
An Overview of Medical Artificial Intelligence

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ABSTRACT

Artificial intelligence (AI) refers to the utilization of computers and technology to emulate intelligent behavior and critical thinking akin to that of a person. In 1956, John McCarthy initially defined the term artificial intelligence as the science and engineering of creating intelligent machines. This article provides a comprehensive introduction of artificial intelligence in medicine, addressing relevant terminology, concepts, and both existing and prospective uses of AI. It seeks to enhance the understanding and acquaintance with AI among primary care practitioners. Searches on PubMed and Google were conducted utilizing the keywords 'artificial intelligence.' Additional references were acquired through cross-referencing the principal articles. Recent advancements in artificial intelligence technology and its present uses in the medical profession have been thoroughly examined. Artificial intelligence has the potential to transform medical practice in unprecedented ways; nevertheless, many of its practical applications remain nascent and require further exploration and development. Healthcare practitioners must comprehend and adapt to these advancements to enhance healthcare delivery to the population.

Introduction

Alan Turing (1950) was a pioneer in the fields of contemporary computing and artificial intelligence. The "Turing test" is predicated on the premise that a computer's intelligent behavior is defined by its capacity to attain human-level performance in cognitive activities [1-6] The 1980s and 1990s had a significant increase in interest in artificial intelligence. Various artificial intelligence techniques, including fuzzy expert systems, Bayesian networks, artificial neural networks, and hybrid intelligent systems, have been employed in diverse clinical environments within healthcare. In 2016, the majority of funding in AI research were allocated to healthcare applications relative to other sectors [7-12]

Artificial intelligence in medicine can be categorized into two subtypes: virtual and physical [13-24] The virtual component encompasses applications including electronic health record systems and neural network-based assistance in treatment decisions. The physical aspect involves robots aiding in surgical procedures, advanced prosthetics for individuals with disabilities, and care for the elderly.

Evidence-based medicine relies on establishing clinical correlations and insights by building relationships and patterns from the existing information database. Historically, we utilized statistical techniques to identify these patterns and correlations. Computers acquire the skill of patient diagnosis through two primary methodologies: flowcharts and database approaches.

The flowchart-based method entails converting the history-taking procedure, when a physician poses a sequence of inquiries and thereafter deduces a likely diagnosis by synthesizing the reported symptom complex. This necessitates inputting substantial data into machine-based cloud networks, taking into account the diverse symptoms and disease processes observed in standard medical practice. The efficacy of this strategy is

constrained due to the computers' inability to perceive and collect cues that can solely be discerned by a physician during the patient interaction.

Conversely, the database approach employs the principles of deep learning and pattern recognition, which entail instructing a computer through iterative algorithms to identify certain groups of symptoms or particular clinical/radiological images. An illustration of this methodology is Google's artificial intelligence initiative commenced in 2012. This system autonomously learned to identify cats using 10 million YouTube films, with efficiency enhancing through the analysis of an increasing number of photos. Following three days of training, it achieved a 75% accuracy in predicting an image of a cat [14-35]

Materials and Methods

Searches on PubMed and Google were conducted with the keywords "artificial intelligence." Additional references were acquired through cross-referencing the principal articles. An overview of several applications employing AI technology that are either operational or under development is provided.

Results

Numerous applications of AI are currently employed in the medical sector, including online appointment scheduling, digital check-ins at healthcare facilities, medical record digitization, reminder notifications for follow-up appointments and immunization schedules for children and pregnant women, as well as drug dosage algorithms and alerts for adverse effects when prescribing multidrug regimens. The pie chart [Figure 1] summarizes the extensive applications of AI in medicine.

Radiology is the discipline that has been the most proactive and receptive to the adoption of new technology. Computers, previously utilized in clinical imaging for administrative tasks such as image acquisition and storage, have now evolved into an essential element of the work environment with the advent of picture archiving and communication systems. The application of CAD (computer-assisted diagnosis) in screening mammography is widely recognized. Recent investigations have demonstrated that CAD offers limited diagnostic assistance, as seen by its positive predictive values, sensitivity, and specificity. Moreover, erroneous diagnoses may divert the radiologist's attention, leading to superfluous investigations [36- 48] as recommended

Artificial intelligence could significantly assist in radiology by not just annotating aberrant examinations but also by swiftly finding negative results in computed tomography, X-rays, and magnetic resonance imaging, particularly in high-volume environments and hospitals with limited human resources.

DXplain, a decision support system, was created by the University of Massachusetts in 1986. It provides a list of possible differential diagnoses based on symptom complexes and serves as an instructional resource for medical students, addressing gaps not covered in regular textbooks [49]. Germwatcher is a system created by the University of Washington for the detection and investigation of hospital-acquired illnesses [50]. Babylon is an online program in the UK that enables individuals to interact with doctors, assess symptoms,

receive advice, track their health, and purchase test kits. Additionally, the scope of AI has broadened to include therapeutic services. AI-therapy is an online program designed to assist patients in addressing their social anxiety through the therapeutic methodology of cognitive behavioral therapy. It was derived from the program CBTpsych.com at the University of Sydney [51-61]

The Da Vinci robotic surgical system, created by Intuitive Surgical, has transformed the domain of surgery, particularly in urology and gynecological procedures. The system's robotic arms replicate a surgeon's hand movements with enhanced precision and offer 3D visualization and magnification capabilities, enabling the surgeon to execute minute incisions.³ Since 2018, Buoy Health and Boston Children's Hospital have been collaboratively developing a web-based AI system that offers guidance to parents regarding their sick child by addressing inquiries about medications and the necessity of a doctor's appointment for symptoms [62] The National Institute of Health (NIH) has developed the AiCure App, which utilizes smartphone webcam access to monitor patient medicine usage, hence decreasing nonadherence rates [63]

Fitbit, Apple, and various other health monitors may assess heart rate, activity levels, sleep quality, and some have introduced ECG monitoring as a novel feature. These advancements can notify the user of any changes and provide the physician with a clearer understanding of the patient's condition. The Netherlands employs artificial intelligence to analyze its healthcare system, identifying errors in treatment and operational inefficiencies to prevent avoidable hospitalizations.

In addition to existing inventions, there are specific advancements in various stages of development that will enhance physicians' capabilities. IBM's Watson Health serves as a prime example, designed to effectively recognize indications of heart disease and cancer. Stanford University is developing a program for AI-assisted care (PAC). PAC possesses an advanced senior wellness support system and intelligent ICUs that detect behavioral changes in old individuals residing alone and ICU patients through the utilization of various sensors. PAC is expanding its initiatives in Intelligent Hand Hygiene support and Healthcare conversational agents. Hand hygiene assistance employs depth sensors and advanced computer vision technologies to ensure optimal hand hygiene for physicians and nursing personnel, thereby diminishing hospital-acquired infections [64-73] Healthcare conversational initiatives examine the responses of Siri, Google Now, S Voice, and Cortana to inquiries regarding mental health, interpersonal violence, and physical health from mobile phone users, facilitating early patient care access. Molly is a virtual nurse under development to deliver follow-up care to released patients, enabling physicians to concentrate on more urgent situations.

Discussion

Artificial intelligence is expanding inside the public health sector and will significantly influence all facets of primary care. AI-enabled computer apps will assist primary care providers in more effectively identifying patients needing further attention and delivering tailored regimens for each individual. Primary care providers can utilize AI to document

notes, assess patient interactions, and input necessary information straight into EHR systems. These programs will gather and evaluate patient data, presenting it to primary care physicians along with insights on the patients' medical need.

A 2016 survey revealed that physicians allocated 27% of their office hours to direct clinical interactions with patients and devoted 49.2% to electronic health records and administrative tasks. During patient consultations, physicians allocated 52.9% of their time on electronic health records and ancillary tasks. In conclusion, physicians utilizing documentation support, such as dictation help or medical scribe services, interacted more directly with patients than those who did not employ these services. Moreover, the augmented utilization of AI in medicine diminishes manual labor, liberates the primary care physician's time, and enhances productivity, accuracy, and effectiveness [74-85].

The search for and development of pharmacological medicines targeting a specific ailment through clinical trials require years and incur substantial costs. For instance, AI was employed to evaluate existing treatments that potentially combat the developing threat of the Ebola virus, a process that would have otherwise required years. Through the utilization of AI, we may adopt the novel paradigm of "precision medicine."

Several research have shown instances where AI systems surpassed dermatologists in accurately diagnosing worrisome skin lesions [17-18] This is due to AI systems' ability to learn from successive cases and their capacity to process numerous cases within minutes, vastly beyond the quantity a doctor could assess in a single lifetime. AI-based decision-making methodologies are employed in scenarios where specialists frequently have differing opinions, such as the identification of pulmonary tuberculosis on chest radiographs [19]

The current period of AI-augmented practice has an equal number of doubters and advocates [Figure 2]. The heightened use of technology has diminished job possibilities, raising concerns among aspiring and current physicians. Machines may analytically and rationally interpret human behavior; but, they cannot cultivate certain human attributes such as critical thinking, interpersonal and communication skills, emotional intelligence, and creativity.

In 2016, the Digital Mammography DREAM Challenge was conducted, wherein multiple computer networks collaborated to develop an AI-based system by analyzing 640,000 digital mammograms. The optimal results attained were a specificity of 0.81, a sensitivity of 0.80, and an area under the receiver operating characteristic curve of 0.87, which approximately corresponds to the lowest 10% of radiologists [20]. In conclusion, while AI possesses significant potential, it is improbable that it will completely supplant physicians[85-88].

Artificial intelligence will be an essential component of medicine in the future. Therefore, it is essential to educate the new generation of medical students on the principles and applications of AI, as well as how to operate effectively alongside robots to enhance productivity, while also fostering soft skills such as empathy [89-90].

Conclusion

It is essential for primary care physicians to become proficient in forthcoming AI advancements and the uncharted domain that medicine is progressing toward. The objective should be to establish a nuanced, mutually advantageous equilibrium between the efficient application of automation and AI and the human capabilities and discernment of skilled primary care physicians. The complete replacement of humans by AI in medicine is a significant problem that could impede the potential benefits of its implementation.

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