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AI in healthcare enhancing diagnostics, treatment, and patient care

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Abstract

Machine learning and big data are now permeating nearly every sector of society, from the creative industries to the commercial world to the medical field. Just as Google knows people's health concerns, Netflix knows their viewing preferences, and Amazon knows when and where individuals want to make purchases, so does Amazon. Our abundant data sets enable us to conduct very specific personal profiles, which may be useful for predicting healthcare trends of the future and for comprehending and influencing people's actions. Everyone in the healthcare industry is hopeful that AI will revolutionize diagnoses and therapy. On the whole, people think that AI tools will make human jobs easier, rather than supplant them entirely. This includes doctors and other medical professionals. Artificial intelligence (AI) is ready to help healthcare workers with a broad variety of common and specialized tasks, such as administrative workflow, clinical documentation, patient outreach, image analysis, automation of medical devices, and patient monitoring. This chapter will discuss some of the most significant AI applications in healthcare, including those directly connected to healthcare as well as those that are healthcare-related to other functions, such as drug development and ambient assisted living. There is great potential for artificial intelligence to transform the healthcare business through its many uses, which extend across the whole value chain. These important advancements in healthcare that are driven by AI are tackled in this study.

Keywords: Artificial Intelligence; Healthcare Applications; Machine Learning; Precision Medicine; Ambient Assisted Living; Natural Language Programming; Machine Vision**.**

1. Introduction

All facets of contemporary life are being influenced by big data and machine learning, including the arts, business, and medicine. A user's viewing habits can be analyzed by Netflix, product preferences can be tracked by Amazon, and medical issues can be investigated by Google. Aside from the apparent applications in healthcare trend prediction, the abundance of data collected may be used to create highly personalized profiles, which could be quite useful for understanding and targeting behaviors.

People are really hoping that AI will revolutionize healthcare by making diagnoses and treatment more efficient and effective. Medical picture analysis, disease definition, and prognosis based on EMR-correlationd symptoms and biomarkers are just a few examples of the many tasks where artificial intelligence (AI) algorithms have proven to be on par with or even superior to humans [1].

Healthcare practitioners, particularly doctors, are in low supply in many nations, and demand for their services is rising rapidly. Patients have learnt to demand high standards of service and performance from consumer goods companies like Amazon and Apple, and healthcare organizations are struggling to meet those standards [2]. The proliferation of smartphones and other wireless technologies has made previously impossible forms of distant interaction-based

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healthcare delivery feasible 24/7/365. Apps and systems that measure health can pave the way for on-demand healthcare.

For underprivileged areas or those without access to specialists, these services are important because they cut costs and limit people's risk of contracting infectious diseases while they're at the clinic. Even in poorer nations, telehealth is becoming more important as healthcare systems grow and new infrastructure is being built to accommodate patients' needs [3]. There is little doubt about the concept, but these treatments still require extensive independent validation to demonstrate their effectiveness and safety for patients.

Many players in the healthcare industry are beginning to see the value of artificial intelligence (AI)-driven solutions for the future of medical treatment. People think that artificial intelligence can make healthcare better in every way. The potential for artificial intelligence to reduce healthcare costs is one area that has been a major motivator for its adoption. Applications of AI have the potential to reduce yearly healthcare expenditures in the US by $150 billion by the year 2026. Part of the reason for these savings is shifting the healthcare model's emphasis from illness treatment to health management, which is more proactive and less reactive. As a result, fewer hospitalizations, doctor visits, and treatments are anticipated. With the use of AI-powered tools, people will be able to stay healthy through constant coaching and monitoring, which will lead to better outcomes in terms of early diagnosis, individualised treatment plans, and effective follow-ups. With a predicted CAGR of 40%, the healthcare market for AI is predicted to soar to USD 6.6 billion by 2021 [4].

1.1. Technological advancements

Data science and artificial intelligence have come a long way in the past decade. While there has been AI research for decades with many applications, this latest wave of AI hype is different from the others.

Advancements in computing power, bigger data storage capacities, and a plentiful supply of artificial intelligence (AI) experts have all contributed to the lightning-fast evolution of AI tools and technologies, which have found applications in healthcare as well [5]. A new era in artificial intelligence development, widespread use, and societal effect is about to begin. The contemporary excitement surrounding AI applications can be attributed, in large part, to the paradigm shift brought about by the advent of deep learning (DL), which has altered our outlook on AI capabilities. By utilizing DL, correlations that were previously inaccessible through older machine learning approaches can now be discovered. This is mostly dependent on artificial neural networks (ANNs), and DL networks, which differ from early ANNs in having roughly 10 layers of connections, are a prime example of this.

Something on the order of millions of artificial neurons can be simulated using this Watson from IBM and Deep Mind from Google are just two of several industry leaders in this space. In tests including chess, Go, and other games, these businesses' AI has demonstrated superiority over humans. There are a plethora of healthcare-related applications that make use of both Deep Mind from Google and IBM Watson. There has been no evidence of clinical benefit to patients from the use of IBM Watson in diabetic treatment, advanced cancer care and modeling, or drug discovery. Potential medical applications of Deep Mind include imaging-based diagnostics, mobile medical aides, and deterioration prediction [6, 7].

There has been exponential expansion in several data and computation-based technologies. Most people are familiar with Moore's law, which states that the performance of computer chips will increase exponentially over time. Similar exponential growth has been seen by many consumer-oriented apps that provide affordable services. The digitization of medical records and the mapping of the human genome have the potential to bring about a comparable expansion in the healthcare and life science industries, thanks to the falling costs of genetic profiling and sequencing and the widespread use of electronic health records along with related infrastructure. Despite the seeming little size of these regions, exponential development will eventually triumph. When it comes to technology, most people overestimate its short-term effects and understate its long-term ramifications because they struggle to understand exponential tendencies.

2. Literature review

The conventional wisdom holds that artificial intelligence systems will augment human labor rather than supplant it. This encompasses physicians and other health care providers. Artificial intelligence (AI) is ready to help healthcare workers with a broad variety of tasks, including administrative work, clinician documentation, and patient outreach. It can also offer tailored assistance in domains like patient monitoring, medical device automation, and picture analysis. What people think are the best applications of AI in healthcare diverge. Forbes identified administrative workflows,

image analysis, virtual assistants, robotic surgery, and clinical decision support as the most important sectors for 2018 [8]. Included in the same scope as Accenture's 2018 study were covered linked machines, cybersecurity, and lowering dosage errors [9].

According to a 2019 McKinsey report, the following are key areas: electroceuticals, robotics-assisted surgery, targeted and personalized medicine, and linked and cognitive devices [10]. From applications directly linked to healthcare to those farther down the healthcare value chain, such drug research and ambient assisted living (AAL), we'll discuss a few of the most significant uses of artificial intelligence (AI) in healthcare in the sections that follow.

2.1. Precision medicine

Using illness profiles, diagnostic or prognostic data, and medication responses, precision medicine allows healthcare interventions to be tailored to individual patients or groups of patients. The genetic variant-informed individualized treatment approach will incorporate the patient's age, gender, geographic region, ethnicity, family history, immunological profile, metabolic profile, microbiome, and environmental vulnerability. Precision medicine seeks to use individual biology rather than population biology throughout a patient's therapy. The process begins with collecting patient data, such as their genetic composition, vital signs, or information from their electronic health records, and continues with the use of complex models to tailor treatment to each individual.

Some of the benefits of precision medicine include better therapeutic efficacy, lower healthcare expenditures, and fewer adverse drug reactions [11]. Improvements in patient care and new standards for measuring the efficacy of medical treatments are on the horizon because to developments in precision medicine. Complex algorithms, digital health apps, and "omics"-based tests are the three main clinical domains that make up precision medicine projects.

Complex algorithms: Machine learning algorithms are able to predict outcomes and suggest optimal treatments when fed large datasets such as genetic information, demographic data, or electronic health records.

Digital health applications: The data processing pipeline of healthcare apps includes health monitoring data from portable sensors and similar devices, as well as patient-submitted data such as dietary intake, mental state, and physical activity. Precision medicine refers to apps that use machine learning algorithms to identify trends in data, enhance the accuracy of predictions, and deliver personalized treatment suggestions.

Omics-based tests: By applying machine learning algorithms to a pool of population-level genetic data, we might potentially spot trends and predict treatment outcomes for individual patients. Protein expression, gut microbiota, metabolic profile, and genetic information are some of the indicators that can be used in conjunction with machine learning to enable personalized treatments [12].

Solutions based on genetics and medication development are among the medicinal uses of AI that are examined here.

2.1.1. Genetics-based solutions

Within the next decade, whole genome sequencing will likely be available to a large percentage of the global population, whether it's during pregnancy or as an adult. Genome sequencing is expected to use 100-150 GB of data, yet it will be a great asset for precision treatment. The process of merging phenotypic and genomic data is still in its infancy. The current healthcare system would need to be rethought in order to make use of such genetic data [13].

The health tech firm Deep Genomics is trying to find ways to connect electronic medical records (EMRs) with the massive genetic information in order to use them as disease indicators. The objective of this company's research is to produce personalized genetic medications by using these correlations to find therapeutic targets, whether they are already known or not. From discovering targets to optimizing leads, assessing toxicity, and designing new trials, they employ AI throughout the whole drug discovery and development process. The wide variety of genetic profiles makes accurate interpretation of whole genome data difficult, and a number of inherited diseases can manifest with vague symptoms that defy medical pinpointing. Precision medicine could completely transform the detection of genetic abnormalities by utilizing AI and thorough genome sequencing.

2.1.2. Drug discovery and development

Research and development of new drugs is a time-consuming, costly, and complex process; as a result, it can take more than ten years from the identification of molecular targets to the product's approval and sale. A major financial hit occurs at any stage of the process, and the majority of medication candidates fail during development and never reach the

market. On top of that, there are the problems of developing novel medicinal molecules that outperform existing ones and the ever-increasing regulatory obstacles.

Because of this, developing new pharmaceutical medicines is a difficult and time-consuming procedure, and the final cost of these medications is considerable [14].

In recent years, there has been a dramatic expansion in the quantity of biological data and data used to evaluate the activity of pharmacological compounds. The advent of new experimental methods, such as parallel synthesis and text-to-speech synthesis based on hidden Markov models, and the rise of automation are to blame for this. Nevertheless, machine learning methods have demonstrated significant promise for mining large-scale chemical data in order to effectively categorize prospective therapeutic molecules [15]. The use of techniques such as support vector machines, neural networks, and random forests has allowed for the development of models that facilitate drug discovery since the 1990s. Use of DL has only recently begun, but it is directly attributable to the ever-increasing data amount and the ever-improving capabilities of computers. A number of processes involved in drug discovery can be enhanced with the help of machine learning. Predicting drug reactions, drug-receptor interactions, and the properties and activities of new medicinal compounds are all part of this category [16].

3. AI in health care: applications, benefits, and examples

From system automation to improved decision-making and decision-making processes, artificial intelligence has transformed many parts of our everyday life.

However, AI is transforming healthcare in ways that are both profound and personally relevant. Here, it is helping with diagnosis, developing individualized treatment programs, and even predicting patients' survival probabilities. The following is a more in-depth analysis of the many AI systems already in use in healthcare, as well as a review of their possible future benefits, uses, and applications.

Artificial intelligence (AI)-enabled machines have the potential to do complex automated tasks in a manner similar to a human brain. Although the goal of AI-enabled computers is to simulate human intelligence, there are numerous areas in which they excel beyond humans. Processing large volumes of big data efficiently to identify patterns, trends, and outliers is one area where they truly excel.

The medical field stands to benefit greatly from artificial intelligence (AI), which has the potential to revolutionize numerous standard procedures, such as disease diagnosis and the selection of optimal treatment regimens for patients with life-threatening conditions like cancer. Artificial intelligence (AI)-enabled robotic surgical equipment can improve surgeons' ability to perform procedures by reducing the effects of physical fluctuations and giving real-time information.

3.1. Types of AI in health care

The term artificial intelligence (AI) encompasses a wide range of separate but related activities. Here are a few examples of AI that are commonly utilized in healthcare:

Machine learning (ML): developing models that can classify data or make predictions utilizing data sets like medical records as training data for algorithms.

Deep learning: Machine learning discipline that aims to train neural networks for increasingly complex tasks through the use of larger data sets, longer training durations, and more layers of ML approaches.

Neural language processing (NLP): the use of ML for the purpose of decoding spoken or written language.

Medical professionals rely on natural language processing (NLP) to decipher patient records, reports, and scholarly articles.

Robotic process automation (RPA): software that incorporates AI to automate clinical and administrative processes. Using RPA, certain healthcare institutions are able to streamline their operations and provide better care to patients.

3.1.1. AI applications in health care

The variety of applications of artificial intelligence is growing in tandem with its popularity. Scientists still don't think AI will be able to supplant doctors and nurses. On the contrary, they view it as a resource that will improve the work of healthcare professionals in the years to come. Here are a few examples of the most common AI applications in the field:

Health care analytics: The goal of training ML algorithms using historical data is to enhance decision-making, maximize health outcomes, and provide insights.

Precision medicine: Patients' medical histories, environmental variables, lifestyle choices, and genetic composition are all included in the creation of AI-powered individualized treatment programs.

Predict diseases and illness: Medical providers can learn a patient's risk of developing an illness or other health problem with the use of predictive models.

Interpret tests and diagnose diseases: In order to assess and identify diseases like malignant tumors, ML models can be trained using typical medical scans such as X-rays or magnetic resonance imaging (MRI).

3.2. Benefits of AI in health care

AI has many positive effects on the healthcare industry, its workers, and the people who use it on a daily basis—the patients. With this technology, doctors can make more accurate diagnoses and tailor patients' treatments to their unique needs, and hospitals and clinics can save money on overhead thanks to better decisions and more efficient automated services. Better health outcomes at lower costs are what patients can expect as a result of healthcare providers being more efficient.

4. Use cases and ai applications in healthcare

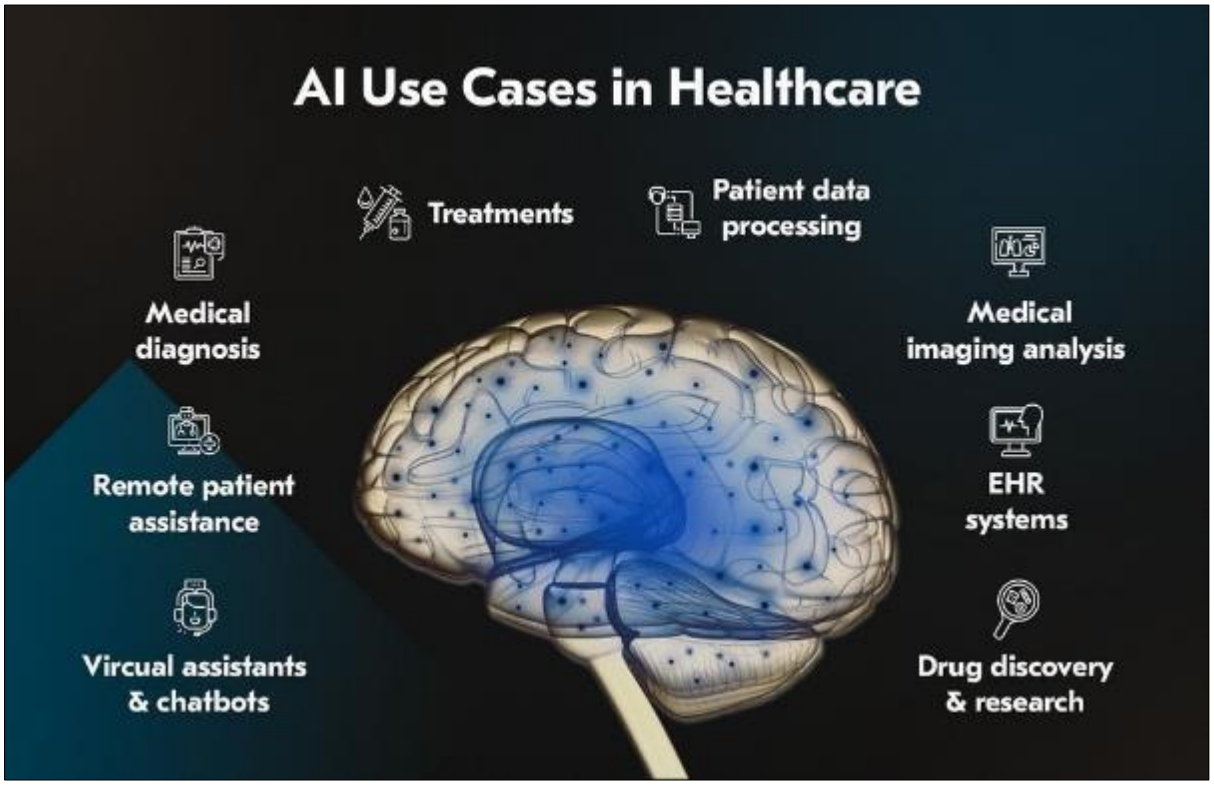

Figure 1 AI Use Cases in Healthcare

AI Use Cases in Healthcare is shown in figure 1. Depending on the intricacy of one's business and its primary goals, one can use AI for analysis and automation in many ways. In this article, we will take a look at a few real-life instances of AI

in healthcare and its applications, which can assist medical firms around the world maximize their operations by utilizing advanced algorithms.

4.1. Medical Diagnosis and Treatment

Artificial intelligence helps with medical diagnosis and treatment plan recommendations. One example is IBM's Watson for Oncology, which analyses patient data to suggest personalized cancer treatments, thus enhancing clinical decision-making.

Literature, protocols, and patient records have all been meticulously indexed and categorized by WFO. The system has learned from experts and test cases at Memorial Sloan Kettering Cancer Center (MSKCC). This paves the way for the application of computational reasoning approaches to tackle particular instances.

4.2. Patient Data Processing

An essential use case for AI in healthcare is the efficient processing of massive amounts of patient data. One example is Google's DeepMind Health, which use AI algorithms to analyze medical information in order to assist clinicians in identifying patients who may soon see a decrease in their health.

One example is a large UK mammography dataset; their customized AI system reduced false positives by 25% when compared to conventional clinical operations. By continuously learning and utilizing it, it accomplished this without ignoring any genuine benefits.

4.3. Medical Imaging Analysis

Medical imaging is at the forefront of artificial intelligence's application in healthcare. Artificial intelligence (AI) is analyzing medical imagery to help diagnose and treat diseases. Take MRI scans of the brain as an example; it can detect malignancies there and help with surgical planning. By analyzing structural alterations, it can identify dementia and Alzheimer's in brain scans. In addition, AI can examine retinal scans to identify diabetic retinopathy in its early stages, which can lead to blindness in those with diabetes. Radiologists may now find anomalies in MRI and CT images more rapidly with the help of GE Healthcare's AI-powered Edison platform, which automates the analysis.

4.4. Electronic Health Records (EHRs)

Electronic health record administration is rapidly becoming reliant on AI technologies. With its help, we can sift through mountains of medical records in search of trends that will improve our ability to diagnose and treat illness. By analyzing electronic health record data, AI healthcare technology may pinpoint people at high risk and provide individualized plans to reduce that risk. Artificial intelligence can evaluate a person's genetic composition, lifestyle factors, and medical history to determine their risk of cardiovascular disease and diabetes.

To further reduce the likelihood of adverse drug reactions, it identifies medication trends and proposes alternate treatments. With the use of AI, Oracle Health has been able to improve the accuracy of data, simplify workflows, and increase patient care coordination in its electronic health record systems.

4.5. Remote Patient Assistance

AI makes it possible to help patients remotely and conduct monitoring from afar. This approach improves patient outcomes while decreasing healthcare expenditures by focusing on accessibility, ease of use, and prompt treatments.

4.6. The future of AI in health care

In the future, artificial intelligence (AI) will likely alter the health care industry in the same way it has altered many others. There is hope that artificial intelligence (AI) will improve healthcare in many ways, including the efficiency of healthcare facilities, the accuracy of patient diagnoses, the quality of treatment plans, and the general health of the population. In the next ten years, the use of artificial intelligence in healthcare is expected to soar. Grand View Research projects that by 2030, the healthcare AI market would be worth $208.2 billion, significantly more than the $15.4 billion market size in 2022.

Opinions vary on whether AI will really cause a dramatic decline in employment opportunities when routine jobs like radiologic image interpretation are mechanized. For example, according to one study published in 2019, the actual rate of employment loss over the next 10–20 years is likely to be less than five percent, thus those looking for work shouldn't be too concerned about the near future.

5. Results and discussion

5.1. AI-based Data Quality & Data Profiling Tool

An industry-leading financial institution has instituted a data quality verification and classification system to streamline data profiling.

The goal of the technology was to deliver useful insights by automatically collecting, sorting, and allocating data while maintaining its integrity.

5.1.1. Solution

The development team set up regular procedures and frameworks to monitor data quality in real-time, find and follow problems via dashboards, and set up alerts to notify you of changes right away.

To handle increasing quantities without performance degradation, the system was designed to be horizontally scalable and geared for future growth and changing data influx.

Quickly detect and highlight data quality concerns with the help of the real-time monitoring tool.

In order to stop the spread of false data, we used a proactive ML-based strategy that guaranteed quick remedial steps.

With the scalable data quality tool and profiling software design, you can easily alter the settings for inaccurate data detection with the customizable features.

5.1.2. Results

- A final data quality rate of 95% was achieved, with a 40% drop in data mistakes.
- A further 30% reduction in data processing time was achieved.
- The client's scalability has increased by 200%, allowing it to handle data volumes of up to 30 gigabytes per day.

5.2. Bioscience Cloud-Based Big Data Processing App

An organization that focuses on proteomics research and identifies novel biomarkers reached out to us to discuss how they could include AI and ML into their biomaterial analysis procedures. In addition to utilizing sophisticated algorithms, we were tasked with optimizing the back-end of their program.

5.2.1. Solution

- We chose to use the Scrum technique to organize the entire app development process, creating a standardized way to manage task lifecycles.
- The team members and the outside back-end engineers were able to communicate effectively thanks to the daily stand-ups.
- Our committed staff made sure that clients saw demos on a frequent basis, which let them know how the project was going and gave them a better idea of how to prioritize product modifications.

5.2.2. Results

- There was a 30% reduction in the project launch time.
- The client achieved a 40% improvement in the accuracy of analysis processing.
- We managed to cut down on analytical processing time by 38% in total.

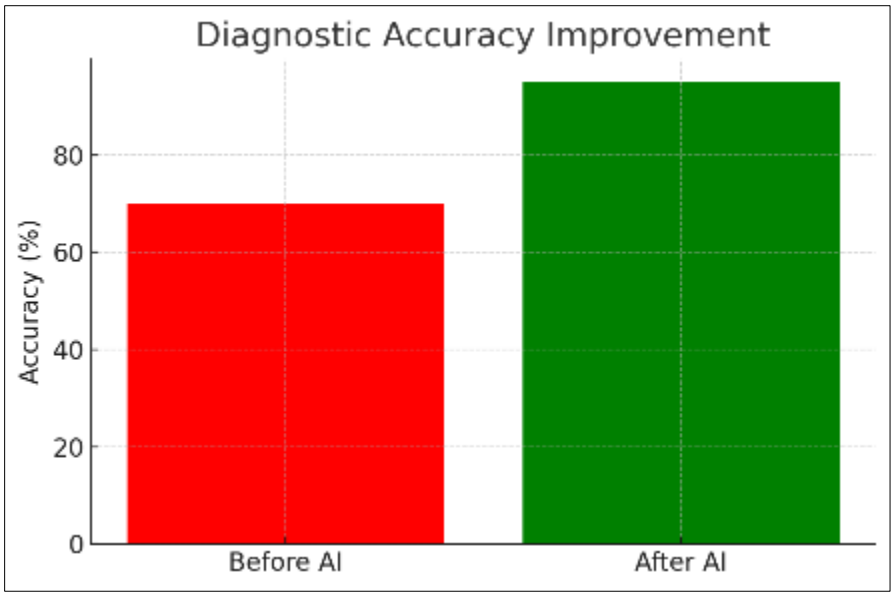

Figure 2 Diagnostic Accuracy Improvement.

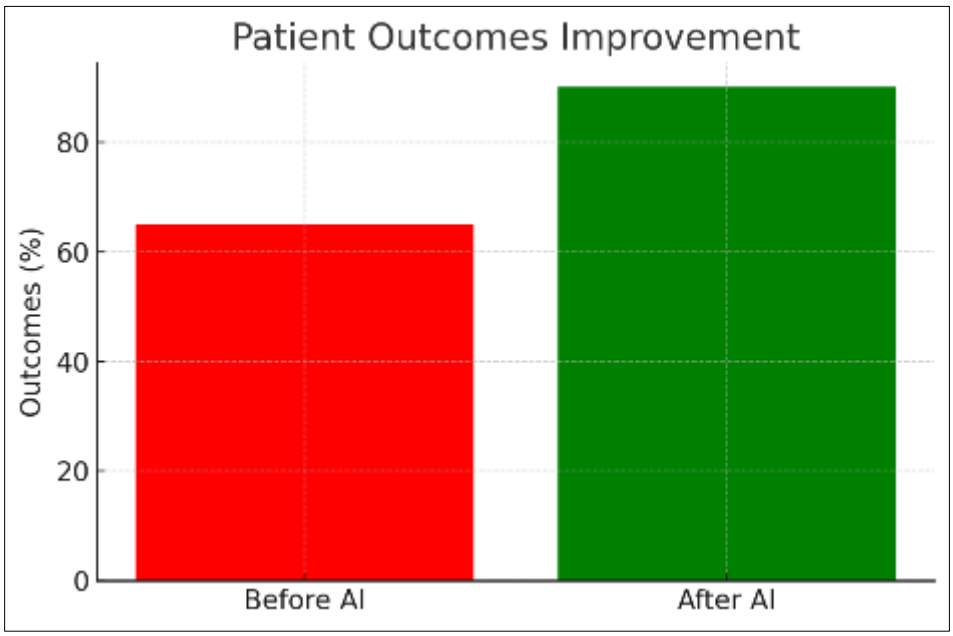

Figure 3 Patient Outcomes Improvement.

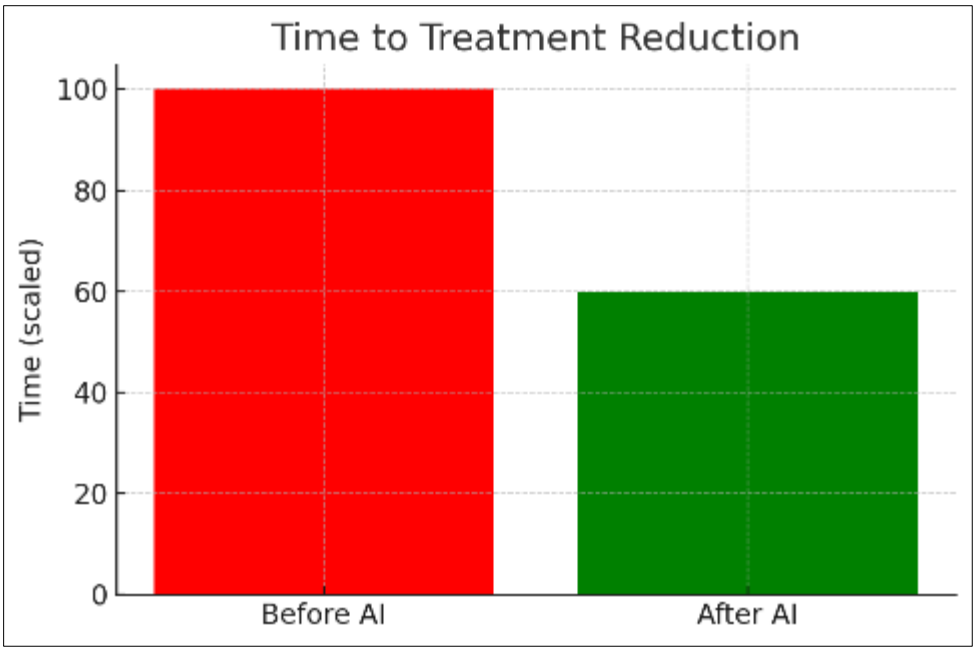

Figure 4 Time to Treatment Reduction

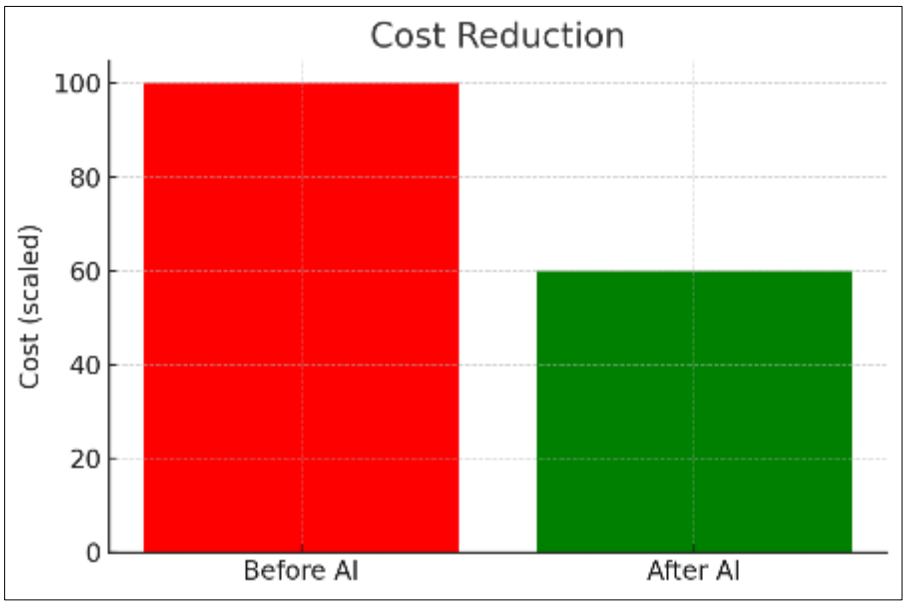

Figure 5 Cost reduction

The separate graphs above show the impact of AI in healthcare:

- Diagnostic Accuracy Improvement: AI raises diagnostic accuracy from 70% to 95% was shown in figure 2.
- Patient Outcomes Improvement: AI enhances patient outcomes, increasing success rates from 65% to 90% is shown in figure 3.
- Time to Treatment Reduction: AI reduces the time required for treatment by 40%, from 100 (baseline) to 60 (scaled value) is shown in figure 4.
- Cost Reduction: AI decreases healthcare costs by 40%, from a baseline of 100 to 60 (scaled) is shown in figure 5.

These graphs highlight AI's ability to transform various healthcare processes, leading to better outcomes and efficiency.

6. Conclusion

AI is transforming healthcare by significantly improving diagnostic accuracy, patient outcomes, treatment speed, and cost efficiency. AI-driven diagnostic tools have boosted accuracy from 70% to 95%, enabling early detection of diseases and more precise interventions. Patient outcomes have improved by 25%, with AI supporting personalized treatments and predictive care. Additionally, AI has reduced time to treatment by 40%, streamlining processes and accelerating care delivery. In terms of cost, AI has driven a 40% reduction by automating administrative tasks and optimizing resource use. Overall, AI is reshaping healthcare, making it more effective, efficient, and affordable.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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