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Review article

Artificial Intelligence in Health care and its application in Saudi Arabia

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Background

In recent years, the utilization of Artificial Intelligence (AI) has increased dramatically with the launch of vision 2030 in Saudi Arabia (SA). Vision 2030 is a quality-driven mission set to make SA one of the most efficient countries in healthcare.

SA has launched several initiatives for the national digitalization mission. The Saudi Data and Artificial Intelligence Authority (SDAIA) has been established for that purpose, other entities including the National Healthcare Command and Control Center (NHCCC).

The most successful and promising application of AI so far is in diagnostic radiology and conceptualizing a personalized health plan. With the current trend in precision medicine, AI will be a valuable asset in producing an individualized healthcare plan.

The potential for AI has been amplified throughout the Covid-19 pandemic and has accelerated the agenda for an immediate execution plan. In each phase of the pandemic, AI has been integral to identifying novel strains of the virus, undergoing containment measures, and assisting in the public's adherence to them.

This review explores the potential of AI in healthcare, its drawbacks, and the role of AI in the national health transformation mission launched by SA. Despite the potential of AI in healthcare, it has significant limitations, mainly the lack of institutional resources and inadequate training of healthcare workers.

Summary

The potential of AI is nearly limitless, but only a fraction of its capabilities have been explored. SA has launched several initiatives to utilize AI in healthcare, including multiple health mobile apps, telemedicine, and electronic medical health records. These initiatives formed a cornerstone in helping SA handle the pandemic more efficiently.

Keywords: ***Artificial Intelligence, Healthcare Digitalization, Mobile Health***

Introduction

AI is often thought to exceed human capability in some aspects, specifically, quick computation in subjects that require analysis of large quantities of data, done by AI in a fraction of the time a human would take to do a similar function. This carries economic benefits, both cost and time-wise. It would facilitate work that requires several results to be calculated then read simultaneously, thereby leaving healthcare staff with the space and time to work on other issues, distributing the work in a more time-effective manner. This carries over when considering the fact that this helps to speed up the process of accurately diagnosing and treating patients, making the time of staff more effective and freeing up beds more often. This saves both time and money within the community as a whole.

The capabilities of AI stretch as far as dealing with global challenges such as organizing healthcare staff placement worldwide in case of staff shortage and solving inequality concerning access to healthcare in low-resource countries [1-5]. AI technology and what we may achieve with its use play an important role in the betterment of healthcare delivery in many ways. A list of important aspects are discussed here.

Discussion

With the rapid development of technology, AI has been applied with a wide range of purposes, especially in healthcare. AI has the opportunity to bring important health issues to light [6]. Given its broad, dynamic, and rapidly growing capabilities, AI has been applied in the field of medicine since as early as the 1950s when physicians made the first attempts to improve their diagnoses using computer-aided programs [6].

Theory, methods, and models from artificial intelligence (AI) are changing the health care landscape in clinical and community settings and have already shown promising results in multiple applications in healthcare, including integrated health information systems, patient education, geocoding health data, social media analytics, epidemic and syndromic surveillance, predictive modeling and decision support, mobile health, and medical imaging (e.g. radiology and retinal image analyses) [7].

Among the currently successful ventures, medical imaging diagnosis is showing the greatest results so far, demonstrating high diagnostic accuracy [8]. Most specialties rely on medical imaging for a clear diagnosis, and it has become a staple in healthcare. Since the 1960s, computational approaches have been applied for radiological diagnosis [8]. With the use of modern AI, radiological diagnoses are now more highly accurate in cases such as lung cancer screening and classification of lung nodules [8]. In spite of this, AI cannot be relied on to perform diagnostics on its own and must be assisted by a radiologist for the best results [9].

Health intelligence is a fundamental block in personalized healthcare, which is defined as managing diseases while considering each individual's variations in genes, environment, and lifestyles [10]. Artificial intelligence helps personalized healthcare by collecting and processing personal data from multiple sources, and preferences of patients and their families to help create care that is more specific and personalized for each patient, and delivering tailored therapy [10].

Furthermore, there has been a drastic improvement in machine learning algorithms with the introduction of deep learning technology, which is used for pattern recognition [11]. Machine learning has improved to the point that it became very similar to the ability of an average human in performing specific tasks such as image and speech recognition [11].

One of the major goals of vision 2030 is to be listed as one of the top 10 countries by 2030 [12]. The significant increase in the proportion of patients who receive complete medical treatment within a certain amount of time, from emergency room entrance to exit from hospital, without sacrificing the quality of care is one of the goals of Vision 2030 [13]. Being able to increase this proportion from 36% to 54% will, without doubt, need a good health plan [13].

Saudi Arabia has been working to digitally transform many of its sectors since the launch of the national agenda, Vision 2030, in 2017 [14]. Digital transformation or digitization is redefining the organization's process and systems digitally which is a key factor for the Saudi Vision [12]. It is reinventing the experience, communication, and overall efficiency of organizations by artificial intelligence and analytics [12]. The Saudi Data and Artificial Intelligence Authority (SDAIA) was established in August 2019 by a Royal Decree to facilitate the transition and help achieve Vision 2030's goals and reach KSA's fullest potentials [15]. SDAIA's core mandate is to support and drive the data and AI agenda within the Kingdom, and its vision is to position KSA as a global leader in the elite league of data-driven economies [15].

Saudi Arabia expects communication technology (ICT) usage and digitization to accelerate the execution of the plans and programs envisaged in the Vision 2030 blueprint and the NTP, and help drive economic and social development, promote good governance, and enhance national security [12].

Technology will be a key enabler and driver of the numerous changes envisioned by Vision 2030, with the goal of developing the nation's digital infrastructure [12].

Saudi Arabia's initiatives in digitalizing healthcare

Saudi Arabia's government and private sectors combined developed and launched around 19 various apps and platforms that serve public health functions and provide health care services for the health industry [14]. A detailed account of each is provided. In addition, Education processes continued using an established electronic learning infrastructure with a promising direction toward wider adoption in the future [14]. In 2017, as part of Vision 2030, the Ministry of Education (MOE) established the National Center for e-Learning. This center serves to supervise and support eLearning in Saudi Arabia. The current COVID-19 pandemic poses immense challenges to maintaining the continuity of educational services across the Kingdom [14]. All educational institutions, including higher education institutions, continued delivery of education during the lockdown. Both public and private institutions used various two-way e-learning methods to continue teaching and student learning. This ranged from individual institute-based platforms such as Blackboard and McGraw-Hill Connect to common commercial platforms such as Zoom, Google Class, and FaceTime [14].

The government of Saudi Arabia has implemented and is supporting and financing the further implementation of electronic health (e-health) services in diverse healthcare facilities in different parts of the country [16].

E-health refers to automating the delivery of healthcare instead of doing it manually [13], which makes it more efficient. It also allows patients and healthcare workers to access and manage data in ways that were impossible previously, and it facilitates and improves the collaboration among various health sectors and healthcare professionals [16].

The Ministry of Health of Saudi Arabia has a vision which is to advance standards, quality, accessibility, and equability of healthcare in the country [16.] As that being said one of the areas of digital transformation of healthcare in Saudi Arabia is health informatics approaches such as clinical decision support systems (CDSS) and electronic medical health records (EMR), which have improved healthcare delivery, the interaction between patients and healthcare workers, and reduced costs [16].

Telemedicine and mobile health have also been used and implemented in Saudi Arabia. They have been beneficial in improving the accessibility of health services, especially for patients such as the elderly who may have difficulties in reaching healthcare providers more than others [16].

Implementing e-health in Saudi Arabia has helped in the creation of evidence-based medicine by using the data generated from these sectors, and it is contributing positively to the development of effective healthcare policies and programs [16].

Although the government of Saudi Arabia is making efforts to implement e-health services, there are some challenges faced, such as the lack of resources of some healthcare institutions, lack of skills and knowledge of some healthcare workers.

National Healthcare Command and Control Center

The Ministry of Health (MOH) of Saudi Arabia has defined the Command-and-Control Center as the "Public Health Emergency Operation Center that ensures a timely and rapid response to Health Events with relevant local and international stakeholders, which oversees MOH's preparedness for public health events and leads health surveillance to handle national and international health threats" [17]. The Command-and-Control Center has three main functions: Preparedness; thorough preventive measures, Surveillance as monitoring threats, and Rapid response to public health events [17].

The MOH National Healthcare Command Center (NHCC) was established in 2019 in Riyadh, which has been active throughout the COVID 19 pandemic [18]. NHCC used both artificial intelligence and human actions to improve healthcare [18]. It is believed that because Saudi Arabia witnessed the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) epidemic in 2012, its public health and infection control measures have improved, becoming useful later when the country dealt with COVID-19 [19]. Despite that some organizations have used the Health Care Incident Command System (HICS) in the preparation of Ebola outbreak 2014, COVID

19 pandemic is very challenging in which the HICS needed to be better prepared [20].

The concept of the Virtual Incident Command Center was explained by an article published in 2006. At the beginning, the article potentiated the need for a standardized center facing incidents including natural catastrophes. However, incident management has been difficult due to many factors including; geographic dispersal, requirement of visual information such as diagrams and the need for communication and discussion. We can overcome these factors using the Virtual incident Command system in which participants communicate, make decisions without being physically there, and they can share images, maps and 3D locations [21].

Vision and strategy

The NHCC has established real-time surveillance systems, comprehensive information platforms and communication facilities which assisted in achieving the Initiation, Integration, and Innovation that enabled them to respond to various crises such as communicable disease outbreaks, biological disasters, and medical emergencies. It also assesses and addresses risks before and during their occurrence.

It can coordinate with officials at all levels as well as provide comprehensive information and insight to decision-makers regarding the current situation and public health emergency to help them anticipate and take action in a timely manner. Therefore an effective and rapid response of all units to the crisis will ensure the safety and health of our citizens [22].

Application of AI during the Covid Pandemic

Role in Covid Pandemic (Phase One)

The first few months of 2020 have profoundly changed the way we live our lives and carry out our daily activities. COVID-19 pandemic has dramatically accelerated the adoption of Artificial Intelligence (AI) in different fields. We have witnessed the equivalent of two years of digital transformation compressed into just a few months.

AI is usually applied as a data-driven approach to complex problems since the relations involved are usually hard to describe by mathematical or statistical models. It means that the type of data strongly influences the AI methodologies to be adopted in a specific context [23].

AI could have a significant impact in preventing the outbreak of a pandemic by adopting methodologies and general-purpose tools able to adapt themselves to critical scenarios quickly. Infectious disease monitoring, drug repurposing, fast and accurate data analysis, social media analytics, and learning methodologies for the early detection of human diseases are topics where AI could play a crucial role [23].

In the specific case of the COVID-19 pandemic, the first accessible scientific information was the SARS-CoV- 2 whole genome sequence, used to identify potential drugs for its treatment. Based on these data, the detection of medicine candidates and possible drug combinations targeting the COVID-19 virus has been explored through drug repurposing approaches to reduce the time and lower the cost in comparison with ex-Novo drug discovery. At the same time, thanks to AI applications, techniques have been developed to gain a more in-depth understanding of the pathogen: for instance, methodologies that can provide a rapid classification of novel viruses, identifying their intrinsic genomic signatures, can be used to recognize similarities with other known pathogens [23].

On 11th March 2020, the WHO Director Dr. Ghebreyesus used the term 'pandemic' to characterize the outbreak of COVID-19. Countries such as Italy, Iran, South Korea, and Japan had registered growing numbers of cases by that time, with the virus spreading to over 100 countries and infecting more than 120,000 people [23].

One of the main issues in this phase is to minimize the pandemic's impact on healthcare systems. The importance of containment measures becomes central to prevent catastrophic situations, and tools to enhance estimations of the number of infected people in specific geographical locations can allow wise planning of ICUs and emergency structures. In these different contexts, methodologies based on AI models start to be developed to support the quarantine verification task. As a first attempt, AI can support video surveillance systems to check the correct usage of masks or enhance public health monitoring through IoT data. Furthermore, simulation toolkits, providing estimates of the epidemiological parameters combined with components seeking the optimal trade-off policies between the decision makers' constraints and goals, evidence how AI models can be used to model problems connected with the spread and impact of infectious diseases based on geographical and time data as inputs.

Concerning COVID-19, the SARS-CoV-2 virus has been found to frequently attack the lungs, causing pneumonia-related issues; therefore, the principal diagnostic tool consists of medical imaging for this kind of disease. In this context, AI has a most useful application in diagnostic tasks due to the well-known capabilities of, in particular, DL models to work in the field of image segmentation and recognition. Thanks to data collected during the earlier phases and to the collaborative effort of scientists worldwide, some previously conjectured strategies can now be applied in real context [23].

In addition to the measured accuracy of the applied strategies, in this phase of a pandemic, the diagnosis's timing is also essential. Early diagnoses allow efficient planning in patient sorting, reducing the pressure on medical structures, and managing hospitalization. In this context, AI can be applied to rapid examinations, such as lung ultrasonography (LUS) images or blood counts to obtain an estimation of the degree of severity of the disease, and thereby to organize more efficiently admissions to ICUs [23].

Post-covid (phase-two)

Thanks to restrictive methods and adequate detection and surveillance, at this phase the spread of the virus is contained and the number of new cases have begun to decrease [23]. The spread of infection can be controlled by simple basic methods such as social distancing, but this method leads to a negative impact on society and economies [23]. To reduce the need to use these restrictive methods, using smart strategies can be the key, and here came the rule of AI. AI was applied in several different aspects, providing tools that can detect early symptoms such as automated measurement of body temperature in public spaces [23]. Many countries have used phone applications that alert people with a warning of potential close contact with people who are infected, or people suspected to be infected. These strategies have helped a lot in the identification of potential outbreaks and in avoiding theme [23].

The final phase of a pandemic is defined by WHO GIP (2009) as the post-pandemic phase. In this phase, the virus presence might be endemic, and the infection rate is comparable with that of seasonal influenza in countries that monitor it appropriately [23].

Conclusion

As the application of AI in healthcare has increased recently, numerous benefits have been shown but its limitations have been revealed as well. Saudi Arabia made a tremendous effort to utilize AI in a short period, ventures ranging from national digitalization to mobile health apps. Covid-19 is a challenge to the healthcare system globally, although the impact of Covid-19 has been mostly negative, the pandemic has forced SA for prompt AI application, and as a result, we have witnessed an exponential growth in digital transformation.

Statements

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Authors 11, 12, 13, 14, and 15 conceived of the presented idea. Authors 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 16 helped supervise and compile the project. Authors 10 and 16 helped to format, edit, and proofread. All authors discussed the results and commented on the manuscript.

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