systems is radiology (2). Lung cancer and stroke can be diagnosed by analyzing computed tomography scans (3,4). Sudden heart attack risk can be determined by analyzing the electrocardiograms of patients in cardiology (5). In dermatology, the classification of lesions can be made by analyzing skin disease images (6,7). Determining diabetic retinopathy indicators can be performed by analyzing eye images (8). Apart from image-based applications, for example, in psychiatry, sensors that enable speech tone and facial expression to recognize emotions can help diagnose depression, identify people with suicidal thoughts, and other diagnoses with the use of interactive chatbots (9-11). Moreover, it facilitates stroke, autism, or electroencephalographic diagnosis of neurological disorders (12,13). Additionally, the role of artificial intelligence and digital technologies in the protection and improvement of health is inevitable.

The biggest advantage of these systems is that they can examine thousands of images in minutes and provide services independent of time and space. Its ability to be used 24/7 in any environment is among its advantages. The use of mobile phones as ultraso-

nography devices or a microscope with an apparatus enables the assessment of patients before coming to the hospital.

In addition to decision support systems, studies in the field of genetics are carried out with artificial intelligence-assisted surgeries, effects in drug development, applications for the determination of personalized treatments, therapies and drugs, and gene editing skills; studies are ongoing for its development (14,15).

Artificial intelligence and pulmonary medicine

In respiratory medicine, the main application areas of artificial intelligence and machine learning have enabled the development of decision support systems to assist physicians by processing physiological data from physical examination to radiological and clinical diagnosis of the disease.

For example, classification techniques can help our physicians in analyzing a person's health data (such as blood analysis, imaging output), discovering complex connections or fine details that a physician cannot easily see, and detecting an invisible disease or a tumor (16). Thus, applying a limited number of the most accurate diagnostic methods can both support the early diagnosis of the patient's disease and prevent the allocation of resources for unnecessary diagnostic methods. Furthermore, getting results quickly will reduce waiting time in accessing healthcare services. Additionally, it is possible to produce personalized treatment plans by examining the health data of the person (17).

One of the innovations developed during the COVID-19 pandemic is telemedicine and remote patient evaluation. An artificial intelligence application that can help pulmonologists in this regard is digital stethoscopes that provide remote examination opportunities (18). The algorithm of the lung sounds of patients and healthy people are taught with electronic stethoscopes; then the analysis and pre-diagnosis of the patient sounds are obtained (19). Smart stethoscopes, in which the sounds of lung diseases are taught, provide voice transmission and disease identification with mobile phone connection when examining the patient remotely. This method, which is also applied in diagnosing COVID-19, aims to diagnose COVID-19 from lung sounds and to make risk stratification (20).

Furthermore, lung radiology is an area where artificial intelligence and deep learning methods are frequently used. As a start, several programs have been developed that analyze lung X-ray images. It has been used in the diagnosis of tuberculosis (21), heart failure (22), and pneumothorax (23). In a simulation conducted by Baltruschat and colleagues, it has been found that evaluating chest X-ray images with artificial intelligence reduces the diagnosis time and provides an earlier evaluation time in cases that require urgency (24). Moreover, several algorithms for X-ray images have been developed during the COVID-19 pandemic and widely used in China (25,26). The system provides a probability to get a preliminary diagnosis on new radiographs as a result of teaching various lung images to the system (27,28).

In advanced imaging methods, studies are carried out to detect pathologies in thoracic computed tomography. Studies on detecting pneumonia, lung masses, mesothelioma, pulmonary embolism, obstructive pulmonary diseases, and emphysema have been conducted (26,29-34). In the study of Lenfant et al., computed tomography pulmonary angiography (CTPA) images in cases of pulmonary embolism whave been evaluated with artificial intelligence-based hybrid iterative reconstruction technique and in terms of image quality and exposure rate of radiation, and positive results have been obtained (35). By measuring areas of emphysema in the lung, a possible diagnosis of chronic obstructive pulmonary disease and its progression can be calculated (36). A new histogram software has been used to facilitate the diagnosis of interstitial lung diseases (ILD) in the study by Barthomai et al. and the computed tomography images of the patients have been evaluated quantitatively, retrospectively. Obtaining quantitative data for ILD, whose differential diagnosis is still difficult today, will provide great convenience in early diagnosis and treatment (37). These studies are not only in the field of image analysis. In the study of Topalovic et al., pulmonologists and artificial intelligence-based software have compared in evaluating pulmonary function tests. Pulmonologists diagnosed 24-62% of all cases correctly, while AI-based software diagnosed 82% of all cases (38).

There are advanced studies especially on the diagnosis of lung cancer and its staging, the classification and treatment recommendations for mesothelioma disease, and the management of pulmonary nodules. For example, in the study conducted by Xinling Li and colleagues, data such as the probability of malignancy and follow-up processes of pulmonary nodules

and the quality of nodules provide great convenience in diagnosis with artificial intelligence modeling (39). In the study of Ardila et al., in lung cancer screening using artificial intelligence, the accuracy and consistency of the screening have been compared with the performance of six radiologists, and it has been shown that artificial intelligence is superior (40). Today, where manpower and performance are very important, the development of artificial intelligence-based facilitating platforms has great importance.

In another study conducted by Gao and colleagues, multi-drug-resistant tuberculosis cases have been detected from thoracic tomography with deep learning techniques (41).

Moreover, studies involving analyzing ultrasonography images obtained by thoracic ultrasound and endobronchial ultrasonography (EBUS) used in diagnostic procedures have been conducted (42,43). Using these images, obtaining a malignant or benign disease preliminary diagnosis helps in determining the area to be sampled (44).

Currently, tomography image analysis and applications for the COVID-19 pandemic attract attention. Due to the current pandemic situation, diagnosis and early treatment are extremely crucial. The study by Andrew Soltan and colleagues has obtained an accuracy of 92.5% in early diagnosis and diagnosis in the waiting period of polymerase chain reaction test results in COVID-19 with artificial intelligence modeling (45).

Again, to reduce the workforce, to reach the diagnosis quickly, and not to waste time in the treatment process, Infervision InferRead has been made widely available for the diagnosis of COVID-19 with thoracic tomography (46). In a similar study, disease progression analysis has been performed by examining sequential images of the patients (47).

As in all areas of health, artificial intelligence applications will continue to develop in the branch of chest diseases, which includes internal, surgical, and imaging units.

Wearable Devices

In the available literature, wearable device technology is defined as "an electronic device category that can be an accessory, intertwined with clothing, can be implanted on the body of the user and even tattooed on the skin." In this context, it is seen that wearable technology has evolved over time, from pocket watches to smartwatches that give feedback about our health today. For a product to be considered a wearable technology, the product must transfer the information from smart sensors to the computer via wireless connections. A concept known as the Internet of Health Things (IoHT) has emerged as a sub-branch of the Internet of Things (IoT) concept, which plays a major role in the popularity of wearable devices. Thus, it is possible to make machine-to-machine (M2M) communication with the IoT in medical devices and to connect to a cloud platform where the data sent by the sensors are captured, stored, and analyzed.

It is known that wearable devices such as smartphones, smart wristbands, and smartwatches can collect large amounts of sensor data about people's activities throughout the day. With more data collected, various applications such as behavior detection, motion detection, and psychological stress alert can be developed. Thus, smartwatch applications have been developed to diagnose COVID-19 in the pre-symptomatic period (48). Heart rate, respiratory rate, saturation, and fever of individuals during exercise and rest are recorded with the help of wearable devices, and abnormal findings are detected (48).

During the pandemic when telemedicine applications are widespread, several research on how to perform remote patient follow-up, which is the most striking advantage of wearable technology, have been carried out. Remote monitoring of cardiac patients using wearable technologies, monitoring the patient's sound vibrations in real time with the help of a mobile device by positioning a microphone in the throat area for the follow-up of respiratory diseases, and in this way, the application aims to understand the patient's condition from the changing sound acoustics of the patient and reduce the intervention time. Examples include performing polysomnography in a home environment with the help of wearable devices and transferring them to the system recording sleep disorders (49-54).

Limitations and Further Studies

To date, it has been reported that artificial intelligence technologies have been successfully applied clinically using wearable devices and induce the development of various applications. However, cur-

rent methodologies still face several challenges that need further research and answers to unexplained questions.

It is necessary to work on how to effectively eliminate individual differences and how to make the classification model more applicable on a wider scale.

The limited energy supply and storage of the wearable devices are extremely limited in the battery and storage resources of the wearable devices; hence, it is necessary to investigate further how to effectively control the computational and storage consumption of the model without losing precision.

Successful implementation of artificial intelligence and wearables requires a large amount of data. In this scenario, it is critical to keep privacy as a top priority. Therefore, ethical situations and legal limits should be determined for data sharing and storage.

CONCLUSION

The main goal of using artificial intelligence in health is not to take the role of clinicians, but to create assistive systems rather than replace the experience and human touch of the physician. In case of automation in processes such as data entry and analysis of test results, artificial intelligence systems will save time by warning and informing about potential problems and will allow doctors to pay more attention to patients and interpret signals more effectively. Considering that the world population is getting older and the need for doctors is increasing, every second saved can save and prolong lives.

In the current and future pandemic conditions, artificial intelligence applications will help fight diseases more easily and with less manpower. In this context, in today's developing technology worldwide, more support and opportunities should be provided to artificial intelligence and its applications, considering the ethical rules.

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