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An Analysis of AI's Function in Medical Aspects

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Abstract

Applications of artificial intelligence (AI) have revolutionised healthcare. This study conducts a comprehensive literature review to elucidate the role of AI in healthcare, concentrating on the following key areas: (i) medical imaging and diagnostics, (ii) virtual patient care, (iii) medical research and drug discovery, (iv) patient engagement and compliance, (v) rehabilitation, and (vi) additional administrative applications. The influence of AI is evident in the identification of clinical conditions through medical imaging and diagnostic services, the management of the coronavirus disease 2019 (COVID-19) outbreak via early diagnosis, the provision of virtual patient care utilising AI-driven tools, the administration of electronic health records, the enhancement of patient engagement and adherence to treatment plans, the alleviation of administrative burdens on healthcare professionals (HCPs), the discovery of novel pharmaceuticals and vaccines, the detection of prescription errors, extensive data storage and analysis, and technology-assisted rehabilitation. This scientific proposal encounters several technological, ethical, and social problems, such as privacy, safety, autonomy, costs, information and permission, accessibility, and effectiveness, in the integration of AI into healthcare. The regulation of AI applications is essential for patient safety and accountability, as well as for increasing healthcare professionals' confidence in fostering acceptance and improving substantial health outcomes. Effective governance is essential to accurately tackle regulatory, ethical, and trust challenges while promoting the adoption and application of AI. The COVID-19 pandemic has catalysed a revolution in healthcare via the notion of AI, potentially advancing the fulfilment of future healthcare requirements.

Keywords: Artificial Intelligence; Ethics; Governance; Healthcare.

Introduction

Global health systems are at a pivotal juncture, with escalating healthcare costs that have significantly outstripped GDP growth rates, jeopardising the viability of health systems [1]. This issue was very clear with the onset of the 2019 coronavirus illness. The COVID-19 epidemic and the conflict in Ukraine. The confluence of constrained finances, an ageing population, rising chronic illnesses, and the pressure on healthcare institutions that have historically failed to meet heightened demand for service accessibility and availability is evident. The COVID-19 pandemic is causing health system failures in several nations, such as India, Brazil, and Indonesia.

Health systems rely on robust disease management protocols and evidence-based care strategies to address needs and standardise practices in accordance with industrial healthcare delivery services. The notion of a Highly Reliable Organization (HRO) underscores the management of its services by either an Accountable Care Organization (ACO) or a Health Maintenance Organization (HMO). The prevalence of chronic illnesses in the United States is consistently rising; 60% of individuals are afflicted with one chronic condition, while 40% suffer from more than two, resulting in yearly healthcare expenditures of USD 3.3 trillion. Furthermore, this scenario rapidly evolved with the emergence of the infectious illness initially reported in Wuhan, China, in 2019, which was officially named COVID-19 by the World Health Organization on 11 February 2020 [5]. Since that time, healthcare has been experiencing a digital transition that will alter many of the essential components of medical care. This disease may result from the substantial pressure imposed by COVID-19 on global healthcare systems, including infrastructure, supply chains, and personnel. The epidemic compelled healthcare stakeholders to embrace digital technology [7,8]. Significant basic transformations occurred in the healthcare industry during the post-pandemic period. Current-generation patients exhibit active participation in healthcare-related decision-making, attributed to the heightened acceptability of virtual healthcare systems and corresponding digital advancements [9]. Nonetheless, significant obstacles may arise, and the solutions to address them will facilitate the transition to the next healthcare era. Patient experiences and requirements drive developments in the healthcare industry. Their primary focus is the establishment of digitally enhanced physician–patient interactions and ensuring the availability of patient-centric services worldwide [10]. The deployment of modern digital devices is essential for enhancing customer happiness, enabling tracking, monitoring health state, and improving medication adherence [11]. These elements would be more advantageous throughout the post-hospitalization phase using digital health platforms. Simultaneously, healthcare consumers are apprehensive about disclosing their sensitive information; thus, healthcare organisations (HCOs) must maintain customer confidence by demonstrating openness, empathy, and dependability in their services [11].

The emergence of biomedical science, encompassing genomics, digital medicine, artificial intelligence (AI), and its subset, machine learning (ML), underpins the transformation of healthcare, necessitating a new labour force and standards of practice. Genomics and other technologies, including as biometrics, tissue engineering, and the vaccine sector, have the potential to enhance and revolutionise diagnostics, treatments, care delivery, regenerative therapies, and precision medicine frameworks [12]. Table 1 delineates the meanings of terminology pertinent to AI.

Digital health technologies (DHTs) encompass mobile health (mHealth), health information technology (HIT), wearable devices, telehealth, telemedicine, mobile Internet devices (MIDs), and personalised medicine. Recently, advancements in artificial intelligence, the metaverse, and data sciences are impacting smart health. These technologies provide enhanced prevention, early identification of life-threatening disorders, and remote management of chronic conditions outside traditional care settings, such as via wireless observed therapy (WOT), using an innovative approach to monitoring treatment adherence [39]. The most promising approach is to provide and administer health services ubiquitously and at any moment in the era of disruptive and minimally invasive medicine. MIDs enable the receiver to access essential resources, including related apps and social media platforms. The uses of MIDs are extensive and allow professionals access to scientific databases such Medscape, Web of Science, and Scopus. Social media networks, including YouTube, Facebook, WhatsApp, Wikipedia, and other instant messaging software, are accessible to both professionals and non-professionals. Digital health modalities using AI in healthcare are rapidly advancing in the post-COVID-19 age [4].

Artificial Intelligence, Machine Learning, and Digital Health Technologies have catalysed a transformation in healthcare, particularly after the disruption of the global healthcare system by COVID-19. Currently, AI is incorporating emerging technologies, such as the Internet of Things (IoT), with the decentralised health technologies used by customers. With the extensive integration of AI and ML in healthcare systems, the IoT is anticipated to evolve into the intelligence of things; the application of acquired data will modify processes, hence influencing behaviour and values. Moreover, advanced medical technology, namely AI-driven solutions, has garnered much interest among the general populace, as it facilitates the implementation of the 4P model of medicine—predictive, preventative, personalised, and participatory—thereby enhancing patient autonomy. The integration of AI into healthcare has shown improvements in efficiency, speed, and cost-effectiveness.

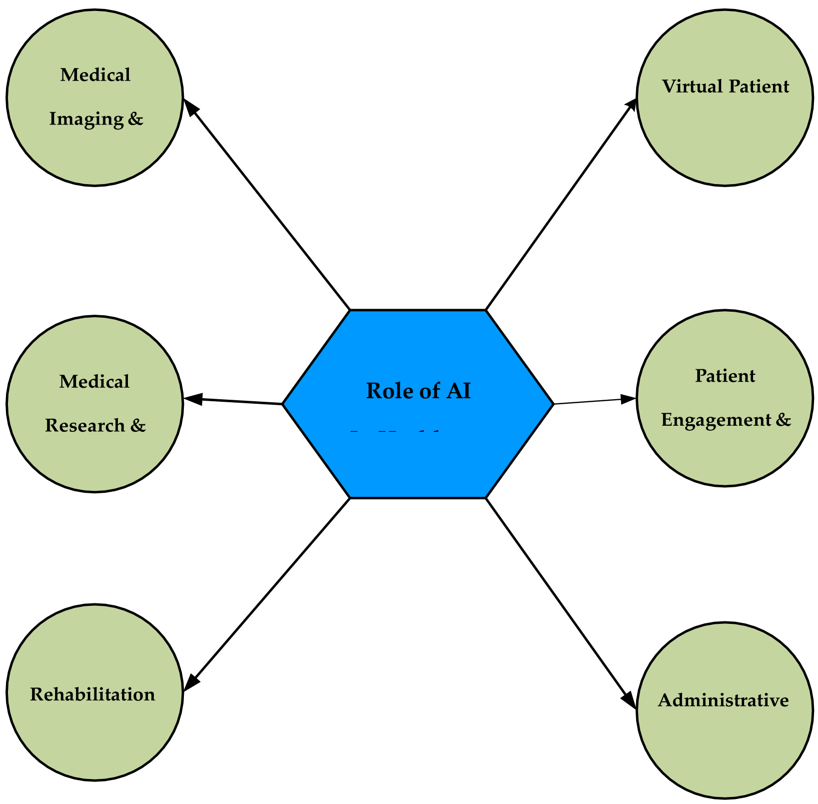

Figure 1. Utilisation of artificial intelligence in several facets of healthcare.

Digital health solutions provide healthcare professionals with a comprehensive perspective on patient health by enabling access to patient data. They also enable individuals to get additional health statistics from their providers. These have genuine chances to enhance treatment outcomes and effectiveness; nonetheless, there are apprehensions about the potential psychological impact, especially with the prevalent use of SM and IMAs by patients, the public, and professionals [3]. Furthermore, aggregated data from various sources, including health information systems (HISs), wearable devices, telemedicine, mHealth, telehealth, medical imaging devices (MIDs), and other

AI-driven medical technologies, generate substantial datasets that enhance the application of machine learning (ML) and artificial intelligence (AI) in healthcare systems. This is achieved through the learning processes derived from the data collected from these sources, encompassing research information, user experiences, and the analysis of extensive datasets. Moreover, electronic health Electronic Health Records (EHRs) include diverse patient healthcare data. Health statistics may be integrated utilising advanced AI technology to provide precise insights into patient treatment. Artificial intelligence has emerged as a viable option for large-scale data applications in healthcare [6]. Furthermore, big data analytics empowers healthcare providers to enhance their clinical services by optimising electronic health records using analytical algorithms [47]. This analytics use AI advancements to filter extensive data across several criteria for enhanced data analysis [4]. This review aims to elucidate the role of AI in healthcare, emphasising the following key aspects: (i) medical imaging and diagnostics, (ii) virtual patient care, (iii) medical research and drug discovery, (iv) patient engagement and compliance, (v) rehabilitation, and (vi) other administrative applications. Furthermore, the authors discuss several problems associated with the use of AI in healthcare. These findings enhance the current literature by advancing the advantages of AI technologies in healthcare.

The Function of Artificial Intelligence in Healthcare

Medical Imaging and Diagnostic Services

Artificial intelligence is an influential instrument for image analysis, increasingly used by radiology experts for the early detection of various illnesses and for minimising diagnostic inaccuracies within the realm of prevention. Similarly, AI serves as an intelligent and promising instrument for the analysis of ECG and echocardiography charts used by cardiologists to enhance their decision-making processes. The Ultromics platform, described at an Oxford hospital, employs AI to analyse echocardiogram images that detect heartbeat patterns and identify ischaemic heart disease [49]. Artificial Intelligence has shown promising outcomes in the early identification of ailments like breast and skin cancer, ocular illnesses, and pneumonia using body imaging techniques [50–52]. AI techniques evaluate speech patterns to predict psychotic events and identify features of neurological disorders, including Parkinson's disease [3]. A new research forecasted the development of diabetes via machine learning techniques. The findings indicated that a two-class augmented decision tree was the most effective model for predicting several diabetic factors [55]. Moreover, various medical imaging modalities, such as X-ray, computed tomography (CT), and ultrasound (US), using AI methodologies have substantially aided in the early detection of COVID-19. Their findings indicated that all handmade feature learning (HCFL), deep neural networks (DNN), and hybrid methodologies successfully predicted COVID-19 instances. A recent study elucidated the use of CT scans, X-rays, MRIs, and ultrasounds in the diagnosis of COVID-19. It said that AI has been crucial in assisting the public in combating the formidable pathogen [5]. Additionally, a deep learning model known as a transformer is used in medical imaging analysis, including registration, detection, classification, image-to-image translation, segmentation, and video-based applications [34]. Prior research elucidated the use of transformers in distinguishing COVID-19 from pneumonia by X-ray and CT imaging to fulfil the critical need for the rapid and effective management of COVID-19 patients [5]. A further research used the ImageNet-pretrained vision transformer (ViT)-B/32 network to identify COVID-19 using inputs including patches of chest X-ray images [60]. Wang et al. [1] developed a novel hybrid technique using chest CT for the automated detection of COVID-19. This is a computer vision diagnostic method using wavelet Renyi entropy (WRE) and an innovative three-segment biogeography-grounded optimisation (3SBBO) algorithm. It consists of WRE, a feedforward neural network (FNN), and the 3SBBO algorithm. WRE extracts image features; 3SBBO optimises the network's biases and weights; and the FNN classifies the images. This technique demonstrated superior performance compared to the kernel-based extreme learning machine, extreme learning machine using the bat algorithm, and radial basis function neural network in the detection of COVID-19. Furthermore, Gheflati et al. [6] indicated that the ViT is used to classify normal, malignant, and benign breast tissues using ultrasound (US) pictures. It demonstrated superior performance in classifying US breast pictures compared to convolutional neural networks (CNNs).

Moreover, AI encompasses the use of artificial neural networks, specifically deep learning methodologies known as Generative Adversarial Networks (GANs), which influence the domain of radiology. GANs include two artificial neural networks: (i) a generator that produces pictures like genuine ones, and (ii) a discriminator that identifies the distinction between synthetic and actual images. In radiology, the generative model may replicate pictures in accordance with the training data and generate new images that exhibit the characteristics of the training dataset. The discriminant model is trained to categorise pictures, such as determining if a radiograph indicates the presence of pneumonia. The conclusion was that the generator model, when trained with the discriminator model, may enhance radiological tasks such as anomaly detection, image synthesis, and cross-domain image synthesis [63]. Proficient radiologists struggled to differentiate between lung cancer nodule pictures produced by GANs and authentic images [4]. Furthermore, GANs provide a significant possibility to enhance medical teaching and research. They rapidly create instructional materials and simulations for student education. For example, when students struggle to distinguish between "lower lobe collapse" and "consolidation," representative samples of each condition might be created and shown to them. Consequently, synthetic data may enhance student learning by providing resources for edge-case scenarios. Synthetic control arms have been created by modelling placebo groups based on historical data, which reduces the need for an actual placebo group, hence lowering expenses and increasing the number of treatment arms in clinical studies [6]. Furthermore, ChatGPT is a deep learning-based big language model used by the public for medical guidance, thereby raising significant concerns. The public may be inclined to use such a model to ascertain potential diagnoses based on clinical characteristics or to get treatment recommendations, so substituting expert medical advice [66]. A prior research conducted in the United States revealed that around one-third of individuals sought Internet-based medical information for self-diagnosis. Consequently, almost fifty percent of them sought medical advice on the Internet-based results [7].

In addition, AI-driven medical practice, particularly in medical imaging-guided diagnosis and treatment, is supported by a metaverse of "medical technology and AI" (MeTAI). The essential uses of MeTAI include "virtual comparative scanning," "raw data sharing," "augmented regulatory science," and "metaversed medical intervention." The MeTAI ecosystem is executed as follows: The patient's scans are first simulated using virtual machines to determine the optimal imaging result prior to the real CT scan. A genuine scan is conducted based on this information. Subsequently, the metaverse pictures are sent to the patient's medical team upon the patient's consent. In accordance with security protocols, the tomographic raw data and pictures are sent to the medical researchers. The aggregation of authentic and simulated visuals, data, and additional medical evidence may be integrated into the metaverse and used in enhanced clinical trials. Finally, the patient has a metaverse-assisted remote robotic procedure and is thereafter monitored in the metaverse for rehabilitation if deemed therapeutically necessary. MeTAI encounters issues including security, inequality, investment, and privacy [8].

Moreover, medical scans are methodically collected and stored for a duration, and are readily accessible for the training of AI systems [6]. These AI systems may decrease the time and expense associated with analysing medical scans, perhaps allowing an increased number of scans for more focused management. Artificial intelligence is influencing clinical decision-making and illness diagnosis. It can process, analyse, and present extensive data across several modalities for illness diagnosis and clinical decision-making. It may assist doctors in making superior clinical judgements or perhaps replace human judgement in therapeutic areas [7]. Moreover, studies using computer-aided diagnostics have shown exceptional sensitivity, accuracy, and specificity in detecting subtle radiographic anomalies, with the potential to enhance public health. However, outcome evaluation in AI imaging investigations is often characterised by lesion identification, neglecting the biological severity and characteristics of a lesion, which may result in a distorted representation of AI performance. Furthermore, including non-patient-related radiological and pathological endpoints may enhance the anticipated sensitivity, but at a cost risk escalating false positives and potential overdiagnosis by identifying modest anomalies that may resemble latent illness [2].

Telehealth Services

the progression of wearable technology and the prospects of using machine learning and artificial intelligence in healthcare is a concept that has been previously investigated. Consequently, patient monitoring and management via virtual care using active and intelligent wearable technology solutions have materialised and become integral to the standards of care. Furthermore, AI contributes to the management of chronic conditions like diabetes mellitus, hypertension, sleep apnoea, and chronic bronchial asthma via the use of wearable, non-invasive sensors. [74]. A prior research advocated for a sophisticated sensor system using an integrated sensor network to monitor an individual's residence and surroundings, therefore acquiring data on their health state and behaviour. The suggested platform comprises inconspicuous, biomedical, and wearable sensors. These sensors track physiological parameters like respiration rate, pulse rate, breathing waveform, blood pressure, and electrocardiogram (ECG). A smart device, such as a tablet, has been suggested to serve as an interface between the individual and the sensors. The gathered data are sent to the cloud for storage and analysis pertaining to geriatric care [75]. A case study by Patel and Tarakji [76] examined a woman in whom atrial fibrillation was identified as the likely aetiology of her stroke after a comprehensive negative evaluation. The patient was instructed to monitor ECG readings with a wearable digital gadget. Subsequently, her electrophysiologist validated the recorded data. Consequently, consumer wearable digital technologies facilitate achieving accurate diagnoses. The feasibility of constructing machine learning models to predict emotional states using mobile sensor data, capable of managing heterogeneous datasets with significant missing information. Such models might serve as important instruments for clinicians to evaluate patients' emotional states. Additional study is advised to address the issues of scarce and lost tagged data, enabling future efforts to concentrate on the development of more novel models.

The predominance of SARS-CoV-2 has led to the global COVID-19 pandemic, resulting in advancements in wearable technologies that assess physiological changes in biometrics and provide online active patient monitoring [8]. Wearable sensor data may serve as indicators for the early prediction of COVID-19. Furthermore, ongoing real-time research utilising wearable technology in COVID-19 cases will enhance understanding of clinical features often overlooked by users and validated through laboratory investigations, thereby improving the tracking and detection of COVID-19 outbreaks. Artificial intelligence using predictive models with machine learning and extensive data can forecast the development of some illnesses, including diabetic nephropathy, and diagnosis SARS-CoV-2 infection in solid organ transplantation. Yu et al. [81] underscored the need of incorporating AI into bedside care during COVID-19 and future pandemics after analysing interactions with new AI-enabled tools for point-of-care use in these scenarios. The COVID-19 epidemic has necessitated the emergence of remote healthcare services. Metaverse apps may provide a superior experience compared to typical videoconferencing-based telemedicine solutions [82]. A recent research indicated that the proliferation of telemedicine with metaverse development surged 38-fold during COVID-19 [6]. This rise may have resulted from the reduction in in-person consultations and the management of viral transmission risk during the COVID-19 pandemic [83,84]. It also disclosed the potential for new metaverse technologies, including virtual comparison scanning and raw data exchange, which would be consistent, user-friendly, and cost-effective, and would function well [8]. Moreover, metaverse systems may include augmented reality (AR) glasses, enabling users to view live video feeds and audio conversations for real-time interaction with physicians. Augmented reality systems enable users to establish direct connections and provide real-time updates on emergency situations, facilitating timely and efficient management by distant doctors. The use of contemporary technologies, including AI, telepresence, blockchain, virtual reality (VR), augmented reality (AR), and digital twinning, enables creative methods for delivering cost-effective management that enhances patient outcomes. The metaverse evolves a an online experience that simulates human emotions and movements. It encompasses the extensive financial and social frameworks of both tangible and virtual realms [86]. Moreover, AI might strengthen the metaverse framework to increase the 3D immersive experience and improve the fundamental services of virtual environments [7].

Remote patient monitoring (RPM) is a branch of telemedicine that enables healthcare professionals to observe, assess, and document patient states outside of conventional settings. RPM enhances the efficacy of medical interventions via the use of sensors and communication technology. It facilitates the remote assessment of health data or patient concerns. It also enables patients to interact with and acknowledge their health status [8]. The dependability of traditional patient-monitoring systems is contingent upon healthcare professionals' time management, which is influenced by their workload. This monitoring also includes invasive techniques necessitating skin contact to assess health status. Remote Patient Monitoring (RPM) in healthcare is accomplished via the integration of innovative Internet of Things (IoT) techniques, including contact-based sensors, wearable technology, and telehealth apps. It is often used to assess vital signs or other physiological parameters, including motion recognition, which may aid in medical decision-making or treatment protocols for conditions such as mental disorders and movement disorders [9]. Moreover, healthcare professionals used RPM systems to ensure the continuity of patient care during the COVID epidemic. A recent research assessed two remote patient-monitoring systems, the CareSimple COVID platform and the Telecare COVID platform, for the surveillance of COVID-19 patients. The two platforms were found to be well welcomed by COVID-19 patients, with little major variations in their experiences of the platforms. It is advisable to contemplate using these platforms throughout the post-pandemic and post-hospitalization phases [90]. In relation to RPM applications, traditional machine learning and deep learning are often used artificial intelligence technologies for the detection and prediction of vital signs, as well as for the classification of patients' physical motions. AI-driven RPM designs have revolutionised healthcare monitoring systems to identify early indicators of patient deterioration, analyse patient behaviour patterns using reinforcement learning, and customise the monitoring of health variables using federated learning. Nonetheless, AI has the potential to revolutionise RPM facilities; yet, it faces many obstacles, including privacy concerns, signal processing issues, data volume management, uncertainty, unbalanced datasets, feature extraction difficulties, and the need for explainability [9].

Additionally, ChatGPT, an artificial intelligence language model, was created by OpenAI. It operates as a more precise AI-driven chatbot capable of comprehending natural language dialogues and addressing customer enquiries. The ChatGPT-enabled chatbot provides information on a specific medical condition or treatment protocol. It provides accurate and up-to-date responses to the patient's enquiries on their clinical characteristics, medications, and treatment protocols in many languages. It delineates patients' medical information for healthcare professionals and may assist them in executing remote patient monitoring to maintain patient health. Additionally, it encourages patients to monitor their vital signs, enabling them to alert healthcare professionals in the event of any odd changes. It enables people to schedule consultations with doctors [1]. ChatGPT may also give replies for a software application that assists patients in managing their treatment, akin to a virtual assistant who reminds them to adhere to their medical prescriptions and provide information on their health state. The proliferation of virtual assistants for patients exemplifies the use of ChatGPT in the medical field. A virtual assistant may provide guidance in managing chronic conditions like diabetes or recommend over-the-counter medications or home remedies for individuals with influenza or colds. Digital platforms, including mobile apps, voice assistants, and websites, may be used to access these virtual helpers. Nonetheless, ChatGPT in healthcare has constraints, namely with medical ethics, data interpretation, privacy, security, permission, and responsibility [9].

Conclusion

Conversely, data connection is a drawback for deployed Wearable Patient-Monitoring (WPM) systems, since patients are confined inside fixed locations using low-Bluetooth-range monitoring equipment. Moreover, user acceptability is a critical component of WPM systems. It depends on user awareness, as well as the acceptability of patients and physicians. Cost concerns may emerge when using mobile data for communication across several time periods and data collecting [73].

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