AI and Machine Learning in Healthcare - Applications, Challenges and Ethics

# AI and Machine Learning in Healthcare - Applications, Challenges and Ethics

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## Abstract

**Purpose**: This research aims to discuss how AI and machine learning can be used in healthcare, challenges associated with implementation and the ethics around the widespread adoption of AI in the health care ecosystem while understanding the regulations around the technology implementation.

**Methodology**: By conducting qualitative analysis on various applications of AI and machine learning in health care and its impacts on patient care, the analysis summarizes the challenges and ethics associated with the implementation.

**Findings**: Results indicate that in the last few years, the data collected in the healthcare industry has increased manifold. Some studies suggest that structured data is growing by 40% each year, unstructured data is growing by over 80% and global data produced is forty zettabytes (ZB) as of 2020. With the increased regulatory and compliance requirements, effective data governance is a mandate for industries like healthcare where there is greater focus on data privacy, data security and personal information protection. This rapid explosion of data and the need to ensure the data is available at the right time has led to increased adoption of artificial intelligence (AI) and machine learning solutions across healthcare organizations to gain meaningful insights from the data collected. These technologies are proving to transform many aspects of healthcare ecosystem from patient care to administrative functions.

**Unique contribution to theory, policy, and practice**: Currently AI and machine learning are aiding providers and patients by improving the health outcomes, but further research   is necessary to validate to ensure these technologies are complying the regulatory guidelines without comprising on the patient care and the ethics involved when it comes to patient security and privacy.

**Keywords**: *Artificial Intelligence, Machine Learning, Ethics, Compliance, Data Governance, Deep Learning, Natural Language Processing, Neural Networks*

## Introduction

Healthcare technology has changed the whole landscape of patient care, making information accessible at the fingertips, and giving the healthcare providers better decision-making capabilities. With the growth of emerging technologies like Artificial intelligence and machine learning there is significant improvement in quality of care despite some resistance in adopting the technology. While AI is not a replacement for human physicians it can supplement in data-driven decision making and aid in clinical support systems by reducing human errors [1]. AI technology has potential to transform different facets of healthcare ecosystem that include diagnosis to creating treatment plan, drug trials, administrative tasks in hospitals, clinical decision support and surgical aids.

As per the metrics published [2] , there was a rapid increase in the use of AI in healthcare from 2021 to 2024 and is forecasted to grow to 188 billion by 2030. Per the report, healthcare data integrations and natural language processing (NLP) is most used AI software in healthcare intended to support clinicians and physicians in decision-making. The chart below shows the healthcare market size in AI from 2021 to 2030.
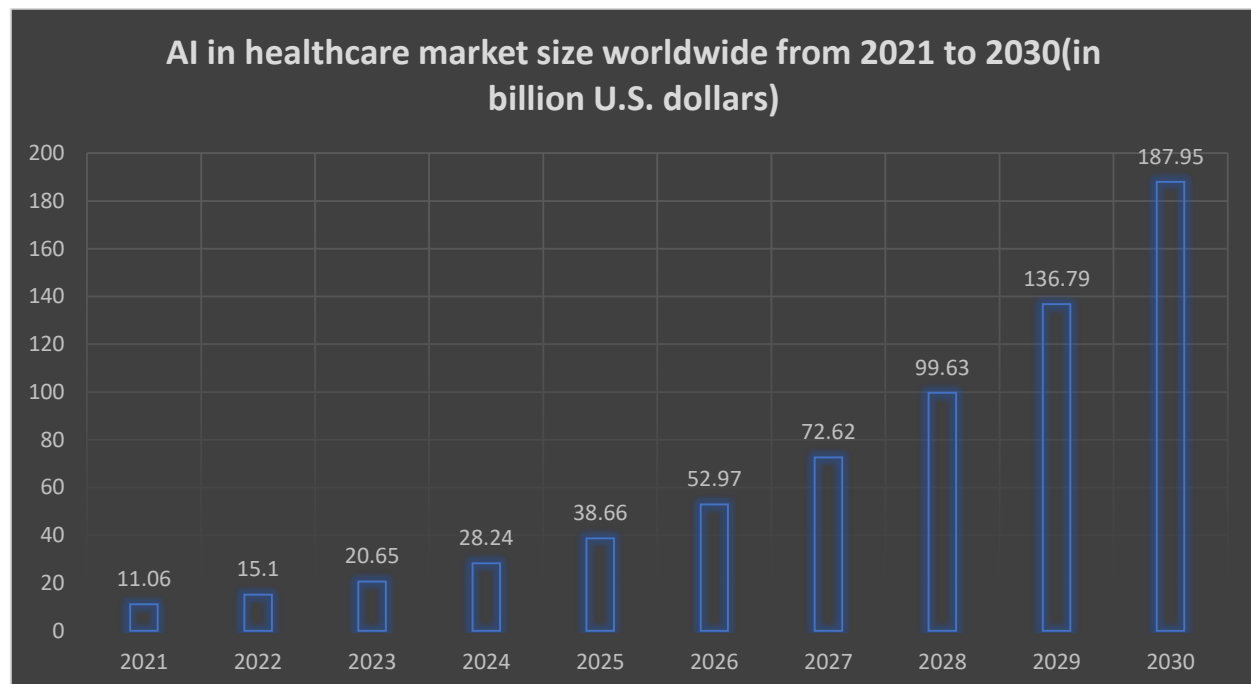


Figure 1 - AI in healthcare market size worldwide 2021-2030

## Applications of AI in Healthcare

Medical Imaging analysis when integrated with artificial intelligence (AI) can completely transform the diagnostic medicine by improving the effectiveness of early diagnosis and accuracy of many life-threatening conditions such as cancer, brain, and heart related ailments. AI algorithms, particularly machine learning and deep learning help in analyzing large amounts of data generated

from medical images such as X-rays, MRIs, and CT scans for anomalies, identify patterns that could indicate presence of disease faster and with more precision than possible by radiologists [3]. AI can also help automate the initial analysis and image sorting allowing physicians to focus on patient care. The convolutional neural networks (CNNs) are being used in image analysis and image recognition tasks. The reconstruction of 2D images to 3D images is helping with more comprehensive anatomy view to gain deep understanding of the complex issues. Augmented Reality (AR) and Virtual Reality (VR) is helping physicians in many areas of healthcare ranging from surgical planning to training.

Predictive Analytics in AI integrates machine learning with statistical models forecast outcomes based on past historical data. This enables organizations to make data-driven decisions and gain efficiency and accuracy in making informed strategies using future trends or outcomes. Machine learning models are widely used in pattern recognition and help identify occurrence of a disease or health care risk. Deep learning techniques such as neural networks are used in image and speech recognition as it is effectively used in working with unstructured data such as MRIs, X-rays, and audio files. These two types of predictive analytics can help in early detection and management of diseases in the form of more accurate, and efficient analysis of large data sets. Research indicates that deep learning with its superior predictive capabilities and ability to outperform human accuracy has found wide range of applications ranging from molecular diagnostics such as identification of pathogenic variants to DNA sequencing and gene splicing , and to tasks such as protein structure classification and medical informatics [1].

One of the most promising developments in AI space and pharmaceutical industry is the integration of AI in drug discovery and development process by enhancing the efficiencies using deep learning all the way through clinical trial phase of the drug development. AI models can be used to analyze substantial amounts of chemical compositions and genomic data during drug discovery process when creating new drugs [4] . The models can also be trained to screen millions of compounds and their combinations for understanding the efficiency and effectiveness of the drug thereby reducing the costs involved and finally the models can be used to help identify the potential side effects during both preclinical and clinical trials by monitoring patient conditions real time and the efficacy of the drug in reaching specific targets in the body by predicting the absorption, distribution, metabolism, excretion, and toxicity (ADMET).

Precision Medicine or personalized medicine using AI is aimed at creating personal care plans based on the individual traits of the patient. AI and machine learning can help us understand genetic history, the environment conditions, lifestyle factors and family history to create targeted interventions and care plans. With the help of gene sequencing AI can identify gene mutations that can cause certain diseases across all the age spectra thus enabling the doctors for decision making [1]. Machine learning models can predict the drug dosages, efficiencies, and response to medication over time based on the patient's genetic makeup. With the help of wearable technology AI can analyze the treatment effectiveness and adjust the treatment plan in real time.

AI powered virtual health assistants (VHA) with the help of natural language processing (NLP) and other AI technologies are transforming patient care by improving healthcare access and gaining efficiencies in provider workflows. VHAs are helping patients schedule appointments, medication reminders and providing information for basic queries via text and voice responses. With the help of speech to text conversion technology VHAs are reducing the language barriers in health care and enabling interactions with Providers for the non-English speaking population. According to the Global Virtual Assistants in Healthcare Market – Analysis and Forecast report, the global virtual assistance in healthcare market size is expected to reach $2.1 billion by 2031 and the healthcare provider segment is expected to be dominant in the use of VHA to provide at home treatments as shows in the figure 2 below [5]. VHAs enabled access to healthcare support 24/7 especially in rural areas with scarcity of medical professionals by providing information about the health conditions, treatment plans including nutrition and medications thus eliminating the need for travelling to physical locations.
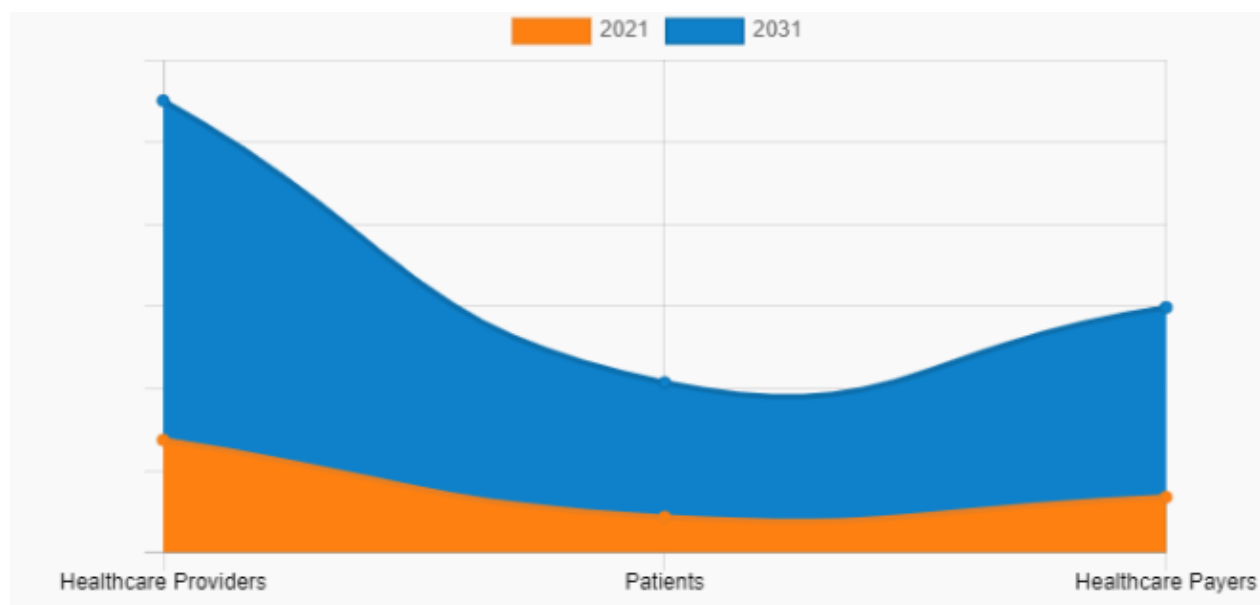


Figure 2 – Virtual Assistance in Healthcare market

AI is also helping in optimization of healthcare operations and gaining efficiencies and reducing the operational costs. AI can be used in financial operations from authorizations, claims and to fraud detection thus preventing significant losses to healthcare organizations. AI helps in accurate medical coding and reduce human errors and improve the revenue and compliance standings of the organizations. AI aids the physicians in data driven decision making by analyzing large volumes of patient data, both structured and unstructured, and provides care recommendations. AI can also help with supply chain management by predicting the need for medical supplies and tracking the inventory in real time. Some of the AI applications in healthcare are shown in figure 3 below.
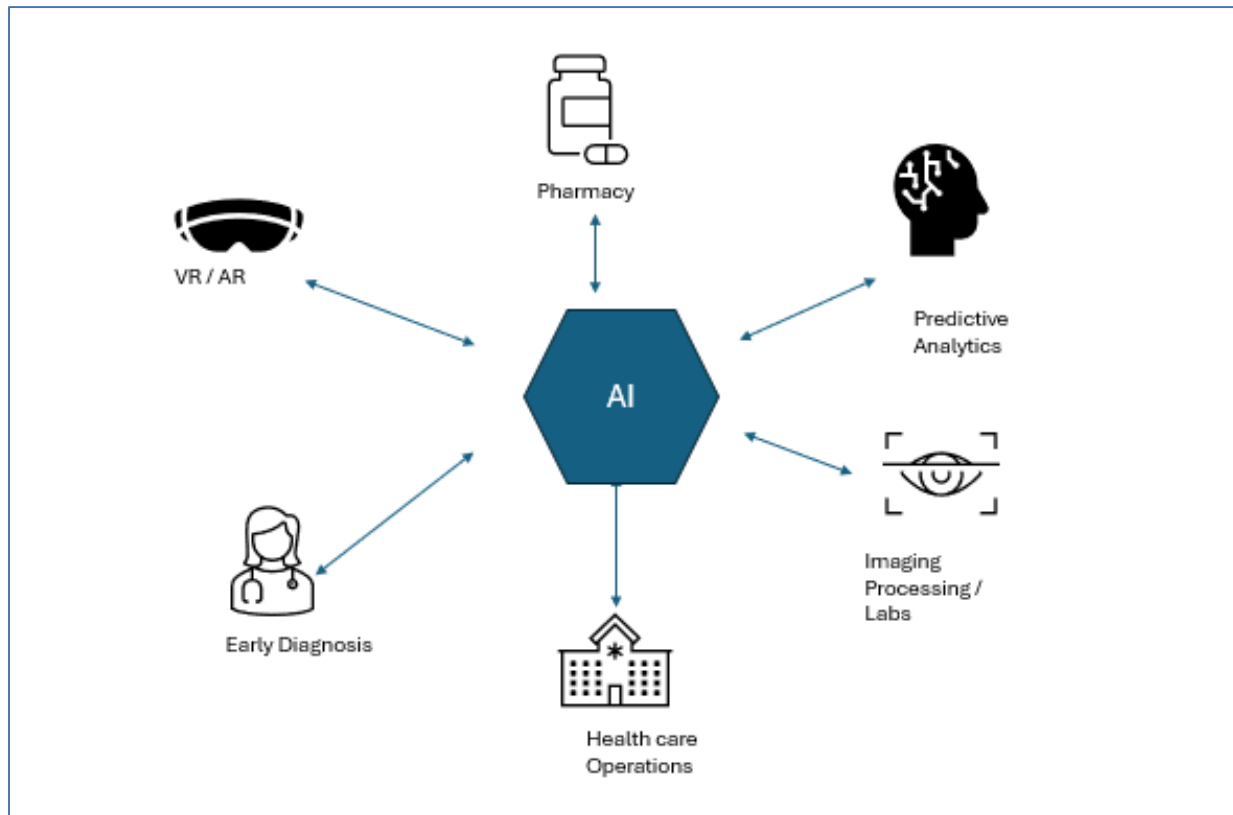
Figure 3: Application of AI in healthcare

## Challenges and Considerations

The substantial potential AI offers to healthcare landscape comes with risks to data privacy and security. Given the extremely sensitive nature of health care data and the privacy regulations that the data is subjected to, and the increasing use of AI in analyzing this data it is crucial to address these challenges. Unauthorized access to patient data would result in violation of patient privacy. Also, the AI models make use of large data and can potentially result in data breaches and unauthorized access to the data. Some ways to mitigate these risks is by removing or obfuscating the patient identifying information (PII) from the data sets that are used in AI model training. It is crucial to ensure that AI solutions comply with the local health regulations such as Health Insurance Portability and Accountability Act (HIPAA) in the U.S., the (GDPR) in Europe to protect patient data. Ensuring effective access and data transfer controls are in place is essential to minimize unauthorized access [6].

Lack of interpretability and transparency is a major challenge when it comes to the use of AI in clinical decision making and healthcare settings. Most of the AI models used in healthcare such as deep learning models and neural networks are hard to interpret even for the creators. The higher the complexity of the model the harder it is to understand the internal workings of the model making it difficult for health care providers to trust the recommendations of AI and integrate it in their clinical decisions. Lack of transparency on the data used to train the models, the accuracy and

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the limitations of the AI system would result in lack of trust on the outcomes. These challenges can be overcome by using simple linear models that can provide accuracy with greater transparency and using visualization tools that can help users understand the model and the basis of the AI decisions. With the help of XAI methods such as Local interpretable Model-agnostic Explanations (LIME) that provides human understandable terminology, clinicians can understand how the decision-making process works in the model [7].

Challenges associated with data quality and bias are a significant hinderance in adopting AI in healthcare. Inaccuracies in data can result in incorrect AI outcomes. Incomplete data or inconsistencies in the data can degrade the model performance leading to erroneous or potentially inaccurate diagnosis and can have harmful consequences in healthcare. If there are biases in the data used to train the model, whether it is sample bias, or the measurement bias will result in the model making assumptions and would not be applicable across all groups of patients [1]. Hence it is essential to overcome these challenges by ensuring data is collected from multiple trusted sources to capture a broad spectrum of population to establish robustness of the model. Implementing data quality tools to periodically check the quality and finding the gaps in the data will ensure the correctness of data used for model training.

Navigating the Regulatory and Legal Compliance frameworks in the rapidly evolving AI space is a complex challenge for both healthcare organizations and the AI community. It is also challenging to get a patient's consent when AI is used in the diagnosis or treatment. Another barrier when it comes to AI in healthcare is the legal challenge in case of adverse outcomes as there are no clear guidelines as to who should be held accountable in such cases [6]. Therefore, it is important to ensure while implementing AI solutions, adherence to the local regulations and policies are considered.

Integration and adaptation of AI technologies in healthcare organizations would require change to the current processes, availability of expert professionals in the AI field and overcome the resistance from the stakeholders. AI integration in the existing systems also requires the systems to be interoperable to ensure compatibility and seamless data transfers. Obtaining approvals from the regulatory bodies such as FDA that tightly regulate the AI based software implementation in healthcare is both time consuming and costly and thus hindering widespread adoption [6]. Addressing these technical and organization cultural challenges along with ensuring interoperability standards are established are crucial for successful implementation of AI.

**Ethics**

Use of AI in healthcare raises ethical questions related to patient autonomy and need for informed consent. Patients should have transparency and understanding of the use of AI technologies in decision making and treatment. The physicians should ensure that the patient is provided relevant details about the risks, limitations, and potential benefits with the use of AI and provide alternate options to be the patient, so they have the autonomy of making informed decisions about their health care and advocate for their preferences. The patient should also be informed

about the usage of their healthcare data for any research or model training purposes. Equity and access are crucial ethical considerations when adapting AI implementation in healthcare to prevent widespread disparities when it comes to healthcare delivery. There can be profound consequences if the AI enabled tools are used in decision making without adequate testing and controls in place. The AI models can be biased if they are not sufficiently trained on data from different population groups that are targeted for [8]. Hence it is crucial to address these issues to benefit large sections of the population from AI adoption.

## Conclusion

In summary, although AI and machine learning offer immense potential to modernize and transform healthcare, it is important to mitigate challenges and ethical concerns. By ensuring the responsible and ethical use of these technologies, AI can benefit patients and society in delivering accessible health care and thus promote health equity. With the help of AI's capabilities in imaging, pattern recognition, drug research, clinical trials healthcare professionals can improve patient outcomes.

## Recommendations

The result of this study outlines the need to implement ethical AI and machine learning when adopting technology in healthcare keeping patient safety in consideration. There is a need for further research to understand any negative impacts of the technology on the quality of care and patient satisfaction. Furthermore, it is important to evaluate the efficiencies gained and the ease of transition using the data gathered across domains to understand if the machine learning and the AI technologies can help in better data -driven decision making in creating specialized care and reducing physician burn out.

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