



# Arşiv Kaynak Tarama Dergisi

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DERLEME/REVIEW

### Artificial Intelligence Applications in Health

#### Sağlıkta Yapay Zeka Uygulamaları

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#### ABSTRACT

General practitioners (GPs), called family physicians (FP) in certain countries, are the cornerstone of primary health care. The increase in average lifespan and, thereby, the number of chronic diseases has recently increased the workload of FPs and decreased the time spent on the patient. Implementations of Artificial intelligence (AI)-powered systems are essential in FPs to facilitate the jobs of health professionals. Implementing AI-driven systems is expected to help health professionals diagnose and treat. AI involves the machine simulation of human cognitive capabilities, encompassing a range of technologies, including deep learning and machine learning. AI is currently being used across various applications in medicine and continues to evolve, and its role in medicine is expected to become increasingly prominent. AI-enhance sensor systems can continuously monitor physiological parameters and generate personalized medicinal therapy. However, the employment of AI in FPs is still in the very early phase. AI is a tool to aid healthcare professionals in improving the accuracy and speed of diagnosis rather than a replacement for their expertise. This review will focus on applying artificial intelligence in general practices/family medicine.

**Keywords:** Artificial intelligence, family medicine, primary care, disease management

#### ÖZET

Bazı ülkelerde aile hekimleri olarak da adlandırılan genel pratisyenler, birinci basamak sağlık hizmetlerinin temel taşıdır. Ortalama yaşam süresinin ve buna bağlı olarak kronik hastalıkların sayısının artması, son dönemde aile hekimlerinin iş yükünü artırmış ve hastaya ayıracak zamanı azaltmıştır. Sağlık profesyonellerinin işlerini kolaylaştırmak için aile hekimlerinde Yapay zeka (AI) destekli sistemlerin uygulanması önemlidir. Yapay zeka destekli sistemlerin uygulanmasının sağlık profesyonellerine teşhis ve tedavide yardımcı olması beklenir. Yapay zeka, derin öğrenme ve makine öğrenimi de dahil olmak üzere bir dizi teknolojiyi kapsayan, insanın bilişsel yeteneklerinin makine simülasyonunu içerir. Yapay zeka şu anda tıpta çeşitli uygulamalarda kullanılıyor ve gelişmeye devam etmektedir ve tıptaki rolünün giderek daha belirgin hale gelmesi beklenmektedir. Yapay zeka destekli sensör sistemleri, fizyolojik parametreleri sürekli izleyerek kişiselleştirilmiş tıbbi tedavi oluşturabilir. Ancak yapay zekanın aile hekimlerinde kullanılması henüz başlangıç aşamasındadır. Yapay zeka, sağlık profesyonellerinin uzmanlıklarının yerine geçmek yerine, teşhisin doğruluğunu ve hızını artırmalarına yardımcı olan bir araçtır. Bu derlemede yapay zekanın genel pratisyenlikte/aile hekimliğinde uygulanmasına odaklanacağız.

**Anahtar kelimeler:** Yapay zeka, aile hekimliği, birinci basamak sağlık hizmeti, hastalık yönetimi

#### Introduction

Healthcare is wide open to new technologies, including AI, which has been called the stethoscope of modern medicine<sup>1</sup>. Today, the application of technology in healthcare is inevitable, and there are several ways in which AI can improve the practice of modern medicine. AI is not a single technology, but rather a collection of technologies that are directly relevant to healthcare. Based on the available data, AI technology performs tasks by mimicking human intelligence. Computer algorithms use raw data, and patterns are recognized. Independent of human input, AI technologies acquire knowledge<sup>2,3</sup>. AI algorithms can analyze image data that humans cannot. AI outperforms human performance in a number of ways. AI mainly automates repetitive and data-driven tasks such as pattern recognition, data analysis and medical diagnosis. Recent advances in technological maturity, such as ultra-fast computing, have facilitated the application of AI in modern healthcare systems, so expectations for AI-based systems are very high<sup>4,5</sup>. AI applications are being used to assist medical professionals in clinical settings. The rapidly improving performance of AI-based



techniques in caption generation and image recognition, particularly in the last 15 years, has paved the way for the use of AI technologies in modern medicine, including in general practice. As you might imagine, AI-based systems can improve patient care in many ways. In addition, AI systems can also transform administrative processes, potentially reducing the workload of healthcare professionals.

As AI reduces the workload of general practitioners, healthcare staff can spend more time with patients, speeding up processes, reducing waiting times and improving early diagnosis. Life sciences companies are making significant use of AI technologies in many areas, including drug discovery. Efficient drug design can be achieved through the extensive use of AI-based techniques that enable the analysis of specific structural interactions. Based on structural databases, the analysis of molecular interactions and correlations can facilitate novel drug design<sup>6</sup>. In this context, displaying the binding between molecules using AI technologies can predict the *in vitro* activity of that molecule and thus greatly simplify the development process, reducing costs<sup>7</sup>.

In recent years, AI has been applied to diagnostics in secondary care. AI can benefit from filtering, picking up tiny pieces of information to help make predictions. AI as a digital doctor raises the question of whether AI would replace doctors, which could lead to a loss of trust in clinicians and delay the application of AI-based systems in modern medicine. Due to the large number of patients with different diseases, examining patients under time pressure is a challenge for doctors in GP surgeries, which is the main cause of misdiagnosis that often occurs in GP surgeries. However, it is expected that GPs will be better diagnosticians. Notably, those at risk of pre-diabetes, cardiovascular disease, cancer, or those with mental health risks are expected to be diagnosed earlier in general practice.

Given the shortage of doctors in primary care, it is not surprising that such a high volume of patients and working under time pressure increases stress for GPs, which affects the quality of primary care<sup>8</sup>. Therefore, their workload needs to be redistributed to focus on patient care. From this perspective, AI has the potential to significantly assist in several tasks and could be a powerful tool for GPs to manage this enormous workload<sup>9</sup>. By automating routine tasks, AI can help reduce the administrative burden on doctors.

AI has been proposed to improve diagnostic accuracy and efficiency, potentially paving the way for optimal treatment. AI-powered advances in health information technologies, such as clinical decision support systems (CDSS), can help doctors make decisions. In addition, CDSSs can prevent medication errors by supporting diagnosis and prescribing<sup>10-12</sup>. CDSSs are designed to inform healthcare professionals. In addition, these systems provide healthcare professionals with vital information to understand the processes used in modern medicine. While medical devices such as heart or glucose monitors track vital signs, the data collected from these devices by AI can be used to diagnose more complex conditions such as sepsis. This enables timely intervention and treatment. AI is being used successfully in radiology, pathology and dermatology<sup>13,14</sup>. Overall, AI techniques are being used primarily in radiology, where they are already outperforming radiologists in detecting cancerous lesions and helping scientists run costly clinical trials more efficiently<sup>14,15</sup>.

## Employment of AI systems in GPs

Patients in need of medical care will go to GPs for help. GPs are therefore the first point of medical contact for patients in primary care, which places a significant burden on GPs<sup>16</sup>. As a result, GPs are expected to make accurate diagnoses and manage treatment plans. In addition, GPs are expected to provide preventive care. All this workload under time pressure leads to diagnostic uncertainty<sup>8,17</sup>. GPs are responsible for making the initial diagnosis, which is crucial for appropriate care. Misdiagnosis has a significant impact on the quality of primary care. In particular, misdiagnosis of illness and injury can lead to unnecessary hospital admissions or avoidable deaths<sup>18,19</sup>. Similarly, AI-based models can predict who should be admitted to hospital, potentially preventing deaths caused by misdiagnosis. As you might imagine, misdiagnosis is one of the leading causes of increased healthcare costs<sup>20</sup>. Innovative, reliable and rapid approaches to decision making can prevent these risks in GP care<sup>21</sup>. AI-based technologies can detect abnormalities that the human eye might miss. AI-based systems for diagnosing disease are now much improved. They can outperform doctors in detecting breast, brain, skin and bowel cancers, as well as cardiac arrhythmias<sup>22,23,24</sup>. This could improve the accuracy of diagnosis in primary care by reducing the need for unnecessary referrals.

Healthcare professionals spend 25-30% of their work time on administrative and regulatory activities<sup>25</sup>. In addition, AI-driven decision support systems can provide cardiac care professionals with recommendations and suggestions based on the patient's medical history, symptoms and test results. In this way, AI can provide a second opinion to healthcare providers. This can reduce diagnostic errors due to human oversight. AI-powered systems help medical professionals by freeing up their time for more challenging tasks; AI can provide a more vital doctor-patient relationship, which is particularly important in primary care, allowing doctors to provide more holistic and individualized treatments<sup>26,27</sup>.

In addition, the application of AI systems can reduce diagnostic errors, which are seen as a threat to patient safety, as is often the case with GPs<sup>28</sup>. AI can optimise the workload of healthcare professionals through scheduling and triage, allowing doctors to focus on more complex cases. By identifying high-risk patients who need more attention, AI-powered systems allow doctors to intervene early. By promptly and appropriately treating high-risk patients identified by AI-powered systems, physicians can save more lives by reducing the risk to patients. This can help clinicians identify high-risk patients and intervene at the right time to prevent adverse outcomes. In addition, better risk assessment and intervention by GPs using AI-powered systems could prevent unnecessary expenditure.

The removal of specific administrative tasks, including appointment scheduling and triage of administrative staff, can also free up time to focus on more critical tasks such as communicating with patients. Appointment scheduling, care management, communication, teleconsultation, health recommendation systems, resource management and user interaction with electronic medical records are identified as the most common problems in GP practices<sup>29-31</sup>. AI is increasingly being used by GPs to overcome these problems. Disease diagnosis is the most common application of AI-based systems in modern medicine. AI algorithms can help GPs diagnose various medical conditions by analysing patient data such as medical history, test results and symptoms.

AI systems are trained on vast amounts of medical data, including patient records, medical images (such as X-rays and MRIs), and even genomic information. This data is used to build a comprehensive dataset for analysis. For example, patients' electronic health records, such as medical history, test results and treatment information, can be analysed by AI systems. Electronically recorded X-rays, MRIs and CT scans can help diagnose diseases or conditions. AI algorithms can detect anomalies, identify patterns and highlight potential problems for further investigation. The collection of recorded data is therefore valuable for diagnosing and monitoring health conditions.

### **Application of AI in chronic disease management**

The burden of chronic disease is increasing worldwide, reducing quality of life and increasing economic health care costs<sup>32</sup>. In particular, chronic diseases, and especially their management, drive healthcare costs. Especially in the case of chronic diseases, patients expect their doctors to act as human beings who communicate clearly and care for their patients. In this context, AI is proposed to optimize healthcare and reduce costs<sup>33-35</sup>. Doctors could use AI to reduce their workload. AI-based tools are being considered for future real-world medical assistance. Thanks to recent developments in AI, patients with chronic diseases can use AI-based applications for complex conditions. In particular, precise treatment algorithms for cardiovascular diseases and home AI systems for diabetics through smartphone-based real-time assessment provide doctors with more personalized and precise treatment options<sup>36,37</sup>.

### **Application of AI in diabetes management**

Diabetes affects millions of people worldwide. AI-powered systems are playing an important role in diabetes management by improving patient care, diagnosis and treatment. AI algorithms are known to analyse health records, lab results and patient data to predict individuals at risk of developing prediabetes or diabetes. In addition, AI-based continuous glucose monitoring systems alert patients to more effectively manage their blood glucose levels. Similarly, AI can optimise insulin doses by analysing glucose levels, leading to more personalised and accurate treatment plans. AI can also provide personalised diet and exercise recommendations that can help people with diabetes manage their condition effectively and make healthier

choices. In addition, AI-based apps can remind patients to take their medication and enable healthcare providers to track patient progress and treatment plans without in-person visits.

AI-based systems have been widely used to monitor the retina as a platform for disease screening or as a tool to assist in clinical practice. The management of retinal diseases requires multiple follow-up visits for monitoring, which is time consuming and resource intensive. Due to the significant number of patients with diabetic retinopathy, screening for retinopathy is highly recommended and can prevent blindness by allowing timely referral and treatment<sup>38</sup>. AI-enabled home monitoring systems could be a solution for monitoring patients with retinal disease, effectively and efficiently reducing time and costs in the long term. Self-measurement at home (e.g. blood pressure and glucose) between consultations can be recorded and shared with healthcare professionals in the GP's surgery. AI-based models can detect changes in the retina before symptoms occur, allowing immediate intervention to prevent vision loss and thus prevent long-term vision loss. For example, a newly diagnosed patient can be referred to an eye specialist by a local GP. Retina specialists can schedule a follow-up visit that can improve long-term visual outcomes.

### **Application of AI in cardiovascular diseases**

Cardiovascular disease, the leading cause of death, is on the rise worldwide<sup>39</sup>. In today's world, prevention and early diagnosis of cardiovascular disease are critical. However, once diagnosed, the management of the disease is of paramount importance and represents one of the greatest challenges for physicians. It is well known that clinical care currently faces particular challenges, including cost reduction in prevention and treatment, low cost-effectiveness, high readmission and mortality rates, and inadequate patient care. AI-based advanced data analysis systems are increasingly being used to help develop successful cardiovascular treatments<sup>40</sup>. The field of cardiovascular medicine is undergoing a transformation towards personalised medicine. AI is being used in cardiovascular medicine to improve the quality of patient care, which is expected to reduce readmission and mortality rates<sup>41</sup>. The application potential of AI in cardiovascular disease is immense, and the use of AI in this area will enable people with cardiovascular problems to manage their condition effectively.

Algorithms can identify patients at risk of heart attack, where early treatment would benefit the patient<sup>42</sup>. For example, electronic health records and medical images from patient data can be analysed by AI-powered systems to predict the risk of cardiovascular disease<sup>43</sup>. This AI-driven prediction can help identify high-risk individuals and enable early intervention. It also assists physicians in interpreting cardiac imaging, which could enable more accurate and efficient detection of abnormalities in echocardiograms, angiograms and other scans such as MRI and CT scans. AI-powered mobile apps and wearable devices can continuously monitor vital signs and provide real-time patient data, which is particularly beneficial for people with chronic heart conditions. In this line, AI-monitored systems can capture variable lengths of heartbeats to detect arrhythmias<sup>44</sup>.

Similarly, automated ECG interpretation software can accurately detect atrial fibrillation<sup>45</sup>. In addition, AI-powered virtual rehabilitation systems can provide personalized exercise and dietary recommendations to aid recovery and management of cardiovascular disease. Overall, AI-powered applications in cardiovascular disease aim to improve early detection, diagnosis, treatment and patient management, ultimately leading to better outcomes and reduced healthcare costs. Traditional monitoring of patients with cardiovascular disease is often insufficient to detect early signs of disease in a timely manner. However, AI-based technologies offer the opportunity to leverage widespread adoption to implement solutions that can detect early signs of cardiac compression, allowing for timely intervention<sup>46,47</sup>.

### **Application of AI in Arterial hypertension management**

Arterial hypertension (AH) is the largest contributor to the global burden of cardiovascular disease<sup>48-50</sup>. Current therapy for AH is largely focused on the regulation of vascular resistance. There has been no significant change in the pharmacological management of AH in the last 20 years<sup>51</sup>. As the causes of hypertension are diverse, the treatment of hypertension requires novel approaches. The known methods of monitoring blood pressure are invasive manometric measurements using an arterial line or non-invasive oscillometric techniques using an inflatable cuff<sup>52-54</sup>. In particular, the invasive method of measurement has

an increased risk of complications. In this scenario, blood pressure monitoring methods are widely used and need to be optimised. Optimal blood pressure control can be achieved by optimising pharmacological therapy, which is a challenging task for healthcare professionals. Blood pressure control rate is unsatisfactory and cannot be efficiently implemented worldwide<sup>55</sup>. In this context, the use of AI-based systems to prevent, monitor and treat hypertension is well recognised. Incorporating AI techniques into the management of hypertension could help improve patient care, from diagnosis to therapy. As a result, the use of AI systems to monitor blood pressure in clinical practice could become more effective and efficient.

Because hypertension has a variable onset and can be asymptomatic or symptomatic, it is not always possible to predict or detect this condition. AI has the potential to increase efficiency, and the implementation of AI could be beneficial in predicting patients' risk of developing hypertension<sup>56</sup>. The best known example of AI for hypertension diagnosis is 24-hour blood pressure monitoring<sup>57</sup>. By taking direct and repeated blood pressure readings at intervals, AI-driven software with a relatively simple algorithm can detect and even classify hypertension<sup>58,59</sup>.

### Challenges in the implementation of AI in GPs

Although the application of AI-powered systems in primary care and diagnostics is essential and valuable, the widespread implementation of AI techniques presents several challenges<sup>60</sup>. One of the challenges is doctors' lack of trust in AI-enabled systems<sup>61</sup>. Overcoming doctors' lack of trust requires specific tasks to balance the doctor's trust in AI-powered systems. Building trust in such a system is essential for its adoption and use. It also cannot be excluded that the use of AI systems may involve certain risks if doctors unquestioningly trust the suggestions and results of these systems.

The need for AI systems to access vast amounts of data stored in electronic patient records raises questions about how to ensure privacy. The storage of data, the processing of signals, and the transmission and communication of results can present certain security risks. Data security systems should protect data; however, data breaches can occur. Ensuring privacy in GP practices using AI systems is complex and ongoing. It is also important to note that remote monitoring devices and reprogramming capabilities may be vulnerable to cybersecurity threats, and even proprietary programming and communication protocols can be hacked<sup>62</sup>.

Algorithms based on AI technology can be influenced by studies of inconsistent quality that generate the databases that need to be optimised<sup>63</sup>. In addition, it is essential that comprehensive data protection measures are in place. Even if GPs anonymize data, there is always a risk that individual profiles can be traced.

Although AI-enabled technologies can support clinical decision making, trained medical professionals should not be replaced by AI-enabled systems. In particular, trained medical professionals will always be needed to diagnose complex medical conditions. The nuances of a patient's physical exam findings and medical history can always be evaluated by a physician, who is better equipped to understand the data. Therefore, trained medical professionals are needed to make accurate diagnoses. It should also be noted that AI systems are not free from technical issues.

### Conclusions

Applying AI to GPs is seen as a promising way to address this issue. AI-enabled systems can improve the efficiency and quality of healthcare in GP surgeries. Given the increasing amount of data collected in the healthcare system, the application of AI in GP practices will become more common. AI technology will be beneficial by providing new solutions to skilled physicians that will reduce diagnostic errors. The benefits of AI are not only limited to patients, but can also help reduce burnout among doctors by freeing them up. Although digital health technologies could be seen as a threat to healthcare professionals by replacing the widespread use of AI-enabled systems in the professional practice of GPs, they have a long way to go on a daily basis. AI-enabled technologies have immense potential for the future of biomedicine and healthcare, but the widespread use of AI in GP practices has certain drawbacks. The use of AI technologies in healthcare

will require significant changes in medical regulation. So while AI has the potential to transform the future of modern medicine, it is not yet ready to replace doctors in GP surgeries.

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