

Frontiers of Artificial Intelligence in Healthcare

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Abstract -- Chronic diseases are becoming common leading to increased mortality globally. Advances in computer science can usher changes in the healthcare system to increase productivity and improve the care-delivery process to enhance patient satisfaction. Artificial Intelligence (AI) offers a useful tool for medical fraternity to deliver better quality care.

Wearable gadgets using AI display parameters like temperature, blood pressure, pulse rate, sugar levels that allow corrective timely measures.

Adoption of AI in healthcare faces challenges, like lack of trust in the results and meeting specific requirements. Nevertheless, the applications of AI in health care brought multiple benefits to health care providers. AI will be the catalyst for helping us overcome the challenges faced in increasingly over stretched healthcare facilities.

Experts contend health care will probably be more affected by AI than any other area of life. Analysts predict that the AI health-care market is poised to reach \$187 billion in 2030. This article outlines the role of AI in the health care industry to create awareness about its usage to deliver a seamless experience for patients & medical personnel.

Keywords: Artificial intelligence, Clinical decision support, Electronic Health record systems, Outbreak prediction, Chatbots, IoMT

I. INTRODUCTION

HUMAN brain receives data from various sources, analyzes it and 'learns' from it to utilize it for various purposes. Today, we are overwhelmed by excessive data. Here, Artificial intelligence (AI), AI comes to rescue. AI to express in simple words, is the science of making machines that can think like humans. Using this tool, the tsunami of data inundating us can be processed in ways, that we humans can't do. This is achieved via computer statements called, 'algorithms', which mimic decision-making processes of the human brain. This enables the processes to 'learn' from available data and make increasingly more accurate classifications, or predictions over time. AI algorithms analyze medical imaging data, such as X-rays, MRIs, and CT scans, to assist health-care professionals in accurate and swift diagnoses. The large availability of biomedical data brings tremendous opportunities and challenges to health-care research.

Renowned physicist, Stephen William Hawking just before his demise in March 2018 gave an interview to BBC cautioning that

AI poses existential threat to mankind. Likewise, the nuclear bombs too pose grave threat but leading nations including India are augmenting such arsenals. Till arrival of that D-Day, there is good news as we are passing through an exciting era, where applications of AI are emerging every day, assisting humanity in myriads of ways. Hence, colleges, even schools inducted this subject in their academic curricula. In fact AI is the must-do course for aspiring students.

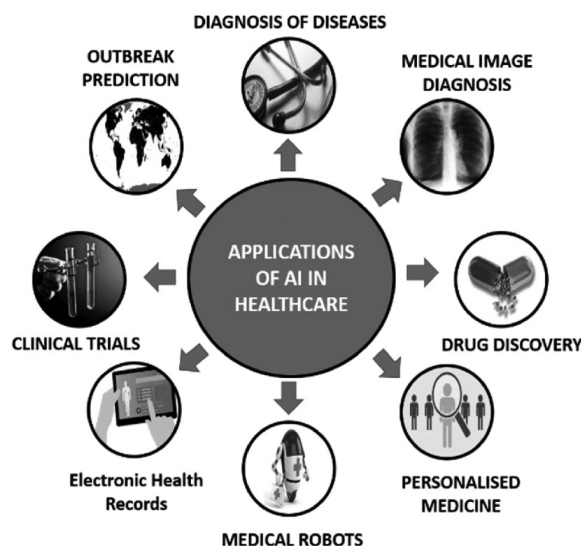


Figure 1. Pervasive role of AI in healthcare.

Some of the domain applications of current AI-use, listed in alphabetical order are: agriculture, e-commerce, entertainment, finance, healthcare, marketing, robotics, self-driving cars, social media and videogames. Parallely, the use of AI created serious ethical concerns, as its misuse can lead to issues like deep fakes.

The world-over, health issues assumed dominant concern, especially after COVID-19. AI which uses 'Natural Language Processing' has come in handy to reduce the increasing strain on health-care delivery personnel, who face the specter of burn-outs due to people becoming increasingly afflicted as the result of air-pollution, faulty-diets, exercise habits and lifestyle issues.

As the global population ages, dementia, heart disease, and cancer are becoming increasingly prevalent. According to

WHO, heart disease is the number 1 cause of death globally and dementia cases are expected to double every 20 years. Meanwhile, the global cancer burden is estimated to be over 28 million cases by 2040 — a 47% rise from 2020. The harsh reality is that most people in the world will soon know someone who has been affected by one of these diseases. The significant progress in precision healthcare offers hope that we might overcome these challenges, revolutionizing how we predict, diagnose, and treat chronic diseases. By considering patients' genes, environments, and lifestyles, health-care providers can use technology to take a more personalized approach, using that unique data to deliver the right treatments to the right patients at the right time. In doing so, they can not only help improve patient outcomes but also help lower costs and ease pressure on healthcare systems. Recent advances are enabling precision healthcare. Driving this is a multi-faceted approach to diagnosing and treating patients. This approach combines artificial intelligence-enabled digital tools, precision diagnostic imaging and therapies based on the individual's profile.

II. MOTIVATION

Finding efficient ways to treat diseases is humanity's continuous effort since ages. AI is emerging an attractive technique in this direction. AI ushered a 'healthcare revolution' in that it is transforming all aspects, namely pharmaceutical research, patient diagnostics besides post-operative treatment.

We have heard the term 'Superbugs', the bacteria that are resistant to several types of antibiotics. They pose serious challenge to doctors and patients. Last year, newspaper reports highlighted how Artificial Intelligence approach was used to discover an antibiotic, named *abaucin* as antidote to a Superbug, named *A. Baumannii*, that kills thousands annually in the US. Researchers at MIT, USA & McMaster University, Canada reported their findings in 25 May 2023 issue of journal *Nature*. The machine learning model was trained and used to analyze a set of 6680 compounds to arrive at the final result that was effective at killing the superbug.

Above is just an example to show that we need not be scared of use of artificial intelligence. In fact AI's astonishing innovations in biology and genetics have just begun. For instance, it was reported that AlphaFold, an AI program performs 'predictions' of protein structure! Going deep into the outcomes of this exercise, one will be surprised to know that it has reached the stage to study sequences and structures of as many as one lakh proteins, making predictions of their 'folded shape' right down to the molecular level. This is mind-boggling.

Nvidia, California based, world-leader in manufacturing AI chips, who recently outpaced Apple in market capitalization made healthcare a major focus of its business as it seeks to capitalize on the myriad future applications of AI.

III. BASIC TERMS

Artificial intelligence comprises different technologies: (i) **Machine Learning** is a statistical technique for fitting models to data and to 'learn' by training models with data. (ii) **Deep Learning** mimics the intricate neural networks of the human brain, to autonomously discover patterns and make decisions from vast amounts of unstructured data. (iii) **Natural language processing (NLP)** is a field of computer science and a sub-field of artificial intelligence that aims to make computers understand human language

AI constitutes a system comprising both software and hardware. Its software aspect is concerned with algorithms. It is a mimic of the human brain—an interconnected network of neurons, in which there are weighted communication channels between neurons. From a hardware perspective, AI is mainly concerned with the implementation of algorithms on a physical computation platform.

Health-care organizations are becoming increasingly interested in how artificial intelligence can support better patient care while reducing costs and improving efficiencies. The healthcare industry has been compiling increasingly larger data sets, often organizing this information in electronic health records (EHRs) as unstructured data. With the help of natural language processing, machine learning rearranges this data into more structured sets from which health-care professionals quickly obtain actionable insights.

APPLICATION	POTENTIAL ANNUAL VALUE BY 2026	KEY DRIVERS FOR ADOPTION
Robot-assisted surgery	\$40B	Technological advances in robotic solutions for more types of surgery
Virtual nursing assistants	20	Increasing pressure caused by medical labor shortage
Administrative workflow	18	Easier integration with existing technology infrastructure
Fraud detection	17	Need to address increasingly complex service and payment fraud attempts
Dosage error reduction	16	Prevalence of medical errors, which leads to tangible penalties
Connected machines	14	Proliferation of connected machines/devices
Clinical trial participation	13	Patent cliff; plethora of data; outcomes-driven approach
Preliminary diagnosis	5	Interoperability/data architecture to enhance accuracy
Automated image diagnosis	3	Storage capacity; greater trust in AI technology
Cybersecurity	2	Increase in breaches; pressure to protect health data

Figure 2. Applications of AI in Healthcare [8].

IV. OUTCOMES

Specifically, AI is used in health-care to enhance outcomes as mentioned below:

Diagnosing patients: AI algorithms can analyze medical imaging data to help health-care professionals make quick and accurate diagnoses. Algorithms are outperforming radiologists at spotting malignant tumors.

Using medical records: AI can help maximize the use of medical records. For example, it can help with exploring insurance coverage options, predicting hospital admission rates, and improving culturally concordant care.

Creating personalized treatment plans: AI can help doctors make personalized treatment plans.

Finding new medicines faster: AI can help researchers find new medicines faster.

Improving procedures: AI can improve procedures at different stages of surgery, including pre-operative, intra-operative, and post-operative.

Improving preventive care: AI can help enhance preventive care and quality of life.

Predicting and tracking infectious diseases: AI has been used to predict and track the spread of infectious diseases. As the world around us changes rapidly, aging populations, as well as public health crises ramp up the workload of providers, causing patient safety-risks and negatively impacting patient satisfaction.

AI is being used to detect links between genetic codes or to maximize hospital efficiency, AI is being leveraged to deploy efficient and precise inventions that will help take better care of patients. AI in healthcare offers several benefits over traditional methods of analytics and making clinical decisions. By using AI algorithms, the systems become more accurate due to their ability to understand training data, which further allows humans to gain unprecedented insights into treatment variability, diagnostics, and patient outcomes.

Chatbots: Chatbot, is an AI-powered service, which allows patients to raise their health-related queries and guide them to deal with the problem. These chatbots are 24/7 available and help in enabling smooth flow and automation of primary care. Such an approach aids in reducing the load on health-care experts, allowing them to focus on other crucial and dire cases. It also saves time and money on avoidable trips to physicians as well as unnecessary hospitalizations.

Better Clinical Decision-Making: While diagnosing patients, it is essential for health professionals to take all crucial pieces of information into account, which means working with unstructured data in medical records. Using multiple AI engines and Natural Language Processing, one can store and process large sets of data, facilitating evaluations and recommendations of each patient individually, thereby improving clinical decision-making. We can also extract the main crux of the patient's conversation with the physician and summarize it into better-structured and more accurate data points using Transcription Generation and Text Summarization techniques. This helps save time in documentation, reduces physician burnout, and improves quality care.

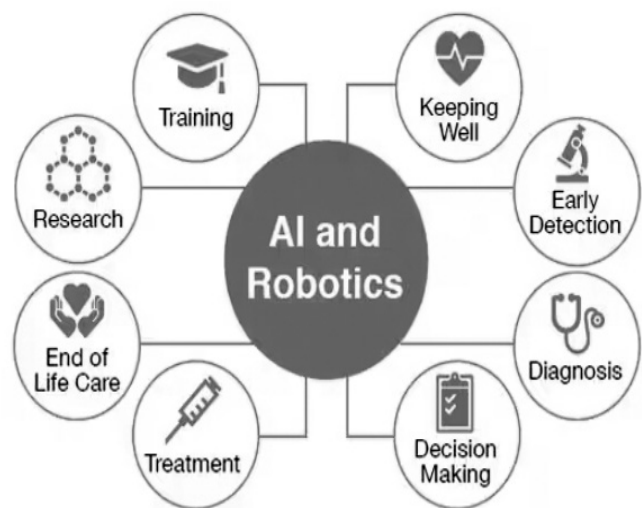


Figure 3. AI and robotics is transforming health care enabling precision surgeries (Source: PwC).

AI-enabled Robotic Surgeries: AI and collaborative robots have revolutionized surgical procedures. Several health-care providers are implementing robotics that assists them during surgeries that require speed, precision, control, and flexibility. This precision helps prevent unintentional or accidental movements during surgeries, resulting in lesser complications, decreased patient-safety risks, and a faster recovery rate.

Monitoring Health through AI-enabled Wearables: The proliferation of consumer wearables and other medical devices combined with AI is used to oversee early-stage heart-disease, enabling doctors to better monitor and detect life-threatening episodes earlier. AI-powered wearables combined with edge computing might be the new edge for hospitals and health-care systems. According to Global Market Insights, market size of AI-wearables in the healthcare is poised to reach \$180 billion by 2025. They can coordinate medical records covering sensitive data for patients, scheduling appointments with physicians, sending follow-ups and clinical appointment reminders to patients. Algorithms in wearable heart monitors and smart-

phone apps allow healthcare experts to monitor heart conditions and give instructions remotely.

Automated analysis for radiographic images: Via combining big data and deep learning technologies, health-care professionals can extract useful information from complex images, including those from CT scans and MRIs. As a result of analyzing the patterns in a digital image, the algorithm can provide additional metrics and results to assist the radiologists analysis to enable an earlier diagnosis.

In addition to making an ideal diagnosis on time, it can also improve radiation workflow by achieving quality control and efficiency, as well as automating risk stratification, which is an effective way to identify patients at higher risk. AI-based medical imaging diagnosis will not eliminate radiologists but rather expand their role in diagnosis and decision-making, which will help reduce medical errors and accidents.

Decreasing the Burden of EHR Usage: Electronic Health Records (EHRs) have played a pivotal role in advancing healthcare's digitalization. However, the switch to EHRs has also introduced several issues for admin staffs such as cognitive overload, endless paperwork, and user burnout. By leveraging AI in the healthcare system, EHR developers have created more intuitive interfaces and automated some of the routine tasks that are time-consuming for end users. Additionally, AI can be used to process routine requests from inboxes, such as medication refills, and send notifications as a result. Likewise, it can prioritize tasks that need the clinician's attention, making it easier for the users to manage their to-do lists.

Disease Prediction: Chronic diseases are increasing in prevalence and mortality worldwide. AI techniques are being used to predict such diseases based on available patient data. These techniques and algorithms can help physicians to identify such conditions much quicker, promoting early intervention and a faster decision-making process. It can also reduce the time and cost involved in analyzing scans, potentially allowing more scans to be taken to offer better target treatment. This technique has shown significant results in detecting conditions such as breast and skin cancers, cardiac arrest, pneumonia, and eye diseases. Therefore, early disease risk identification is beneficial for patients to start treatment early and also motivates them to adopt health-promoting lifestyle.

V. INTERNET OF MEDICAL THINGS

The internet of medical things (IoMT) is the collection of medical devices and applications that connect to healthcare information technology systems through online computer networks. Medical devices equipped with Wi-Fi enable the machine-to-machine communication that is the basis of IoMT. It enables monitoring patients with chronic diseases. Deployment of 5G will be a catalyst.

IoMT increases the amount of health data available to caregivers, the variety of sources it comes from and the speed at which it is collected, transmitted and analyzed. More transmitted data improves both patients' and providers' decision-making capabilities.

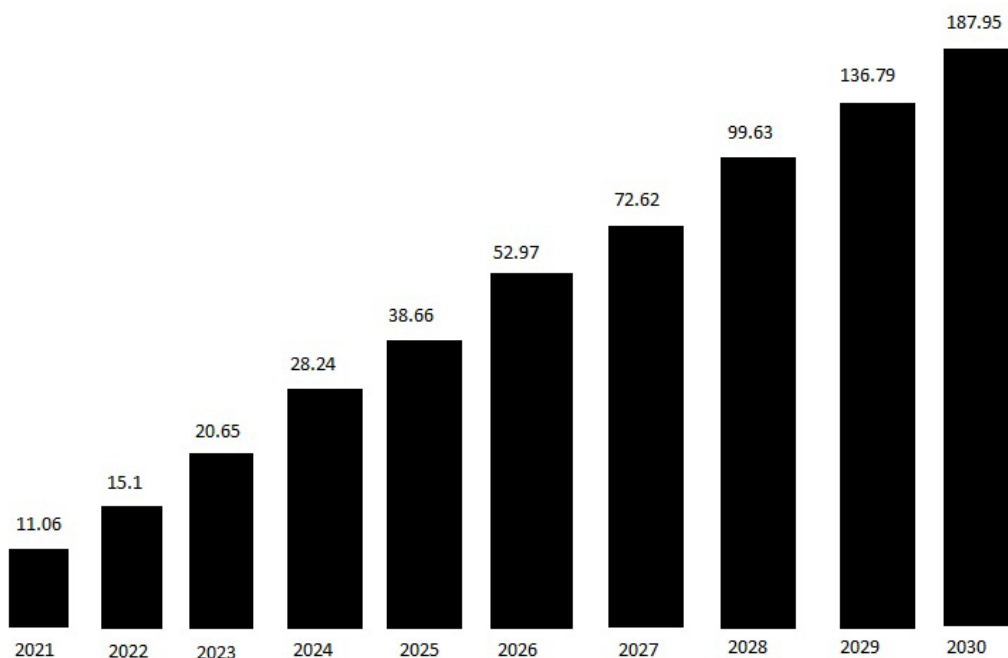


Figure 4. Anticipated growth in AI in healthcare market [9].

IoMT provides the devices and networks that enable telemedicine and virtual care. It will be recalled that Remote health-care capabilities became popular during the height of the COVID-19 pandemic to limit the number of patients traveling to healthcare facilities and to reduce the stress on overburdened hospitals.

VI. CONCLUSION

Healthcare is at an exciting tipping point. AI-powered technologies can observe relations and patterns that humans do and recognize patterns that are un-observable by humans. Nevertheless, adoption of AI in healthcare continues to face challenges, including a lack of trust in the results delivered by such systems and meeting specific requirements. However, the applications of AI in healthcare have already brought multiple benefits to health-care providers.

By enabling faster service, improving workflows, assisting medical and nonmedical staff with repetitive tasks, and developing accurate diagnosis and data analytics, patients, researchers, and physicians can all benefit from the use of AI in healthcare.

AI will be the catalyst for helping us overcome the challenges of clinician burn-out, fragmented health-care systems and patients struggling to access the care they need, when and where they need it.

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