Exploring Artificial Intelligence for Enhanced Healthcare Services

MASTER THESIS

MS BUSINESS ANALTICS

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Abstract

Objective

Artificial intelligence (AI) has the ability to completely change the healthcare sector and the way services are provided. With a focus on the use of AI in clinical decision-making, personalized medicine, and healthcare resource allocation, this research project seeks to explore AI for enhanced healthcare services.

Methods

A mixed-methods research approach will be used for the study, involving the gathering and analysis of both quantitative and qualitative data. To collect quantitative information on the attitudes and perceptions of healthcare providers toward the use of AI in healthcare, a survey will be carried out. To collect qualitative information on patients' and healthcare providers' experiences with AI in healthcare, researchers performed various qualitative research methods.

Results

As demonstrated by the study, improving provider experience is 44%, decreasing per capita cost of care is 46%, improving health outcomes 55% and improving patient experience 55%. The study's findings will shed important light on the present use of AI in healthcare and its potential to enhance patient care. This research study will also point out difficulties and obstacles to the application of AI in healthcare and offer suggestions for overcoming them.

Conclusion

The overall goal of this research study is to add to the increasing body of knowledge about the use of AI in healthcare and to provide guidance for the creation of policies and practices that can support the integration of AI into healthcare services for both patients and healthcare providers.

Keywords: Artificial Intelligence · Machine learning · Robotic single-site · Deep learning · natural language processing

Contents

1. Introduction

Provides real-time AI-driven voice analysis for emotionally intelligent (EI) in healthcare to insurance contact centers and other businesses **(**Jocelyn, V., & Biagi, L., 2022, p. 40). In a study performed in the United States in 2020, 55% of healthcare executives said they thought investing in AI would have the biggest effect on enhancing health outcomes (Stewart, C., 2021, May 7). Additionally, a comparable percentage of respondents stated that improving customer experience would be the biggest advantage of investing in AI (Stewart, C., 2021, May 7). Diagnostic images alone have grown from roughly from 100 to 150 in years of 2007 and 2008 to 1000 - 1100 in years of 2017 and 2018 (Tang, X., 2019, November 28). However, A few high-profile security and healthcare data leak incidents recently (Tang, C., 2019). In a survey of American healthcare executives, 41% said that as of 2021, their use of AI had reached a completely functional level (Stewart, C., 2022, June 7). One of the distinctive features of AI is that, when used to carry out a particular job, it frequently outperforms any one human mind. For instance, Google AI is 88% more effective and 12.1% more precise than a human practitioner at detecting breast cancer (Arsene, C., 2022, November 10).

This study investigates the existing literature on AI approaches to healthcare systems, taking into account the healthcare perspective, and focuses more specifically on responsible AI and ethical concerns in the healthcare system. Therefore, the following research topics serve as the basis for this study: Why is the traditional method of healthcare supported by AI? What are the publication dynamics on the interaction between AI and healthcare systems? How AI improved diagnosis and therapy planning in medical imaging? How do digital health networks employ artificial intelligence? What are the major restrictions and moral issues with using artificial intelligence responsibly in digital health systems? How to facilitate and adopt AI in healthcare networks? How is AI effective in clinical outcomes? What is the precision and dependability of AI in healthcare? Are there any impacts of AI during providing healthcare services? What are the views and sentiments of patients toward AI in healthcare? Finally, what is the cost-effectiveness of both healthcare providers and patients? What is the significance of AI in the future in terms of cost, time, reliability, and accuracy in healthcare?

By identifying the primary dynamics of AI used in healthcare systems and its journey through providing healthcare systems, this research offers unique insights and contributions. The main trends, the most widely used AI techniques, barriers, and advantages related to AI in healthcare system settings are then reported. Additionally, for academics, professionals, and decision-makers interested in exploring and better comprehending the healthcare system and the function of AI as a responsible and disruptive cutting-edge technology, insightful research paths are suggested. The novel

framework that this work uses to help practitioners and academics comprehend responsible AI in the field of healthcare systems.

2. Traditional methods of healthcare services

For an extended period of time, healthcare services have been provided in traditional methods, without even knowing the so-called 'AI'. All kinds of diagnosing disease, major and minor surgeries, physical and occupational therapy, dental care, nutritional support, mental health care, laboratory and diagnostic care, substance abuse treatment, pharmaceutical, outpatient and emergency care, and a variety of more are provided by traditional methods and technologies. Consequently, simple medical treatments took a substantial amount of time, unreliable and overcharged treatments.

According to The Washington Post, a Des Moines resident was listed in stable condition following a recent, record-setting 47-hour operation for a congenital artery problem in a traditional way [20]. However, if the given operation is performed with the help of AI, it may be more precise and faster than those of medical professionals, which could increase the likelihood that affects infants would survive. Medical professionals utilize ultrasound imaging to diagnose fetuses, but human error can lead to some heart problems being undetected. However, Machine learning and deep learning feeds accurate data to AI and progressively better at a task in terms of accuracy, efficiency, and reliability to this specific operation. Researchers in Japan performed a clinical trial of congenital artery operations, and the team strongly believes that AI may help make the diagnosis more reliable and accurate [4]. The longest most protected surgery was reported lasted 96 hours to remove an ovarian cyst and it was performed between February 4 to 8, 1951 Chicago, Illinois. Before the operation, the patient's weight fell 616 lb. and she became 308 lb. after the surgery [8]. In the present day, a similar operation takes between 45 to 100 minutes with the presence of AI based (Robotic single-site) RSS technology [6]. Overall, it can be seen that traditional healthcare services caused unpredictable, inefficient, and uncertain outcomes. Despite that, developing, promoting and utilizing AI technology in the healthcare industry plays a major role and executing a significant change in patient care and treatment.

3. Revolutionizing healthcare with AI

3.1. Involvement of AI in healthcare services

Nowadays, AI is involved in a broad spectrum of fields, including education, security, healthcare, communication and entertainment, business, military, transportation, and a variety of more. In a wider sense, AI refers to a machine or computer that can mimic the

abilities of the human brain and, as a result, learn, analyze, and take actions based on previously acquired knowledge. Therefore, applying AI to healthcare can be useful for analyzing medical data and taking appropriate action to try and anticipate a result. As the significance of this technology is understood, there will be a larger use of AI in healthcare in the future. As stated above, the use of AI technology has the potential to improve treatment, diagnostics, and the amount of time that healthcare workers spend on routine work, allowing them to spend more time engaging with and treating patients [16].

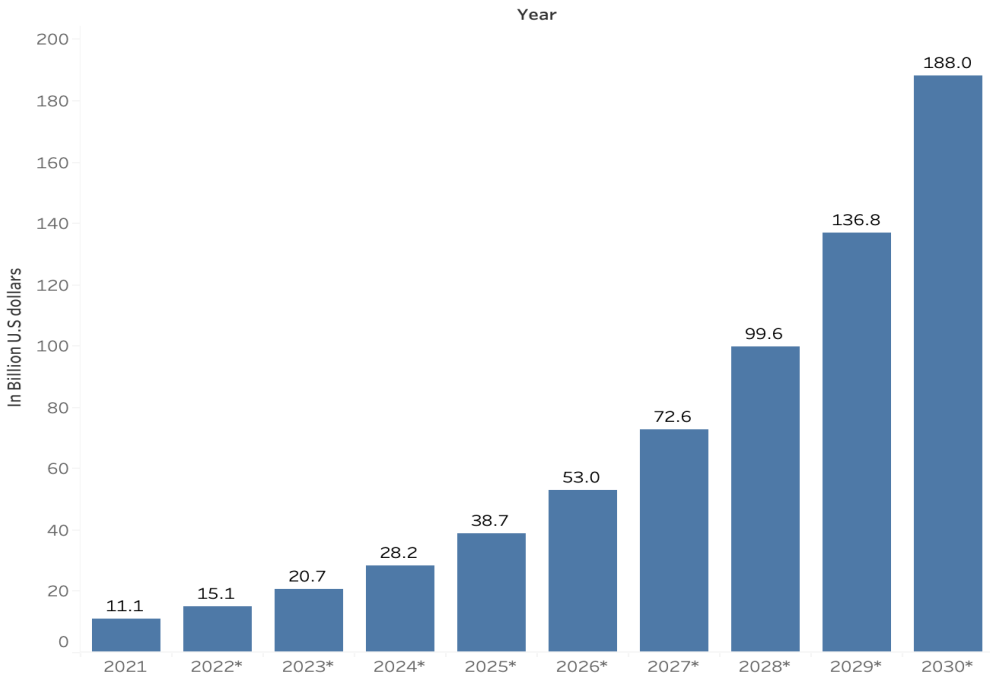

Figure 1: AI in healthcare market size worldwide from 2021 to 2030[14]

The market for artificial intelligence in healthcare was valued at over 11 billion dollars in 2021, and by 2030, it is expected to have grown to approximately 188 billion dollars. A fifth or so of healthcare groups globally were experimenting with artificial intelligence as of 2021, according to research. While a further quarter of hospitals and health organizations said they were just starting to try out AI and machine learning technologies in pilot projects [14]. Healthcare data merging and natural language processing were the two most widely used categories of AI software in the healthcare industry globally in 2021. Nowadays, AI is already providing services in hospitals, reception rooms, clinics or operating rooms, dental offices, laboratory, and emergency rooms. However, most healthcare providers refused to utilize AI. They mentioned that AI would harm their patients and they and they do not want to face legal action. For that reason, some countries of the European Union refused AI's full operation in medical facilities,

hospitals, doctor's offices, ambulatory care centers, wellness centers, rehabilitation centers and urgent care centers.

AI plays a major role in terms of providing quality services and being cost efficient for patients. Despite that, implementing AI in every healthcare provider costs a massive amount of money and enormous resources. Over the long run, implementing AI is inexpensive than Healthcare provider expertise (doctors, nurse practitioners and nurses). In a survey of American healthcare executives, 41% said that as of 2021, their use of AI had reached a completely functional level. Moreover, 26% of respondents said their AI system was only partially effective, while 5% said they had not yet implemented an AI system [12].

3.2. AI's Involvement in the study of medical imaging

Beyond dispute, the most talked-about subject in medical imaging study today—in both diagnostic and therapeutic settings—is artificial AI. For instance, the amount of publications on AI for diagnostic images alone has grown from roughly from 100 to 150 in years of 2007 and 2008 to 1000 - 1100 in years of 2017 and 2018[19]. AI has been used by researchers to autonomously detect intricate patterns in imaging data and provide quantified evaluations of radiographic traits. AI has been used in radiation oncology on various image modalities that are used at various phases of the therapy. such as tumor localization and therapy evaluation. One of the most well-liked study subjects in medical imaging today is radiationomics, which is the extraction of a large number of picture characteristics from radiation images using a high-throughput method.

AI has been effectively used by researchers in radiology to recognize discoveries that are either visible to the human eye or not. Radiology is currently transitioning from a visual art to more empirical science. AI has been effectively used in radiation oncology for automated tumor and organ segmentation, as well as tumor tracking for adaptive therapy. These are excellent reasons for radiomics to advance quickly, along with the rise in popularity of AI and the production of more digital medical images than ever before. A new solution to the problem of precision medicine is radiomics. These studies have shown how useful AI could be in the field of medical imagery [19].

3.3. Assessing the precision and dependability of AI in healthcare

AI is altering the aspects of the healthcare system, including the role of healthcare workers, and it is also opening new opportunities to enhance patient safety and treatment quality. AI must therefore be able to learn and apply information to its surroundings to mimic a human mind. One of the distinctive features of AI is that, when used to carry out a particular job, it

frequently outperforms any one human mind. For instance, Google AI is 88% more effective and 12.1% more precise than a human practitioner at detecting breast cancer [1]. Therefore, AI is more than just a machine that can carry out duties that typically call for human intellect. The software must be superior to any single human in its ability to solve an issue or create an outcome to qualify as AI.

4. Ethical issues and challenges implementing AI to healthcare

Threats to security and privacy were identified as the top worry in a survey about the growing use of AI in healthcare that was conducted in the United States. Safety problems and the possibility of the AI being taken over by malevolent beings were two additional ethical worries. According to a study conducted in Europe, patients are more likely to believe AI when it is used in conjunction with expert judgments than when AI is used alone to make choices.

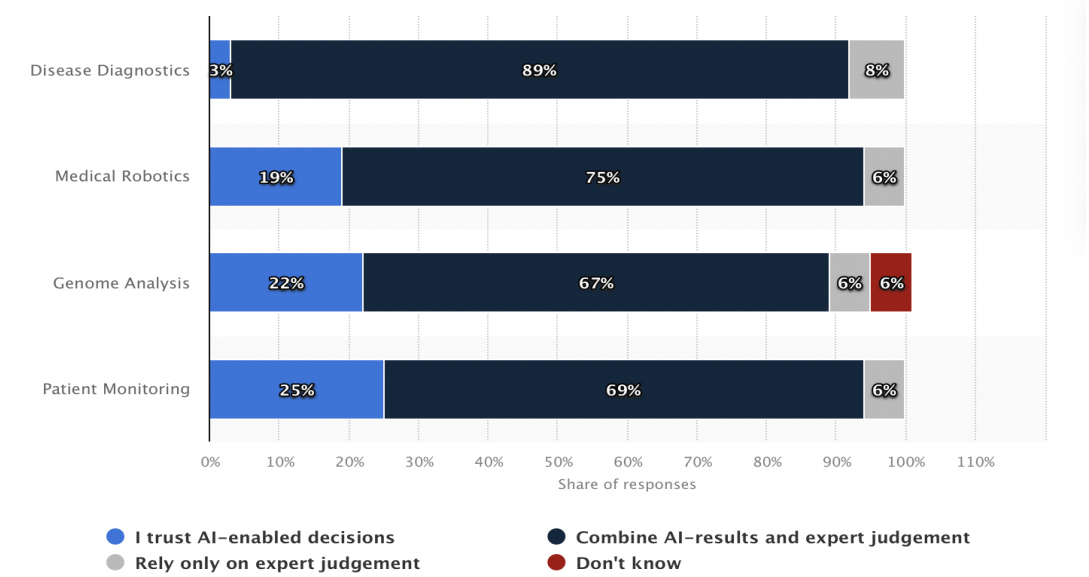

Figure 2: Trust towards use of AI in healthcare in the EU in 2021[Data:11].

Many health leaders held the opinion that investing in AI will enhance both health results and patient experience in hospitals and other healthcare environments, despite the concerns raised by a small number of prospective patients.

There are considerable challenges during implementation of AI to the healthcare industry. In particular, medical imaging data management presents some difficulties. One of the crucial steps of medical imagery is data curation, which is the process of creating, maintaining, and organizing data sets to provide access to researchers. Clinicians struggle to handle medical imaging data with the same capability and precision as the number of images grows rapidly. Regarding policy matters, concerns about patients' privacy are growing. The sharing of medical images across institutions was restricted because

patient-related health information was secured by stringent privacy laws. In spite of that, there have been a number of high-profile security and healthcare data leak incidents recently [19]. Hospitals have tightened up security and data exchange policies as a result of their increased worry over liabilities and securities. Nevertheless, for AI implementations to be successful, a significant quantity of data from numerous organizations is required. It can be difficult to exchange medical images without jeopardizing security.

As previously stated, sharing medical image data to other institutions raised a privacy concern, and it violates Health Insurance Portability and Accountability (HIPAA) policy over breach of confidentiality policy. Therefore, before implementing AI in the healthcare system, it is crucial to understand and follow HIPAA's privacy policy regarding how to maintain confidentiality of handling patients' medical history and their data. Another main challenge is the lack of AI infrastructure in healthcare systems. There are difficulties with data gathering, algorithm creation, and ethical rules for the computer to act at a human level. Furthermore, in pursuit of implementing AI in the healthcare system, raising awareness in society that AI is a life changing modern technology, and by referring to tangible evidence. In particular, it is better to mention how efficient and reliable AI is in succeeding complicated surgeries.

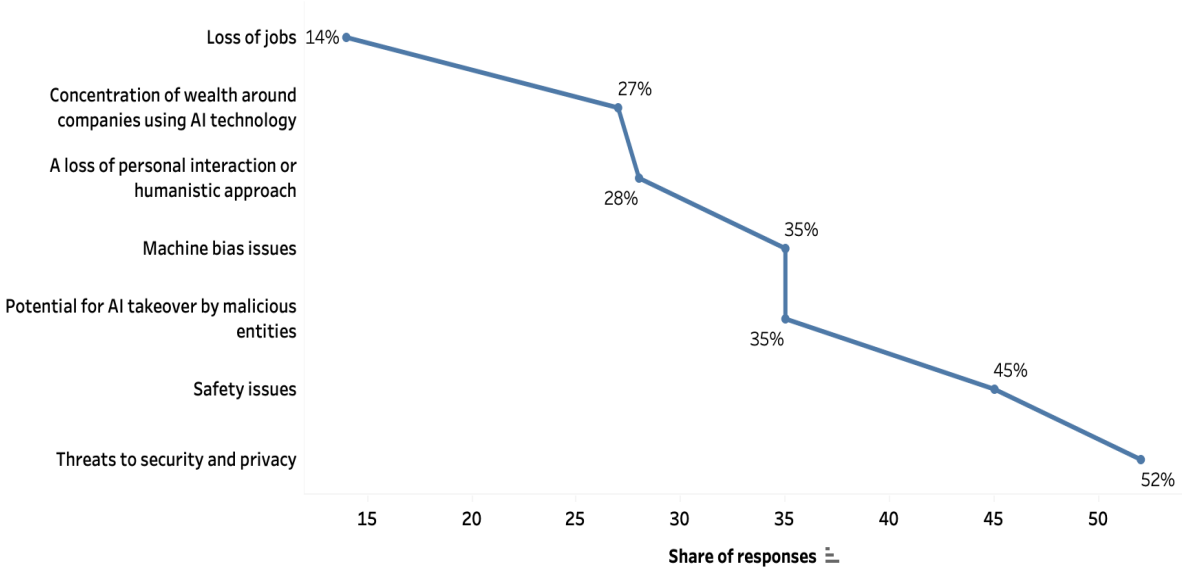

Figure 3: Ethical concerns around AI in healthcare in the U.S. in 2021[Data:12]

Clinicians only need to become conscious of the power of this new technology and comprehend that the world is changing if they want to be able to adjust to future trends and the introduction of AI into the healthcare system. Building an intelligent health

system will improve patient encounters while making doctors stronger at what they do rather than replacing them [12].

5. Investigating how AI effective in clinical outcomes

In a study performed in the United States in 2020, 55% of healthcare executives said they thought investing in AI would have the biggest effect on enhancing health outcomes. Additionally, a comparable percentage of respondents stated that improving customer experience would be the biggest advantage of investing in AI [10].

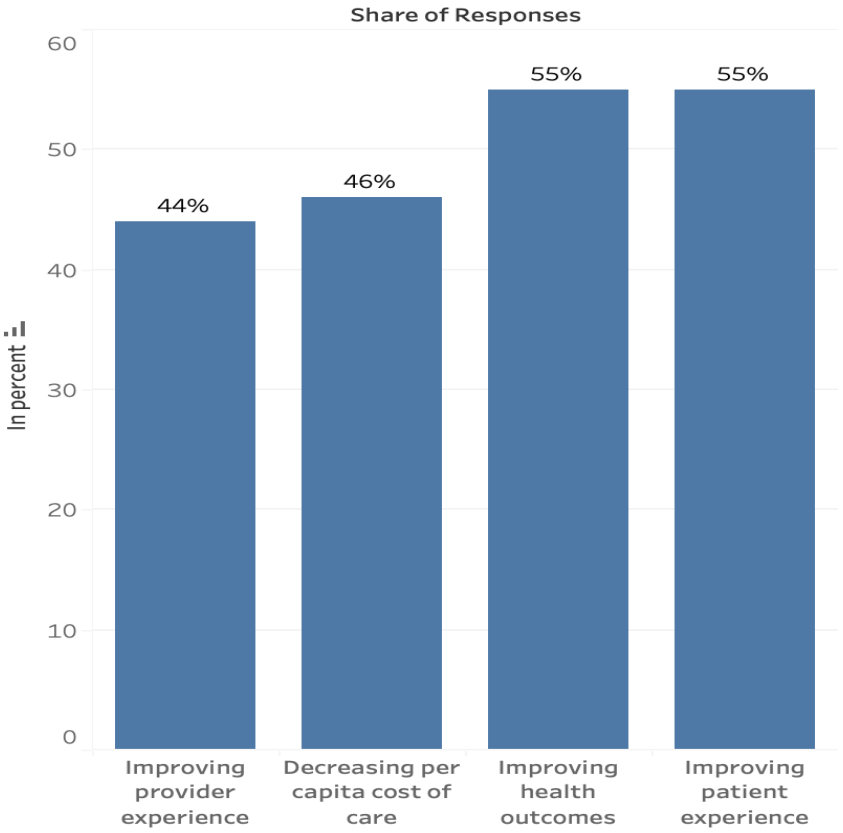

Figure 4: Benefits AI technology will have for health organizations in the U.S. 2020[Data: 10].

As demonstrated by the study, the advantages that AI technology will bring to the U.S. healthcare system by 2020 was that improving provider experience is 44%, decreasing per capita cost of care is 46%, improving health outcomes 55% and improving patient experience 55% [10].

According to this comprehensive study, AI-enabled decision support systems can help increase patient safety by increasing error detection, patient stratification, and medication administration when used properly [2]. To fully grasp how well AI can forecast safety

results in healthcare contexts, additional research will still be required for robust validation of these systems in prospective and real-world clinical situations.

6. Positive Impacts of AI providing healthcare services

The positive impacts of AI in healthcare services may result in better patient results, improved treatment quality, and increased efficiency in the provision of healthcare. Such as improved efficiency and productivity, more prompt and precise diagnoses, improved patient experience, personalized treatment and enhanced drug discovery and development. Data entry and analysis can be automated by AI, freeing up healthcare workers to work on more difficult and crucial duties. This could increase output, lighten the load on the administrative staff, and eventually enhance patient treatment. AI can help medical workers analyze massive quantities of medical data, such as patient histories, and test results, to make diagnoses that are more precise and prompt. This may result in early illness diagnosis, more effective treatments, and better patient outcomes. Furthermore, Healthcare providers can tailor treatment plans based on unique patient requirements and traits by using AI to help spot patterns and trends in patient data.

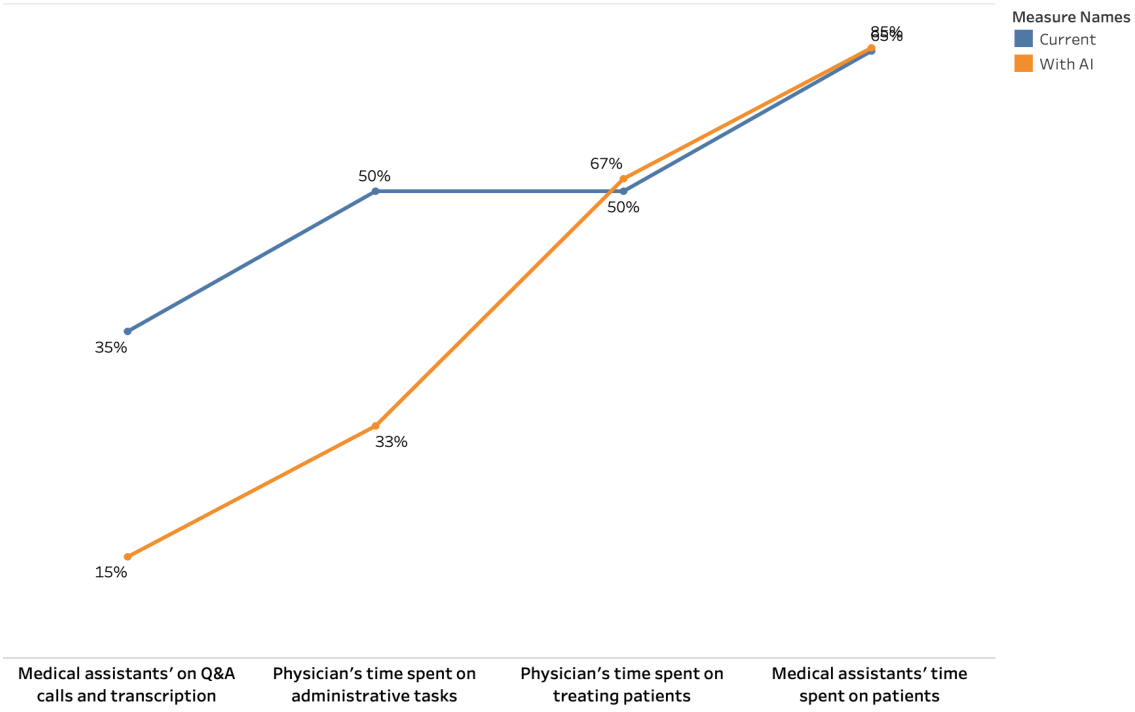

Figure 5: AI reducing time burden of admin tasks to healthcare professionals in Europe 2020[Data:13].

A physician's working hours in 2020 were projected to be approximately divided 50-50 between patient care and office duties in Europe. However, it has been predicted that with the use of AI technologies in the healthcare industry, doctors will be able to devote 17 percent more of their time to patients because the time-consuming nature of routine duties will be lessened [13].

AI can make it easier for patients to receive treatment from the convenience of their homes by facilitating remote surveillance, telehealth consultations, and virtual healthcare services. This can enhance patient happiness, lessen readmissions to the hospital, and better patient experience. Moreover, AI can help with drug finding and development, enabling quicker and more effective drug development procedures that can result in the development of innovative and more potent treatments.

7. The cost-effectiveness of using AI

The cost-effectiveness of AI systems used as decision assistance tools only slightly improved. Since it is doubtful that practitioner diagnosis accuracy will rise in the absence of AI support, it can be presumed that if further advancements in AI are to be anticipated, their cost-effectiveness will as well. To paint a more accurate image of the cost-effectiveness of AI in diagnostic support systems, it is also important to consider the control of AI, rewards for adhering to AI suggestions, and variations in the efficiency and diagnostic process when using AI or not [5]. In the hands of medical professionals, where its benefits are restricted, AI might not necessarily have the greatest advantages, but it could make patient screening easier in situations where specialists are not as prevalent to enable targeted referral.

8. The future of AI in Healthcare

The pandemic, an increase in illnesses linked to contemporary lifestyles, and an expanding global population are all putting enormous strain on our modern healthcare system. The good news is that healthcare could become more affordable, efficient, individualized, and fair by using AI to develop intelligent processes and routines. As some researchers claim, the healthcare sector will likely be most impacted by the massive changes brought on by the fourth industrial revolution. Tom Lawry, National Director of AI for Health & Life Sciences at Microsoft, about the future of healthcare, “Millennials want to be able to have their healthcare consult from the same place they order their dinner — which is their couch. Meanwhile, you have groups like baby boomers who have a very different approach. They're much more inclined to want to focus on a primary care provider…so we have the ability to go from that one-size-fits-all in care delivery with

these systems to using data and AI to truly personalize it, starting with care that's generational. Then even within each generation — millennials, Gen Z, etc. — we have the ability to allow them to access and manage care on their own terms" [9]. Clinicians just need to grasp the potential of this new technology and that the world is changing in order to be able to adjust to future trends and the incorporation of AI into the healthcare system. By creating an intelligent health system, healthcare providers will become better at what they do rather than losing their employment, and patient encounters will also improve [9].

9. Conclusion

The overall goal of this research study is to add to the increasing body of knowledge about the use of AI in healthcare and to provide guidance for the creation of policies and practices that can support the integration of AI into the healthcare system for both patients and healthcare providers. Furthermore, AI has the potential to completely transform the healthcare industry by raising productivity, lowering expenses, and enhancing patient outcomes. Predictive analytics, virtual nursing aides, and other AI-powered technologies have already shown promise in improving diagnosis, therapy, and care coordination.

AI can assist medical professionals in making quicker and more accurate assessments, customizing therapy plans based on patient data, and providing individualized care. Additionally, it can aid medical facilities in operating more efficiently, minimizing mistakes, and raising customer happiness. The use of AI in healthcare is still in its infancy, and there are obstacles to be surmounted, such as privacy issues, legal restrictions, and the requirement for a strong data administration and analytic infrastructure. Additionally, there are worries about how AI could worsen already-existing health disparities and the requirement for openness and responsibility in the creation and application of AI-powered technologies.

In healthcare, AI offers both possibilities and difficulties. The complete potential of AI in healthcare can be achieved while minimizing the risks and challenges related to its adoption with ongoing study, investment, and cooperation between healthcare practitioners, technology developers, policymakers, and patients.

Abbreviations

The following table contains common abbreviations that are used in this document.

Abbreviation	Description
AI	Artificial Intelligence
DL	Deep Learning
HIPPA	Health Insurance Portability and Accountability
ML	Machine Learning
NLP	Natural Language Processing
RSS	Robotic single-site

Glossary

The following table contains unique terms and their descriptions that are used in this document.

Term	Description
Artificial Intelligence	The theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.
Authorization	The action or fact of authorizing or being authorized.
Millennial	Denoting people who born between the early 1980s and the late 1990s .
Natural Language Processing	Concerned with giving computers the ability to understand text and spoken words in much the same way human beings can.
p-value	The p-value is a statistical measure that represents the probability of obtaining a test statistic as extreme or more extreme than the observed value, assuming the null hypothesis is true.
Radiationomics	Radiationomics is a field of study that involves the extraction of quantitative features from medical images.
R-Squared	R-squared is a statistical measure that represent the proportion of the variance for a dependent variable that's explained by an independent variable in a regression model.

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Appendix A

the following Regression Statistics (Table 1) is the calculation of R Square and P value of **people Trust towards use of AI in healthcare in the EU in 2021** between "I trust AI-enabled decisions" and "Combine AI-results and experts judgment. As shown below, R-Square of these two columns is 0.9437 with a p-value of 0.019 intercept. As a result, R-square of 94.37% reveals that 94.37% of the variability observed in the target variable is explained by the regression model. A statistically significant test 0.019 is less than or equal to 0.05 means that the test hypothesis is false or should be rejected.

Share of responses	I trust AI-enabled decisions	Combine AI-results and expert judgement	Rely only on expert judgement	Don't know
Disease Diagnostics	3	89	8	0
Medical Robotics	19	75	6	0
Genome Analysis	22	67	6	6
Patient Monitoring	25	69	6	0

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.971429948
R Square	0.943676144
Adjusted R Square	0.915514216
Standard Error	2.85162353
Observations	4

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	272.4864865	272.4864865	33.5089323	0.02857005
Residual	2	16.26351351	8.131756757		
Total	3	288.75			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	89.20945946	12.51254529	7.129601322	0.01911082	35.3723223	143.046597	35.3723223	143.046597
X Variable 1	-0.959459459	0.165747251	-5.788690032	0.02857005	-1.6726123	-0.2463066	-1.6726123	-0.2463066

Table 1: Regression Statistics between "I trust AI-enabled decisions" and "Combine AI-results and experts judgment.

Appendix B

Table 2 indicates excel based Regression Statistics between "Rely only on expert judgement" and "Combine AI-results and experts judgment. As shown below, R-Square of these two columns is 0.8829 with a p-value of 0.777 intercept. As a result, R-square of 88.29% reveals that 88.29% of the variability observed in the target variable is explained by the regression model. A statistically significant test result p-value greater than 0.05 means that no effect was observed.

Share of responses	I trust AI-enabled decisions	Combine AI-results and expert judgement	Rely only on expert judgement	Don't know
Disease Diagnostics	3	89	8	0
Medical Robotics	19	75	6	0
Genome Analysis	22	67	6	6
Patient Monitoring	25	69	6	0

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.939618477
R Square	0.882882883
Adjusted R Square	0.824324324
Standard Error	0.419136822
Observations	4

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.648648649	2.648648649	15.0769231	0.06038152
Residual	2	0.351351351	0.175675676		
Total	3	3			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.594594595	1.839116705	-0.323304439	0.77713876	-8.5076751	7.31848592	-8.5076751	7.31848592
X Variable 1	0.094594595	0.024361833	3.882901374	0.06038152	-0.0102259	0.1994151	-0.0102259	0.1994151

Table 2: Regression Statistics between “Rely only on expert judgement” and “Combine AI-results and experts judgment.