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A REVIEW ON ARTIFICIAL INTELLIGENCE APPLICATION AND ROLE IN HEALTH CARE MEDICINE

SHASHANK YADAV[1], ADITYA GUPTA[2] AND DR. JAYANT KUMAR MAURYA[3]

1. Research Scholar, Ashok Singh Pharmacy College, Maharoopur Jaunpur U.P. 222180
2. Assistant Professor, Department of Pharmacology, Ashok Singh Pharmacy College, Maharoopur Jaunpur U.P. 222180
3. Academic Head, Ashok Singh Pharmacy College, Maharoopur Jaunpur U.P. 222180

Corresponding Author: **Shashank Yadav**

Abstract

Artificial intelligence (AI) is defined as a field of science and engineering concerned about the computational comprehension of what is commonly called intelligent behavior, and with the creation of artifacts that exhibit such behavior. It is the subfield of computer science. AI turning into a well-known field in computer science as it has enhanced the human life in many areas. AI has recently surpassed human performance in several domains, and there is great hope that in healthcare. AI may allow for better prevention, detection, diagnosis, and treatment of disease. Major disease areas that use AI tool include cancer, neurology, cardiology and diabetes. Review contains the current status of AI applications in healthcare. AI can also be used to automatically spot problems and threats to patient safety, such as patterns of sub- optimal care or outbreaks of hospital-acquired illness with high accuracy and speed.

Keywords: Artificial Intelligence; Computer; Data; Diseases; Healthcare; Robots.

INTRODUCTION

Artificial intelligence (AI) is a topic of discussion in almost every branch of science and engineering. AI is the performance of tasks by computers that are typically thought to need human intelligence. Prominent scientific contests such as the ImageNet Large Scale Visual Recognition Challenges are demonstrating that computers are capable of picture recognition on par with human ability. Significant advancements in speech recognition and natural language processing have also been made possible by AI. These developments raise concerns about how these capabilities might complement or perhaps improve human decision-making in the fields of health and medical care. At least in very narrow cases, two recent high-profile research articles have shown that AI is capable of performing clinical diagnoses on medical images at a level comparable to seasoned clinicians. Nonetheless, there are still several issues with these materials' accessibility and quality in the US.[1]

Fig: AI IN Health Care Startup from CB Insight

Health data is more difficult to collect and share than other forms of data since, on the one hand, privacy concerns are linked to it. Furthermore, health data tend to be closely guarded after they are gathered because they can be expensive to collect, especially in the case of clinical trials and longitudinal investigations.[2]

Why Now?

Artificial Intelligence has been around for many years, and although many of the predictions that it will change our lives have been made, many of them have not materialized. AI research initiatives have come and gone, driven by the advancement of computer hardware capabilities and related algorithm development, along with a certain amount of hype. This background and some observations on the present AI revolution are provided in the JASON 2017 study, which also states that, "starting around 2010, the field of AI has been jolted by the broad and unforeseen successes of a specific, decades-old technology: multi-layer neural networks (NNs)". Two evolutionary developments—fast hardware Graphics Processor Units (GPUs) that enable the training of much larger and especially deeper (i.e., more layers) networks—as well as large labelled data sets—images, web queries, social networks, etc.—that could be used as training testbeds—have combined to reenergize a particular area of AI and bring about a phase change. The "data-driven paradigm" of Deep Learning (DL) on deep neural networks (DNNs), particularly with an architecture known as Convolutional Neural Networks (CNNs), has emerged as a result of this combination. [3]

AI IN HEALTH DIAGNOSTICS: OPPORTUNITIES AND ISSUES FOR CLINICAL PRACTICE

There have been significant demonstrations of the potential utility of Artificial Intelligence approaches based on Deep Learning for use in medical diagnostics. While continuing basic research on these methods is likely to lead to further advances, we recommend parallel, focused work on creating rigorous testing and validation approaches for the clinical use of AI algorithms. This is needed to identify and ameliorate any problems in implementation, as soon as possible, in order to develop confidence within the medical community and to provide feedback to the basic research community on areas where continued development is most needed. We point out a key issue of balance in expectations, which is that AI algorithms, including Deep Learning, should not be expected to perform at higher levels than the training sets.[4]

Developments in Medical Imaging AI Applications In the ensuing segments, we examine instances when Deep Learning applications have been showcased, focusing on the quantitative comprehension of data set characteristics, the formulation of the problem, and the type of comparison standard employed to label the sets. The two instances that are given are based on medical imaging, particularly dermatology and diabetic retinopathy.

Diabetic retinopathy identification in retinal fundus photos By non-invasively photographing the retina through the pupil, numerous eye illnesses can be identified. Since the number of diabetic patients is continually increasing, early detection of diabetic retinopathy is crucial in order to prevent blindness and visual loss. This kind of screening offers the chance to find signs of cardiovascular disease as well as other eye conditions. The goal of low cost, quantitative retinal image analysis is driven by the growing need for such screening and the resulting demands for professional analysis. Using the specially made optics of a "fundus camera," routine imaging for screening can be carried out with or without mydriatic dilatation. Multiple images are captured at various orientations.[5]

1. Dermatological classification of skin cancer

Because just 3-5% of the approximately 1.5 million instances of skin cancer that occur annually in the US are of the deadliest kind, melanoma, which causes 75% of skin cancer deaths, skin cancer presents a difficult diagnostic dilemma. On the other hand, the sensitivity and specificity of screening exams to detect melanomas are 40.2% and 86.1%, respectively, for primary care physicians and 49.0% and 97.6% for dermatologists. Remarkable outcomes were obtained from a recent demonstration of automated skin cancer evaluation utilizing a convolutional neural network (CNN) algorithm. The training set of over 125,000 dermatologist-labelled pictures from 18 separate internet repositories was used by the authors. Additionally, biopsies were used to classify 2,000 of the pictures. The system was trained using approximately 2000 diseases and 757 disease classes on all the dermatologist-labelled photos. Figure 3a displays the taxonomy's upper tiers. When the algorithm was tested, its performance in categorizing at the first level I (three categories: benign, malignant, and non-neoplastic) was 72.1%, which was comparable to the accuracy of two dermatologists, who performed at 66.0 and 65.56%.[6]

2. Data issues

All of the aforementioned examples depended on having access to enormous collections of medical photographs, some of which were kept in meticulously maintained archives. Furthermore, though, each also needed a labeled training set to be created. In the case of retinopathy, these were acquired through labor-intensive, impartial, expert evaluations of the pictures. The training in the dermatological example also relied on the evaluations of the photos by the clinicians. Finding out if the system performs better when trained against a more stringent evaluation, like the results of a biopsy, would be very interesting. There were not enough biopsy-verified photos in the dermatology example data sets to be used as the only training set.[7]

3. Findings:

- AI algorithms based on high quality training sets have demonstrated performance for medical image analysis at the levels of the medical capability that is captured in their training data.

- AI algorithms cannot be expected to perform at a higher level than their training data, but should deliver the same standard of performance consistently for images within the training space. 15 Recommendation:
- Support the assessment of AI algorithms using data labelled at levels that exceed standard assessments, for instance the use of outputs from a further stage of diagnostic testing (e.g., use of biopsy results to label dermatological images).[8]

4. Moving Computational Advances into Clinical Practice

Computational methods are recognized as a special type of tool in medical practice and where they impact clinical practice, are subject to different forms of regulation. AI-based tools represent a new set of opportunities, but lack the extensive basis of experience and validation that is needed for acceptance into formal medical practice. In this section and Section 2.3, we address the question of how AI-based computational approaches could become sufficiently trusted to modify protocols for diagnosis and treatment, enabling improved outcomes at lowered costs. We use the example of a new computational tool that requires large scale computation, but is based on physical properties rather than a trained AI algorithm.[9]

5. Coronary Artery Disease –

Issues driving interest in improved methods A large number of patients experiencing chest pain undergo invasive testing only to reach a negative diagnosis. The negative impacts on patient experience, access to expensive diagnostic facilities, and cost create a strong incentive to develop alternative approaches. The diagnosis of whether a patient has coronary artery disease (CAD), and will benefit from cardiac revascularization (bypass surgery or insertion of a stent) is based on two primary factors. The first is structural: the narrowing of the blood vessels (stenosis) around the heart. The second is functional: reduced flow of blood (ischemia) compared with the flow in a normal coronary artery. Direct measurement of stenosis can be accomplished with invasive coronary angiography, in which a cardiac catheter is inserted to deliver a contrast dye to the arteries supplying the heart followed by X-ray imaging. Direct measurement of blood flow is accomplished by the invasive fluid flow reserve (FFR) technique, based on insertion of a pressure sensor through a cardiac catheter. Unfortunately, the use of invasive coronary angiography for patients with severe chest pain reveals a large fraction (60% for patients who do not have other significant indicators of CAD) who do not have significant arterial narrowing.[10]

EVOLUTION OF STANDARDS FOR AI IN MEDICAL APPLICATIONS

In the US, adoption of AI applications for clinical practice will be regulated by a combination of Food and Drug Administration (FDA) regulations and clinical business models. For non-clinical personal smart device uses discussed in the following section, it will require public (user) confidence and may or may not require regulation. In the example above, the adoption of the FFRCT computational tool required clinical studies. This will also be necessary for AI outcomes to be accepted as definitive decision factors in standard of care. Such decisions may need FDA regulations and the specifics of what those requirements might be are still evolving. FDA has been paying close attention to the international development of both software in medical devices (SiMD) and software as a medical device (SaMD). AI applications can fall into both of these categories. FDA has been participating (actually chairing) an international regulators forum on SiMD and SaMD. The goal of the forum is to develop frameworks, risk categorizations, vocabulary, considerations, and principles that could support regulation around software. Their report on clinical evaluation was put out in the US for public comment by the FDA.[11]

LARGE SCALE HEALTH DATA

To identify novel disease correlations and match patients to the best treatments based on their individual health, life experiences, and genetic profile, one aspirational goal for health and healthcare is to gather large datasets (both labelled and unlabelled) and carefully curate health data. Artificial Intelligence (AI) has the potential to combine all of these data sources to produce novel medical discoveries and fresh perspectives on both public and individual health.

Economic Stability	Neighborhood and Physical Environment	Education	Food	Community and Social Context	Health Care System
Employment	Housing	Literacy	Hunger	Social integration	Health coverage
Income	Transportation	Language	Access to healthy options	Support systems	Provider availability
Expenses	Safety	Early childhood education		Community engagement	Provider linguistic and cultural competency
Debt	Parks	Vocational training		Discrimination	Quality of care
Medical bills	Playgrounds	Higher education			
Support	Walkability				

Fig: Social Determinants of Health Source

The accessibility and availability of high-quality data, as well as the dependability and efficiency of AI algorithms on complicated data streams, will be the main limiting issues, nevertheless. According to estimates, behavioral patterns, environmental exposures, and societal circumstances contribute for 60% of premature deaths. These three categories represent our life experiences as a result of our birthplace, place of residence, place of education, place of employment, and place of recreation. These factors, which are sometimes referred to as the social determinants of health [108], include diet, education, housing and neighborhood conditions, social and cultural context, health care system, and economic stability.[12]

1. Current Effort – All of Us Research Program

A major initiative is just beginning in the U.S. to collect a massive amount of individual health data, including social behavioral information. This is a ten year, $1.5B National Institutes of Health (NIH) Precision Medicine Initiative (PMI) project called All of Us Research Program. The goal is to develop a 1,000,000 person-plus cohort of individuals across the country willing to share their biology, lifestyle, and environment data for the purpose of research. A soft launch for this data collection has just begun at a collection of locations across the country. The initial data collected on participants opting into the study will be surveys capturing 1) basic information on medical history and lifestyle (e.g., personal habits and overall health), physical measurements (e.g., blood pressure, pulse, height, weight, and hip and waist circumference), biosample assessments (blood and urine samples) and, in some cases, DNA testing with additional participant consent; and 4) electronic health records data capturing most fields of the common clinical dataset (e.g., demographics, health care visits, diagnoses, procedures, medications, laboratory tests, and vital signs).[13]

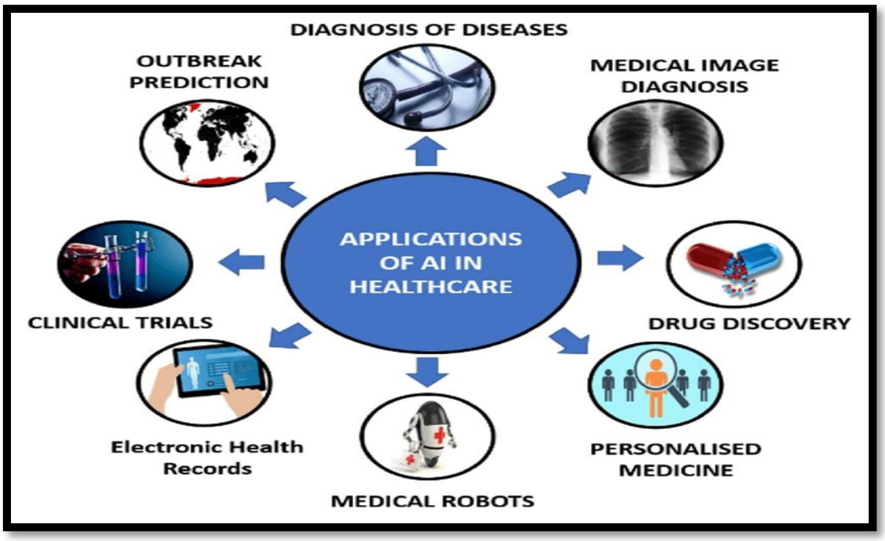
2. All of Us Research Program Participation, Privacy, and Access

Enabling participants, researchers, and the public to access the data will be a key goal of the All of Us Research Program. This brings up privacy-related considerations. From the outset of this program, PMI has acknowledged that de-identification (anonymization) of the data is insufficient to ensure participant privacy protection, a point raised by Jason (2014). The All of Us Research Program is establishing the framework for guaranteeing the confidentiality, integrity, and accessibility of the data in order to foster trust regarding privacy. This is due to the efforts of the two interagency working groups entrusted with creating the framework and guiding principles for data security policies as well as privacy and trust. Participants must be given privacy protections before any of the numerous pieces of data for the All of Us Research Program are collected. A system that allows participants to select which information can be published and to whom must be implemented because it's possible that they won't want to divulge all of the necessary information. On the one hand, based on research that Sage Bionetworks has 38 piloted, innovative techniques are being created to assist participants in understanding informed consent.[14]

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN HEALTH CARE

1. Managing medical records and data

Data management appears to be the most obvious application of artificial intelligence in healthcare. assembling, preserving, acclimating, and tracking its lineage. It is the first step toward transforming the currently available healthcare systems. Google's AI research division launched the Google Deep Mind Health project not too long ago. Its purpose is to mine medical data in order to provide rapid and high-quality healthcare services. The most widely used use of artificial intelligence and digital automation is data management, since gathering and analyzing data is a crucial stage in the provision of healthcare. To provide quicker, more reliable access, robots gather, store, reorganize, and track data.[15]



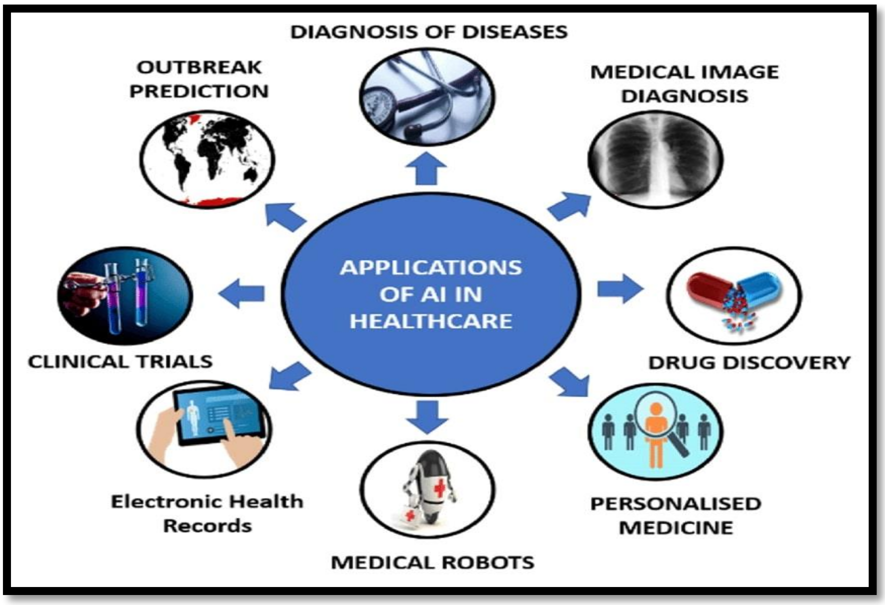


Fig: Application of AI in Health Care

The combination of big data analytics tools has enabled organizations to gain the insights necessary to work much more effectively with patients and make excellent decisions. The use of big data has been increasing significantly, from cutting costs to streamlining hospital staff schedules, from enabling remote patient monitoring to foreseeing epidemics. Artificial Intelligence is a field within computer science and technology that deals with simulating intelligent behavior in computer systems.[16]

2. Doing repetitive jobs

Robots can perform routine operations such as data input, X-ray, CT scan, and test analysis considerably more quickly and precisely. There can be an overwhelming amount of data to review and a significant time commitment in the professions of cardiology and radiology. In the future, radiologists and cardiologists should only examine the most complex situations when human supervision is beneficial. IBM started working on the Medical Sieve algorithm. The goal of this ambitious, long-term research project is to develop the next generation of "cognitive assistants," who will be capable of reasoning, analysis, and a wide variety of clinical expertise.[17]

3. Treatment design

AI is leading to improvements in healthcare treatments, including bettering the way that treatment strategies are organized, analyzing data to produce better treatment plans, and keeping track of therapies. Artificial intelligence (AI) can quickly and more accurately identify disease signs and symptoms in medical images, including MRIs, CT scans, ultrasounds, and x-rays. This enables faster diagnostics, cutting down on patients' waiting times from weeks to just a few hours, and it can also introduce treatment options more quickly. Physicians may now look up information using tools like Modernizing Medicine, which is a medical assistant that records diagnoses, collects patient data, orders tests and prescriptions, and sets up billing details. Furthermore, the aptitude to explore public databases with information from thousands of doctors and patient cases can assist physicians manage better personalized treatments or discover similar cases. AI will encourage clinicians adopt a more extensive strategy for malady administration, better facilitate care designs and help patients to all the more likely oversee and satisfy with their long-haul treatment programs.[18]

4. Digital consultation

Bots for healthcare exist first and foremost for patient engagement. Healthcare bots, which are found in mobile messaging apps, that can facilitate patients quickly and in actual time simply by sending a message for example Babylon and uMotif‟s. Health conversation bots can reply to health-associated questions and even support patients manage medications by providing data on variety of medications and suggested doses. Healthcare Monitoring gadgets that use AI techniques are currently in extensive use. They can be utilized as remote patient monitoring for health indicators, such as postoperation heart action, patient height and weight, and so on. Wearable gadgets, similar to wristwatches, such as those of Fit BIT commercial fitness trackers, are now frequently used. AI can be utilized to remotely decide persistent treatment designs, or alarms to give the client with any issues. Wearable gadgets can monitor information associated to health and comfort, such as the number of steps walked, or else the number of calories burned. This might be significant to patients seeking to drop weight. AI can then interpret this information to provide people better access to knowledge regarding their physical state and thus, give confidence to patient lifestyle changes.[19]

ROLE OF AI IN HEALTHCARE

1. Medical Imaging and Diagnostic Services

AI is a powerful tool for image analysis that is increasingly being used by radiology professionals for the early diagnosis of different diseases and for reducing diagnostic errors in the context of prevention. Likewise, AI is a smart and potential tool for analysing ECG and echocardiography charts that cardiologists use to support their decision making.

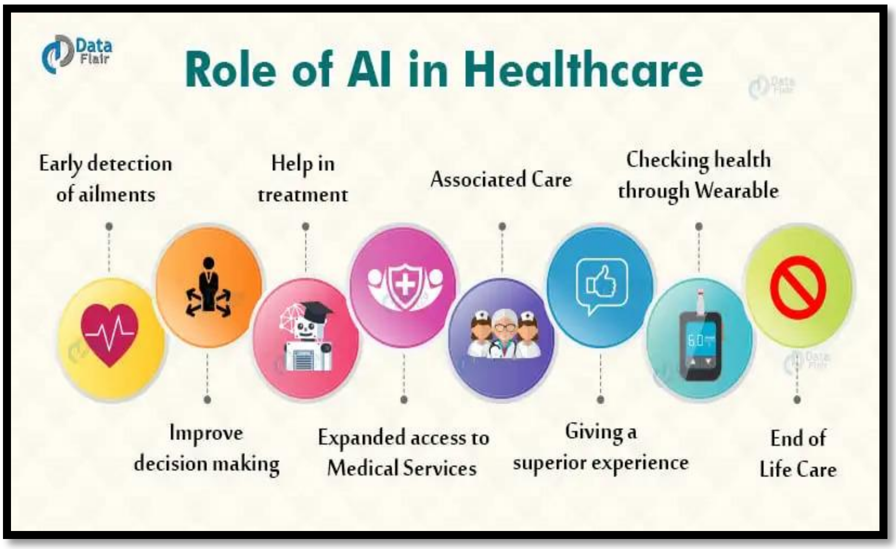


Fig: Role of AI in Health Care

The Culturomics platform, which was reported in a hospital in Oxford, utilizes AI to analyse echocardiography scans that sense heartbeat patterns and detect ischemic heart disease. AI has presented encouraging results in the early detection of diseases such as breast and skin cancer, eye disease, and pneumonia using body imaging modalities. AI tools analyse speech patterns to forecast psychotic occurrences, and recognize and screen the features of neurological diseases such as Parkinson's disease.[20]

2. Virtual Patient Care

Baig et al. noted that the advancement of wearable technology and the potential of using ML and AI in healthcare is an idea that has already been explored. Thus, patient monitoring and management via virtual care with active and sensible wearable technology solutions have become a reality and part of the standards of care. In addition, AI plays a role in controlling chronic diseases such as diabetes mellitus, hypertension, sleep apnea, and chronic bronchial asthma using wearable, non-invasive sensors. A previous study recommended a smart sensor system based on a combined sensor network to observe a person's home and environment and obtain data on a person's health status and behavior. The recommended platform includes sensors that are unobtrusive, biomedical, and wearable.[21]

3. Medical Research and Drug Discovery

AI is ideally suited to analyse the large and complex datasets used in medical research. In addition, it can be applied to hunt scientific research works, integrates various types of data, and supports drug innovation [93]. Pharmaceutical agencies are focusing on AI to streamline drug development. Scientists can utilize predictive analytics to recognize appropriate aspirants for clinical trials and develop exact models of biological processes. ML contributes to clinical trials in the pre-trial phase, choosing the cohort, organizing of participants, and collecting and analysing data. It can augment the patient-oriented view, generalizability, efficacy, and achievement of clinical trials. However, ML needs more emphasis on its functional and philosophical obstacles in clinical trials. In addition to ML, natural language processing (NLP) has exposed potential across various actions enhancing participant management in clinical trials; however, these tools' effects on clinical trial quality and participant experience are uncertain.[22]

4. Patient Engagement and Compliance

Patient engagement and compliance is healthcare's 'last stretch' issue and the end blockade between better and poor health outcomes. Non-compliance means when a patient fails to shadow a treatment course or take the recommended medications. If patients are highly engaged in healthcare, their health outcomes are probably better, i.e., healthcare utilization, cost, and patient experience. A healthcare leaders and executives survey reported that less than 50% of their patients were highly involved in treatment plans. Healthcare providers use their clinical experts to develop treatment plans to improve patients' acute or chronic health. Nevertheless, mostly, it does not matter when a patient misses the required behavioural changes, such as controlling weight, scheduling a follow-up visit, and obeying a treatment plan.

5. Rehabilitation

AI has innovative applications in the field of rehabilitation. It is an idea that includes physical (robotics) and virtual (informatics) branches. Additionally, a subset of AI known as ML refers to precise methods for building algorithms that naturally improve with practice. In rehabilitation, ML is used for perioperative medicine, brain–computer interface technology, myoelectric control, symbiotic neuroproteins, etc. ML methods have also been applied in the field of the musculoskeletal system, e.g., in the evaluation of patient data, clinical decision support, and diagnostic imaging. In therapy, an artificial cognitive application was used to judge rehabilitation exercises based on the signals from the machine. As a result of technological advancement, AI and robotics are transforming approaches and competencies in rehabilitation research and practice. For example, smart homes can assist residents with daily activities and alert caregivers when assistance is needed. In addition, smart mobile and wearable devices are available to collect data and provide users with information to assess health improvement and review progress toward personalized rehabilitation goals.[23]

CHALLENGES FACED BY AI UTILIZATION IN HEALTHCARE

1. Ethical and Social Challenges

Several ethical and social disputes raised by AI overlap with those raised by high reliance on technology; automation; data usage and issues arising from the usefulness of 'telehealth' and assistive technologies, as the effectiveness of AI increases ethical concerns, including the issue of accountability when AI is used in decision making; the ability of AI to make erroneous judgments; AI yield authentication issues; the confirmation of the protection of sensitive data; intrinsic biases in the data used in AI system tests; maintaining public confidence in the growth and benefits of AI systems; influencing the sense of dignity and social isolation of the public in care settings; implications for HCPs' roles and skill requirements; and the ability of AI to be used for malicious activity. Furthermore, safety and reliability problems may occur while using AI to deliver treatment, make decisions, and control healthcare equipment. AI could cause errors, and those might be challenging to detect or might induce adverse effects, which could lead to severe consequences.

2. Governance Challenges

As the implementation of AI technologies in healthcare increases, there is a serious requirement for proper governance to overcome regulatory, ethical, and trust issues. Active governance at the hospital level offers an opportunity to accurately address these issues in the implementation and use of AI. Additionally, a recent study found that governing AI technologies at the healthcare system level is critical to patient safety and healthcare system accountability. Such governance also increases clinician confidence, improves acceptance, and makes significant health consequences possible. The governance structure should be comprehensive to address the challenges related to clinical, operational, and leadership domains while deploying AI-powered applications. Additionally, AI has applications in areas that need regulation, including healthcare, research, and privacy. Nonetheless, AI is developing rapidly and commercially, which could challenge the known outlines. National and international regulations are, therefore, required to introduce AI-controlled applications in healthcare as part of the principles of medical ethics.[24]

3. Technical Challenges Technically

AI models must be simple in their properties and functions in order for HCPs to efficiently operate them. On the other hand, there are a few hurdles to adopting AI in healthcare, including the lack of capacity of developing and maintaining IT infrastructure to support the AI process, the increased costs associated with storing and backing up data for research purposes, and the high cost of augmenting data validity. In addition, AI algorithms can suffer from a variety of shortcomings, including inapplicability outside of the training domain, bias, and brittleness (tendency to be easily fooled). Important factors to consider include dataset shifts, randomly matching confounders instead of true signals, the prevalence of unintended biases in clinical practice, providing interpretability for algorithms, developing reliable measures of confidence in the model, and challenging the generalization to different populations.[25]

DISADVANTAGES OF AI IN HEALTHCARE

Huge datasets are mandatory for machine learning and deep learning models to appropriately categorize or forecast various tasks. Nevertheless, the healthcare industry possesses a composite problem with data accessibility, since patient records are confidential and given the usual hesitancy among HCOs to exchange health data. In addition, data are not readily available once an algorithm is initially executed using them. Notably, ML based systems can continually progress as additional data are provided to their training set; however, it is hard to attain this scenario due to internal corporate resistance. Moreover, AI-based applications raise data security- and privacy-related issues. Hackers usually focus on health records during data breaches, since those records are significant and vulnerable. Hence, it is vital to uphold the confidentiality of health records. Additionally, the overfitting issue occurs when the algorithm absorbs the connections between patient characteristics and results.[26]

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