Impact of Artificial Intelligence (AI) Technology in Healthcare Sector: A Critical Evaluation of Both Sides of the Coin

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ABSTRACT: The influence of artificial intelligence (AI) has drastically risen in recent years, especially in the field of medicine. Its influence has spread so greatly that it is determined to become a pillar in the future medical world. A comprehensive literature search related to AI in healthcare was performed in the PubMed database and retrieved the relevant information from suitable ones. AI excels in aspects such as rapid adaptation, high diagnostic accuracy, and data management that can help improve workforce productivity. With this potential in sight, the FDA has continuously approved more machine learning (ML) software to be used by medical workers and scientists. However, there are few controversies such as increased chances of data breaches, concern for clinical implementation, and potential healthcare dilemmas. In this article, the positive and negative aspects of AI implementation in healthcare are discussed, as well as recommended some potential solutions to the potential issues at hand.

KEYWORDS: Artificial intelligence, machine learning, healthcare, health services, drug design, public health

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Background

Artificial intelligence (AI) is the programing of computer systems to analyze, problem-solve, and make decisions just as a human would.[1] AI was first introduced in the 1950s with many limitations which made it difficult to be introduced into healthcare but has since developed into what we use today in modern medicine.[2] AI began as a simple system series that analyzed "if this, then this. . . rules" used broadly to advancement into algorithms personalized individually.[2]

Early AI in medicine from the 1950s to 1970s has not received much attention and has a lack of acceptance by the scientific communities.[2] This period was more focused on the ability to digitize all data into electronic medical record systems and clinical informatics databases. As well as aid in the development of today's search engines, such as PubMed.[3] The mid-1970s began the flourishment of biomedical search engines, expanding into universities such as Rutgers and Stanford.[2] This created an enhanced networking system for collaboration between several universities for research, later resulting in the first National Institutes of Health (NIH) workshop-the start of collaboration events of the future.[2]

The first of many prototypes of how AI in medicine could positively impact the future started in the late 70s with the introduction of the consultation program Causal-Associational Network (CASNET).[2] The program could use disease data, apply it to an individual, and give advice to the physician on how to help the patient manage the disease.[2] Later, a bacterial pathogen and antibiotic treatment diagnostic AI developed from MYCIN to EMYCIN to INTERNIST-1 in just a few years.[2] The evolution of this system elaborated on the already extensive AI medical knowledge to help assist primary care physicians (PCPs).[2] The AI program that prompted the most influence of AI in medicine was introduced in 1986-DXplain.[2] PCPs were able to input their patient's symptoms, and the program responded with a diagnosis, along with a description of the disease and additional references for the physicians.[2] The program started with 500 diseases and has now expanded to over 2400.[2] The early 2000s introduced Watson, an open-domain question-answering system.[2] This system used the electronic medical record with other electronic resources to provide physicians with evidence-based solutions to their patients' questions.[2] Watson was later expanded upon for the exploration of medical research into new areas. Thus, beginning the expansion of AI into other areas such as pharmacy and patient intake at primary care practices.[2]

Advancements in AI programs have been happening since it was first introduced in the 1950s.[2] The use of them has had a positive impact on the quality of medicine improving accuracy, consistency, and efficiency in all aspects. AI in medicine has evolved over the last 5 decades into personalized diagnostic, therapeutic, and preventative care. In this article, it is discussed how artificial intelligence can positively impact the future of medicine, along with its downsides.

Methodology

A comprehensive literature (Scopus indexed and Web of Science) search related to AI in healthcare, like AI background, and its positive and negative impacts on health settings, drug design, and development, disease screening, and treatment was performed in the PubMed database and extracted the relevant information from appropriate ones. Literature written only in English was selected for this review. The literature discussed the impacts of AI in other industries like automotive, robots, business, banking, etc. was excluded from our considerations.

Artificial Intelligence in Healthcare Services

AI is used daily in many areas of modern healthcare, from the online scheduling service for appointments to drug interaction warnings when physicians prescribe multiple medications to research development.[4] The most widely known and accepted evidence-based medicine used today are flowcharts and database research. A physician will take the patient's history, current symptoms, and lab results to determine the proper diagnosis and give the appropriate treatment plan. An AI system will do this same process, in a fraction amount of time and have greater accuracy because it can tap into multiple databases at once.[4] This is only a small area in which AI has tapped into modern medicine.

Other areas of medicine that have embraced AI include medical imaging, gastroenterology, surgery, and online consultations and therapy. Radiology has taken the largest leap into AI technology with its first use in image acquisition and storage, to now the use of computer-assisted diagnosis (CAD).[3] AI is on its way to helping to decrease the workload on radiologists with quick identification of negative exams and heightened turn-around time for abnormal ones.[5] In 2017, Arterys was the first FDA-approved deep learning application of AI in healthcare.[2] Deep learning (DL) can be used to detect lesions, compose reports, and create differential diagnoses.[3] The first product could analyze cardiac magnetic resonance images in seconds to measure ejection fraction, and since has evolved to liver, lung, chest, and musculoskeletal imaging, and non-contrast CAT scans.[2] DL has since expanded more, with the ability to screen diabetic retinopathy, identification of melanoma and nonmelanoma, prevention of cardiovascular risk, and prediction of Alzheimer's disease progression by analysis of amyloid data.[2]

The development of AI has helped in CAD in gastroenterology also. AI can be applied to colonoscopies to help in the identification and verification of benign versus malignant colon polyps.[2] With the use of the same AI technology, it has been used to differentiate between pancreatitis and pancreatic cancer – something once considered a challenge to determine.[2] On the other side, AI assistance has also been crucial for endoscopies. The AI CAD system has been deemed beneficial for the differentiation between adenomas and polyps, the improvement of imaging, and the development of prediction models for patient prognoses and treatment.[2] The use of AI for diagnostic procedures has since developed into aiding in surgical ones. Robotic arms are the way of the future for surgeries, starting in the fields of urology and gynecology. The robotic arms are set to mimic the surgeon's hands but with more precise movements and better magnification.[3]

The practice of AI within the PCP office to care for patients is rapidly turning into online consultations, advice visits, medication refills, orders of test kits, and much more. A patient can request a consultation with a specific physician based on how they fill out their questionnaire before the visit.[3] This questionnaire will answer the basic questions of past medical history and current symptoms, from that the AI will generate what the physician should order and treatment options.[3] The AI technology for PCP visits is slowly expanding into therapy facilities as well. AI therapy offers an online course for patients to use to help in the treatment of their diagnosis.[3] All the advancements of AI in medicine have come a long way, but there is always room for improvement and expansion.

Artificial Intelligence in Drug Design and Development

Recent studies have also found AI to be useful in reducing time and costs in pharmaceutical technology and drug delivery design.[6] More specifically, machine learning (ML: for forecasting drug absorption, distribution, metabolism, and excretion) and deep learning (DL: for predicting various pharmacokinetic parameters, such as drug absorption, bioavailability, clearance, volume of distribution, and half-life) algorithms can predict the pharmacokinetics and toxicity of potential drug candidates.[6,7] This can drastically reduce the need and purchase of animals for testing and similarly save time. Large companies such as Pfizer, Bayer, and Roche have announced that AI can help use data to make faster decisions and allow them to develop therapies in immune-oncology and cardiovascular diseases.[8,9] More specifically, AI may help in choosing which medications *not* to pursue, potentially mitigating the chances of a poor decision, and reducing the R&D cost.[8] In related cases, AI is being adopted in pharmacometrics to aid in describing non-linear relationships using ML-based techniques.[10] Although it is currently only in the simulation phase, the experimental results demonstrated that the trained network "was able to correctly predict the treatment effects across a certain range of dose levels."[10] In other words, the ML system was able to prescribe correct treatments up to a certain dosage. This shows the potential of AI in not only clinical cases but also in other fields of medicine.

Positive Aspects of Artificial Intelligence in Healthcare

AI has a variety of positive aspects related to its application in healthcare. Currently, it is primarily used in the diagnosis of cancer, neurological diseases, and cardiovascular diseases.[11]

Early detection of NCP plays an important role in transmission prevention and positive outcomes in treatment.[12] Additionally, in the diagnosis of v-raf murine sarcoma viral oncogene homolog B1 (BRAF) V600E mutation in colorectal carcinomas, the AI model used presented a 93.8% diagnostic accuracy.[13] From these results, it is shown that AI models could be what physicians need to confidently advance with a treatment plan. Likewise, AI models would greatly improve the volume of patient's physicians can move through. This added speed would decrease the time patients wait for a diagnosis, as well as expediting the diagnosis to the treatment period. Let alone work for physicians, AI can also provide tremendous care in regulatory requirements and redundant paperwork for nurses.[14] These redundant but necessary parts of a nurse's job require about 25% of their time on shift, which can be used more efficiently by being alongside a patient.[13] Another advantage of AI in the healthcare world is rapid adaptation. The timeline for reporting a new foodborne illness in foodborne outbreaks is about 3 to 4 weeks according to the Centers for Disease Control and Prevention (CDC).[15] An AI system could identify an uncommon set of symptoms or bacterial strains much faster than a physician or laboratory. Which, for new diseases or outbreaks, could be the difference between a containable epidemic, or an uncontrolled pandemic. Evidence of such potential is shown in a study by the University of Oxford, in which AI identified viruses by analyzing their fluorescent labels. As a result, strains of respiratory viruses such as the flu and Covid-19 were identified with >97% accuracy within 5 minutes.[16] Regarding the diagnosis of novel coronavirus pneumonia (NCP), a team of researchers developed an AI system that accurately diagnosed NCP with 92.49% accuracy, 94.93% sensitivity, and 91.13% specificity.[17] This point is apparent in the light of the SARS-CoV-2 pandemic. Perhaps, with the availability and assistance of this technology, the impact of the Covid-19 crisis could have been mitigated.

Negative Impacts of Artificial Intelligence in Healthcare

The debate about incorporating AI into healthcare has raised controversy in the workforce. With the intent to make AI a fundamental pillar in healthcare, several drawbacks and difficulties have been put into consideration. Difficulties such as relevant data accessibility, concern for clinical implementation, and ethical dilemmas between AI and patients.

In an analysis of current AI capabilities, it can be argued that the negatives outweigh the positives. The most popular AI platform ChatGPT, has been proven a lack of authenticity regarding references used in medical articles.[18] The ChatGPT generated 30 short medical papers, each with at least 3 references, and a worse outcome has been found. Overall, 115 references in those medical articles, 47% were fabricated, 46% were authentic but inaccurate, and only 7% of them were authentic and accurately analyzed the information.[18] In response to this, it is very difficult to justify using AI in the medical world provided its current accuracy.

The major ethical concern with AI in health services stems from the common use of electronic health records and their preferential targeting in data breaches.[19,20] These electronic health records, if filled out by a comprehensive AI, could contain more sensitive information about a patient than if it was filled by a healthcare professional. This comprehensive AI could be taking quantitative data, and extrapolating it into a probability of health risks and concerns, which would give greater detail into a patient's medical history to bad actors wanting to sell this information and raise serious privacy concerns.[21]

Beyond privacy, the accountability for the misdiagnosis of an AI is also of issue. AIs are touted as more accurate than physicians in their diagnosis, one study found that AI involved in the diagnosis of arrhythmias had an average F1 score of 0.84 compared to the average cardiologist score, of 0.78.[22] In the instance of a cardiologist defaulting to this AI in their diagnosis when they are uncertain, they would be making the best choice they could make in that instant, but if the AI misdiagnoses this patient, and creates a worse situation, it is hard to pin the blame on the cardiologist.[22] In addition, legal action regarding the error will be very difficult to execute because artificial intelligence cannot be held accountable as a real person would. These issues need to be cleared before AI can be implemented in any impactful way in the diagnosis of serious health conditions. To overcome these obstacles, several approaches like developing ethical governance, model explainability, model interpretability, and ethical auditing possible solutions have been recommended to maximize fairness, accountability, and transparency.[23]

AI needs a larger quantity of data and relevant data accessibility to operate its functions.[24,25] For ML, a process that allows AI to learn without direct instruction to work efficiently, it would need a large quantity of data sets.[25,26] As such, if healthcare providers wanted AI to learn relevant patient data and learn how to manage healthcare databases, the AI would naturally need relevant data accessibility. Accessibility to private patient information which corporations are not willing to give due to privacy concerns. Especially in preparation for cases such as a data breach, due to hackers potentially targeting patient health records. This can cause tremendous security concerns for both the company and, the patient, as it is shown by studies that even a slight leak of information can lead to the patient's privacy being compromised.[27]

Using AI in healthcare also raises concerns about clinical implementation. Humans, as displayed in films and sci-fi stories, fear that AI and robots may eliminate some of their jobs.[28] This has occurred in the past during the Industrial Revolution, and may well occur in the future. This may get rid of human office jobs in terms of efficiency, but AI and computers will always be one step above due to their processing speed.

Additionally, there will be fewer errors made as there is no room for human error.[29] It can be argued that this may not necessarily be true due to unrealistic expectations, but it is still a stigma that can cause uproar in the workplace.

There has been evidence suggesting that there are human and social biases at scale. Although, it was found that it was not the algorithm that was responsible, but rather the underlying data that contained social inequities.[30] This can lead to one race or type of individual being chosen over another, just based on the tone of their skin or place of origin. Since AI will be learning from older systems and data, it is not an impossibility that such discrimination may occur.

Way to Make Artificial Intelligence a Pillar of Healthcare

Multiple issues have arisen in AI making it difficult to form as a fundamental pillar in the healthcare environment. Difficulties such as relevant data accessibility, concern for clinical implementation, and ethical dilemmas will have to be faced in the future.[31] A proposed recommendation for resolving data accessibility for AI is to implement it only for participants willing to share their health information with ML systems which may maintain data privacies.[32] In addition, more stringent data security regulations are needed to maintain privacy through improving client-side data encryption and engaging federated learning to train models without data sharing.[31,33,34] This will mitigate the raising concern regarding the ethics of using AI in the healthcare industry, and will also give AI experience in processing healthcare data. Additionally, there are several more ethical concerns for AI. It will be difficult to hold any person accountable when a poor decision is made. Keeping accountability of AI systems in practice through enforcing strict regulations, performing regular auditing, and validation are suggested to ensure better human-centered AI systems.[35,36] It is imperative that patients are fully aware when AI is processing their information, and that they fully consent to the use of their information for ML. Slowly, as AI improves information processing in healthcare, there could potentially be fewer mistakes than with actual humans. There is also the threat of personal bias toward AI systems, in which people will begin to completely depend on machine work and not make any personal decisions.[37] It will be very difficult to ensure that workers will not do this, and this can only be mitigated by proper training for health experts, medical, and other associated staff in handling AI equipment properly to ensure maximum accuracy in disease screening and treatment.[38] AI education should be developed in a way that can be easy for healthcare workers to understand, and leave room for personal decisions at the discretion of health experts.[39,40] AI can potentially increase workforce efficiency by conducting information processing, leaving healthcare professionals to focus on the vital parts of work.[41,42]

Conclusion

According to the present observation and available evidence, AI has some impact on healthcare settings. Assisting physicians in accurate, quick diagnosis and developing effective treatment plans, expediting patient waiting time, reducing redundant paperwork for nurses, and ensuring the regulatory requirements can be examples of the use of AI in healthcare. Besides the benefits of AI in the medical sector, the negative consequences need to be judged well for use in the workforce. Resolving data accessibility, maintaining data privacy, ensuring the authenticity of ChatGPT, maintaining accountability, and proper training of the health associates are the parameters to overcome the negative aspects of AI.

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Author Contributions

MAR conceived, designed, and wrote this paper. EV, JE and RD wrote the manuscript. YS and MRI supervised, reviewed, and revised the manuscript. The author(s) read and approved the final manuscript.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

Ethics Statement

It was an analysis of online available aggregate data. No Ethical approval was needed.

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