

The Role of Digital Technologies and Artificial Intelligence in Advancing Family Medicine: Enhancing Diagnosis, Treatment, and Improving Public Health

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ABSTRACT

The integration of digital technologies and AI into healthcare has revolutionized family medicine, enhancing the quality of primary care, improving health outcomes, and easing the burden on family physicians. As the cornerstone of primary healthcare, digital technologies and AI such as telemedicine, AI-powered diagnostic tools, clinical decision support systems, and predictive analytics have enhanced the role and functions of family medicine in improving the overall health of the community. In Saudi Arabia, population growth and the increasing prevalence of chronic diseases have increased the demand for primary care services, especially during the COVID-19 pandemic. Digital technologies such as telemedicine and AI-powered health management platforms are improving patient access to care, enhancing physician-patient relationships, and contributing to more efficient disease prevention and management strategies. Furthermore, AI enhancing diagnostic accuracy and personalized treatment plans, while predictive analytics has enabled early identification of at-risk populations. This review explores the potential of digital technologies and AI to transform family medicine by enhancing diagnostic accuracy, improving treatment outcomes, managing chronic conditions, and addressing public health needs. It also discusses the future impacts of these technologies, including their role in reducing healthcare costs, enhancing patient education, and reducing healthcare provider burnout.

Keywords: Digital Health, Artificial Intelligence, Family Medicine, Healthcare.

Introduction:

The medical field has recently witnessed tremendous progress due to technological advancements and digital technologies that have been adapted to suit healthcare [1]. Family medicine is the first line of defense in primary healthcare [2]. Therefore, digital technologies and technologies have radically changed the practices of family doctors, which has led to progress and improvement of healthcare outcomes for patients [1,3].

The World Health Organization has pointed out the role of digital technologies such as artificial intelligence, robotics, the Internet of Things, and others in supporting and improving public health. Which in turn enhances the role of e-health to include smart devices and connected medical tools, enabling more efficient and comprehensive care for the entire community [4]. Family medicine, or as it is known as primary care, focuses on providing comprehensive, diverse and continuous healthcare services, including preventive, curative, psychological health services and chronic disease management. This makes enhancing family medicine using digital technologies and technologies essential to raise the level of community health and reduce the burden on health systems [5].

In the Kingdom of Saudi Arabia, due to the increasing population, the increased risk of chronic diseases [6], and the spread of pandemics, the latest of which was Covid-19 and the burdens it poses on the health system and the increased demand for primary care services. Digital health adoption has accelerated in Saudi Arabia [7]. Digital health adoption has accelerated in Saudi Arabia. Telemedicine, video consultations, the integration of a national health database, and a COVID-19 testing repository system have helped in responding effectively to the COVID-19 crisis and reducing the burden on family physicians [8].

The main digital health tools in primary care and family medicine in Saudi Arabia include clinical decision support, telemedicine, communication between physicians in different specialties, and patient follow-up [9]. In addition to technologies that contribute to predicting diseases and at-risk groups. Digital applications in family medicine are of utmost importance due to their benefits, such as enhancing the relationship between the doctor and the patient, continuous follow-up, educating patients and the community, and others [10].

The patient-physician relationship is critical in family medicine, as it directly impacts health outcomes, patient satisfaction, and disease management [11]. Digital technologies are also facilitating a shift from the traditional “guided collaboration” model, where physicians make decisions, to a “mutual engagement” model, where patients and physicians collaborate in making care decisions. Digital health technologies are revolutionizing family medicine by improving diagnosis, treatment, and overall health [12,13]. Therefore, this review seeks to explore the role of digital technologies in family medicine in diagnosis, treatment, and improving overall health.

Digital family medicine

Digital family medicine is defined as the use and employment of technological and digital technologies in diagnostic and therapeutic medical procedures through

computer data processing, meaning that the computer and digital infrastructure of technology in this family medicine and primary care constitute an essential part of the technology used. The introduction of software, medical imaging tools, robotics and other modern technology and digital technologies has led to many benefits such as accurate diagnosis, developing treatment plans, analyzing laboratory results quickly, detecting any health problems, reducing the burden on family doctors, and communicating between family doctors and patients [14]. Most digital technologies start as stand-alone solutions but will be implemented in more comprehensive digital networks soon. The use of digital technologies in family medicine has led to significant development in its fields in terms of the speed of completing treatment procedures, cooperation between family doctors and other health care workers, continuous follow-up of the progress of treatment for patients, management of chronic diseases, improving health care outcomes and achieving patient satisfaction. Digital family medicine and the development of technical means also contribute to predicting future diseases and risk factors, thus increasing the level of safety in medical procedures and reducing the risk of complications [15]. However, we must distinguish between the effects of digitization and artificial intelligence. Artificial intelligence is a logical part of digitalization that uses algorithms and machine learning to automate tasks that traditionally require human intelligence [16].

Artificial intelligence in family medicine

Artificial intelligence is associated with the ability to simulate human mental abilities and perform activities and tasks that require human intelligence, through computer systems. AI applications are diverse in various activities and fields. In primary healthcare, AI and machine learning (ML) are used in the diagnosis and treatment of many diseases. The main areas of AI use in medicine include health monitoring, patient data management, drug development, surgery, teleconsultation, medical statistics, personalized therapy, and medical imaging [17].

Digital technologies and artificial intelligence help in diagnosis

Accurate medical diagnosis is essential in primary health care. Modern technological techniques rely on a large database that contributes to the accuracy of diagnostic procedures. Machine learning (ML) based on artificial intelligence contributes to more accurate diagnosis, decision-making, and treatment plans. Technologies such as convolutional neural networks (CNN) are applied to detect disease patterns from large data sets, which contributes to the diagnosis of diseases such as cancer, diabetes, and heart disease. The literature indicates the ability of artificial intelligence to reduce diagnostic errors and improve the ability to diagnose accurately. In emergency departments, AI contributes to improving patient flow, diagnosing critical cases, and reducing diagnostic errors, which helps improve treatment outcomes and reduce waiting times [18].

Digital technologies and artificial intelligence help in treatment

Digital applications and artificial intelligence contribute to predicting the extent of the patient's response to treatment, which enhances clinical decision-making by primary care physicians and adjusting treatment plans according to the patient's progress and

response to treatment [19]. The results of a study on cancer patients indicated the ability of artificial intelligence to predict the patient's response to chemotherapy [20]. Another study showed the use of electronic health records to predict the patient's response to antidepressants using artificial intelligence models, which opens the door to developing clinical decision support systems to select the most effective treatments [21].

Digital Applications and Artificial Intelligence in Population Health Management

Digital applications, AI tools, and machine learning (ML) contribute to predictive analytics. Predictive algorithms are used to analyze data, improve patient outcomes, and reduce costs, especially in identifying patients at risk for chronic diseases such as heart and endocrine diseases [22]. By analyzing factors such as medical history, demographic data, and lifestyle factors, patients at higher risk of these diseases can be identified and appropriate interventions can be directed.

These digital applications also contribute to remote monitoring of patients and analyzing the risks they may be exposed to, thus determining the need for medical intervention. Another application of predictive analytics is predicting hospital readmissions. Using demographic data, medical history, and social factors, patients at risk of readmission can be identified and interventions directed to reduce these cases, which contributes to reducing costs and improving health outcomes [23]. AI can also help automate some tasks in public health management such as coordination and care, which contributes to reducing costs and improving care. On the other hand, the use of predictive analytics in Saudi Arabia, such as the "Sehaa" tool that uses Twitter data to detect diseases, shows great potential in population health management [24]. These tools can improve targeted interventions to address chronic diseases in the country. However, the success of predictive analytics depends on the quality of the data and the technology used.

Telemedicine with Digital Technologies and Artificial Intelligence

Given the increasing prevalence of chronic and infectious diseases, the need for digital applications and artificial intelligence tools provides innovative solutions for family doctors in providing primary care services to patients [23]. These tools rely on smart robots that simulate family doctors and provide healthcare to patients based on the patient's information and condition. They also help patients identify symptoms, provide medical advice to patients, monitor vital signs, and collect daily health data and send it to the doctor [25].

The advantage of these tools is that they are available around the clock, making it easier for patients to access healthcare when needed. Smart voice devices also provide significant benefits for elderly patients and those with chronic diseases. In general, virtual health assistants can improve the quality and efficiency of healthcare and reduce costs, which enhances patient interaction and improves their experience [23,25].

Digital Applications and AI in Enhancing Patient Education and Alleviating Healthcare Provider Burnout

This technology contributes to increasing patient education and raising awareness about public health through AI-powered chat in healthcare contexts. Patient education is an integral part of healthcare and one of the main tasks of the family physician, as it enables individuals to understand their medical diagnosis, treatment options, and preventive measures. Researchers have found that ChatGPT, an AI chatbot created by OpenAI, can help diabetes patients understand their diagnosis and treatment options, monitor their symptoms and adherence, provide feedback and encouragement, and answer their questions [26].

The Future of Digital Family Medicine: Key Considerations

The shifting global healthcare landscape and increasing demand for healthcare poses many challenges to healthcare practitioners, especially family physicians. As mentioned, family physicians are the first line of defense in primary healthcare, so patients and society have increased expectations of what a family physician should deliver [27]. To effectively address these changes and challenges, five key priorities have been identified for the future of digital care:

1. **Stakeholder engagement:** Primary healthcare professionals and patients must play an active role in the design and development of ongoing digital solutions to ensure they meet real-world needs [28].
2. **Infrastructure and training:** It is imperative to prioritize the development of infrastructure, support systems, and training for both healthcare providers and patients. This includes improving the infrastructure for data reuse, and ensuring that data, algorithms, and workflows adhere to the FAIR (Findability, Accessibility, Interoperability, and Reusability) principles [29].
3. **Data sharing and regulation:** Clear regulations and best practices must be put in place to promote data sharing and ensure the quality of digital health solutions. This could include digital health accreditation standards that prioritize person-centered care, user experience, and equitable access [27].
4. **Patient safety and privacy:** Protecting patient privacy and ensuring informed consent is paramount. Patients must have confidence in their health data and be assured that it will not be misused or shared without their permission [23].
5. **Addressing health inequities:** Digital technologies should eliminate existing health inequities. They should also foster collaboration between healthcare professionals, policymakers, and patients, which will achieve equitable and inclusive access to healthcare for society [30].

Conclusion

Khaled Abdullah Dhafer Alghamdi, Sultan Hamed Hawash Alanazi, Halimah Ibrahim Sulaiman Alhifzi, Abdulrahman Mousa Qasem Alanazi, Shaima Abdulkareem Battah Alduaiji, Rakan Ali Saud Alhamoud, Nouf ghazi S Abuhekmah

Digital technologies and artificial intelligence are reshaping the family medicine landscape, with tremendous medical advances improving the accuracy of diagnosis, treatment, and overall health management. AI tools and digital applications are helping to enhance primary healthcare, clinical decision-making, treatment planning, and continuous patient monitoring, thereby improving healthcare outcomes. In Saudi Arabia, the adoption of these technologies has accelerated due to the challenges posed by chronic diseases, population growth, and pandemics such as COVID-19. These innovations not only improve clinical efficiency, but also enhance patient engagement, education, and satisfaction. As healthcare systems continue to evolve, it is critical to prioritize infrastructure, training, data sharing, and patient privacy to ensure the successful integration of digital solutions. Furthermore, addressing health disparities and promoting universal access to digital healthcare technologies will be essential to maximize the benefits of these advancements for all segments of society. The future of digital family medicine holds great promise in enhancing the quality, accessibility, and efficiency of primary healthcare.

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