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**The Impact of Using Artificial Intelligence on improving Patient Satisfaction in
Healthcare industry (Systematic Review)**

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ABSTRACT

The systematic analysis focuses on the impact of artificial intelligence applications on improving the level of patient satisfaction. The main aim is to examine the diverse ways in which the integration of AI-based systems enables the healthcare delivery process to meet the patient's needs and expectations by focusing on various aspects of service delivery including diagnosis, medical imaging, medical research, and drug discovery, patient engagement and compliance, virtual patient care, and administrative applications. 6 suitable and credible peer-reviewed journal articles were included in the systematic analysis. They were retrieved from various online databases including Google Scholar and PubMed and had to be critically appraised to determine their validity and suitability when discussing the topic. The findings showed that effective integration of technological innovation enhances the diagnosis process and medical imaging thus positively impacting the quality of services rendered and patient experience. The use of big data analytic functions in AI-based healthcare systems enhances medical research and drug discovery by improving the collection, analysis, and interpretation of the available vast amount of medical data. The technology also enables providing services virtually and remotely which may positively impact patient engagement and compliance with the adopted clinical management plan. The results also showed that the innovation enhances the effectiveness of administrative practices including health records management and billing and payments.

INTRODUCTION

In contemporary society, there is an increased application of patient satisfaction as a critical indicator of the quality of services rendered in a healthcare system. Patient satisfaction indicates the cognitive evaluation and emotional reaction of an individual towards the healthcare experience encountered. According to Almass, et al., (2022), various modifiable factors such as the effectiveness of physician-patient communication, waiting time, and the continuity of care provided significantly influence patient satisfaction. The Kingdom of Saudi Arabia, similarly to other countries globally, is increasingly adopting technological solutions and innovations such as artificial intelligence to enhance patient experience thus improving the level of satisfaction (Almass, et al., 2022). However, for effective integration of artificial intelligence and other technological interventions into the country's healthcare system, the actions and processes involved should be based on empirical evidence collected from studies and clinical practices. The study will provide empirical evidence regarding the impact of utilizing AI on the level of patient satisfaction and the quality of services rendered to patients in the country.

Recent studies by Almass et al. (2022) and Radwan et al. (2023) report moderate levels of overall patient satisfaction in the healthcare sector, with rates of 77% and 85% respectively. To align with Saudi Vision 2030, which prioritizes healthcare system transformation emphasizing efficacy, accessibility, and patient satisfaction, achieving higher levels of patient contentment becomes imperative (Radwan, et al., 2023). Despite the recognized potential of Artificial Intelligence (AI) to address this need, scientific exploration in this area remains limited. Therefore, there is a pressing need for rigorous scientific investigation into the role of AI in enhancing patient satisfaction within the healthcare industry in Saudi Arabia. The main aim of the systematic review is to investigate the diverse ways in which AI has enhanced patient satisfaction within the healthcare industry in KSA by positively influencing various aspects of healthcare delivery.

Objectives

- To determine how AI has improved medical imaging and diagnostics
- To determine how AI has improved virtual patient care, medical research and drug discovery, patient engagement and compliance, rehabilitation, and administrative applications

LITERATURE REVIEW

Introduction

This section provides a comprehensive explanation of the independent and dependent variables and the existing empirical evidence relating to the topic being discussed. The section starts by providing a detailed discussion about artificial intelligence and patient satisfaction aspects including the definitions and their relevance to the study topic. The next part will investigate the impact of artificial intelligence on the level of patient satisfaction attained according to the existing literature in the country and globally. The last section provides an in-depth analysis of the appropriate theoretical framework governing the study and the relationship that various variables share.

Patient Satisfaction

Patient satisfaction is a vital indicator of the quality of health services offered to patients and plays a crucial role in promoting the effectiveness of healthcare systems. Alqahtani, Alanazi & Alsuwaidan, (2023), defines the concept as the degree to which the patient's expectations are met by the quality of services delivered. The patients act as excellent judges of the quality of services received since they have firsthand experience. The feedback that they provide is essential for any healthcare system since it indicates the weaknesses and provides insights regarding the appropriate interventions to implement to enhance the overall quality of medical services provided to the patients. According to Aljarallah, et al., (2022), high levels of patient satisfaction are associated with various positive implications including improved

compliance and adherence to the interventions offered by trained medical personnel, reduced use of medical services, and minimizing the number of malpractice lawsuits. The government in collaboration with other stakeholders in the health department utilizes the satisfaction results to enhance the quality of services offered and improve patient-centered healthcare. It is also considered a source of information regarding the aspects that adversely affect the patient experience and satisfaction according to individual perspectives.

Artificial Intelligence

Artificial intelligence (AI) is a disruptive and powerful aspect of computer science that can fundamentally transform medical practices and the delivery of healthcare services. Bajwa, et al., (2021), define the AI concept as the science and engineering that involves making machines that are intelligent through the application of a set of rules or algorithms that enable the machines to mimic human cognitive functions including problem-solving and learning. The strength of AI technology lies in its autonomous ability to recognize and learn relationships and patterns from large multimodal and multidimensional data sets which is vital for improved healthcare services delivery. According to Davenport and Kalakota, (2019), the concept of AI does not refer to one technology but a collection of them with a significant number having immediate relevance to the medical fields. Some of the AI technologies that generate high value in the healthcare sector include machine learning, rule-based expert systems, natural language processing, robotic process automation, and physical robots. In contemporary society, there is increased utilization of artificial intelligence for diagnostic and treatment purposes when integrated into the healthcare delivery system, and is associated with positive implications including enhancing accuracy in diagnosing and treating a given healthcare condition.

Summary of Past Studies

Alam & Mueller, (2021), highlight research conducted to establish the impact of providing detailed explanations on patient satisfaction and trust levels in AI-based diagnostic systems.

One of the critical areas in which AI can be implemented in healthcare is providing initial diagnoses at the first point of contact for the patients before referring them to specialists hence allowing the medical practitioners to focus on more critical and challenging aspects of healthcare delivery. However, for the AI systems to effectively execute their mandates, the designers need to ensure that the systems provide explanations to both physicians and patients for the diagnoses and predictions arrived at. The study involved two simulation experiments to examine the effectiveness of correct diagnoses and treatment explanations on the patient experience as they receive care. The initial experiment involved testing a re-diagnosis scenario to assess the impacts of local and global explanations on the level of patient satisfaction and trust in the systems. The second simulation experiment involved implementing different kinds of explanations in similar diagnosis scenarios. The results indicated that explanations enhance satisfaction measures during the critical re-diagnosis period. Results from the second experiment indicated that visual and example-based explanations had significant implications on patient satisfaction and trust as compared to situations where there were no explanations.

Dawoodbhay, et al., (2021), focuses on the integration of AI-based solutions in services delivery in mental health units to deal with patient flow issues. The researchers conducted 20 semi-structured interviews involving mental health and artificial intelligence experts. Thematic analysis was the method utilized to analyze and synthesize the data collected to construct an enhanced model that improved the integration of AI at the service level in mental health facilities. The results indicated that the application of artificial intelligence-based solutions can improve patient flow by optimizing resource allocations and streamlining administrative tasks in the facilities. Another critical finding from the study is that the application of real-time data analytics systems in the delivery process can enhance clinician decision-making in different phases including diagnosis, triage, treatment, and discharge. The researchers also established that the development of solutions such as digital phenotyping that

are AI-enabled could help transform mental health care by promoting the implementation of preventative and personalized models of health services delivery. Therefore, the application of artificial intelligence can help solve patient-flow-related issues experienced in the mental health units hence improving the quality of services rendered to the patients.

Mohamad, et al., (2023) highlight another study that has been conducted on the application of AI-based solutions to enhance healthcare services delivery and patient experience. The main aim of the study was to examine the impact of artificial intelligence adoption on organizational positioning which influences a firm's competitiveness for the healthcare organizations operating in Dubai. The study entailed nine semi-structured interviews that involved the head and the members of the robotic surgery in CMC Dubai. The research team aimed to understand the perception of healthcare practitioners regarding the impact of robotic approaches on care delivery, patient safety, and patient satisfaction thus generating a competitive advantage for healthcare organizations. The findings showed that three primary outcomes were significantly influenced by the implementation of AI in healthcare organizational processes including financial, technological, and clinical outcomes. The AI-based tools improve the quality of services rendered and the patient outcomes after undergoing surgical operation procedures according to the study results. Therefore, the research indicated that the application of AI-based technology contributes to competitive advantage for organizations operating in the healthcare industry by positively influencing clinical processes, and administrative tasks such as financial management, patient safety, and patient satisfaction.

Theoretical framework

Our theoretical framework will be based on a model by Al Kuwaiti et al (2023 p. 951), which evaluates how AI impacts various aspects of health care such as *(i) medical imaging and diagnostics, (ii) virtual patient care, (iii) medical research and drug discovery, (iv) patient engagement and compliance, (v) rehabilitation, and (vi) other administrative applications.*

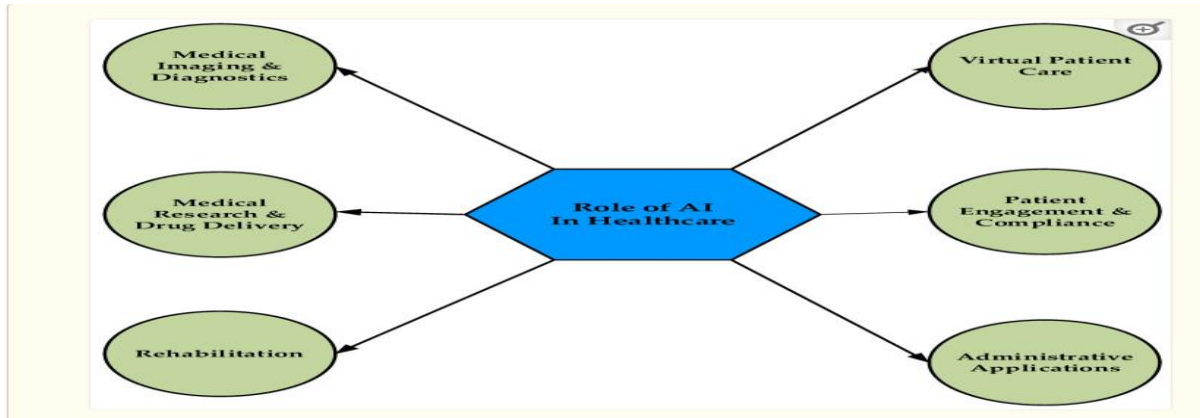


Figure 1 shows the theoretical framework for the systematic analysis

RESEARCH METHODOLOGY

Use of Key Words

The researchers formulated various search words to retrieve suitable empirical studies available in given online-based databases such as Google Scholar. The sources retrieved were credible and suitable peer-reviewed journal articles to explore the topic of the impact of artificial intelligence integration in healthcare on the quality of services rendered and patient experience that is being examined. The keyword term in systematic analysis refers to the search terms that adequately represent the main ideas of the study topic and are usually keyed into the database to retrieve suitable publications that adequately address the topic being discussed. Some of the keywords used in the source's retrieval process include artificial intelligence, machine learning, patient experience, patient satisfaction, and quality of services rendered. The researchers also used Boolean operators to combine the keywords thus refining the search process and ensuring that the retrieved publications are suitable for detailed examination of the study and provide the appropriate empirical evidence to answer the formulated research questions.

Search Strategy

The researcher conducting the systematic review carried out an intensive search on various popular sources of credible publications including Google Scholar and PubMed. The

application of the keywords generated a relatively large number of articles that examine the topic from different perspectives hence the need for coming up with inclusion and exclusion criteria to ensure that the articles included in the analysis are suitable for the research questions. One of the vital aspects used to select viable publications was the year of publication whereby the researcher aimed to ensure that the information analyzed resonates with the recent trends and empirical evidence on the topic. The articles that were published before 2019 were excluded to make sure only the recent trends and study findings were used to discuss the topic at hand. The language of publication was another vital determinant when selecting suitable resources whereby the only articles included were those that were written or had an English version. Another vital inclusion criterion was the accessibility of the entire publication. That is, the articles included in the analysis phase are those that could be fully accessed while those that only the abstract could be retrieved were ignored. The research also considered the suitability of the empirical evidence contained in the articles in discussing and answering the initially formulated study questions.

PRISMA Flow Diagram

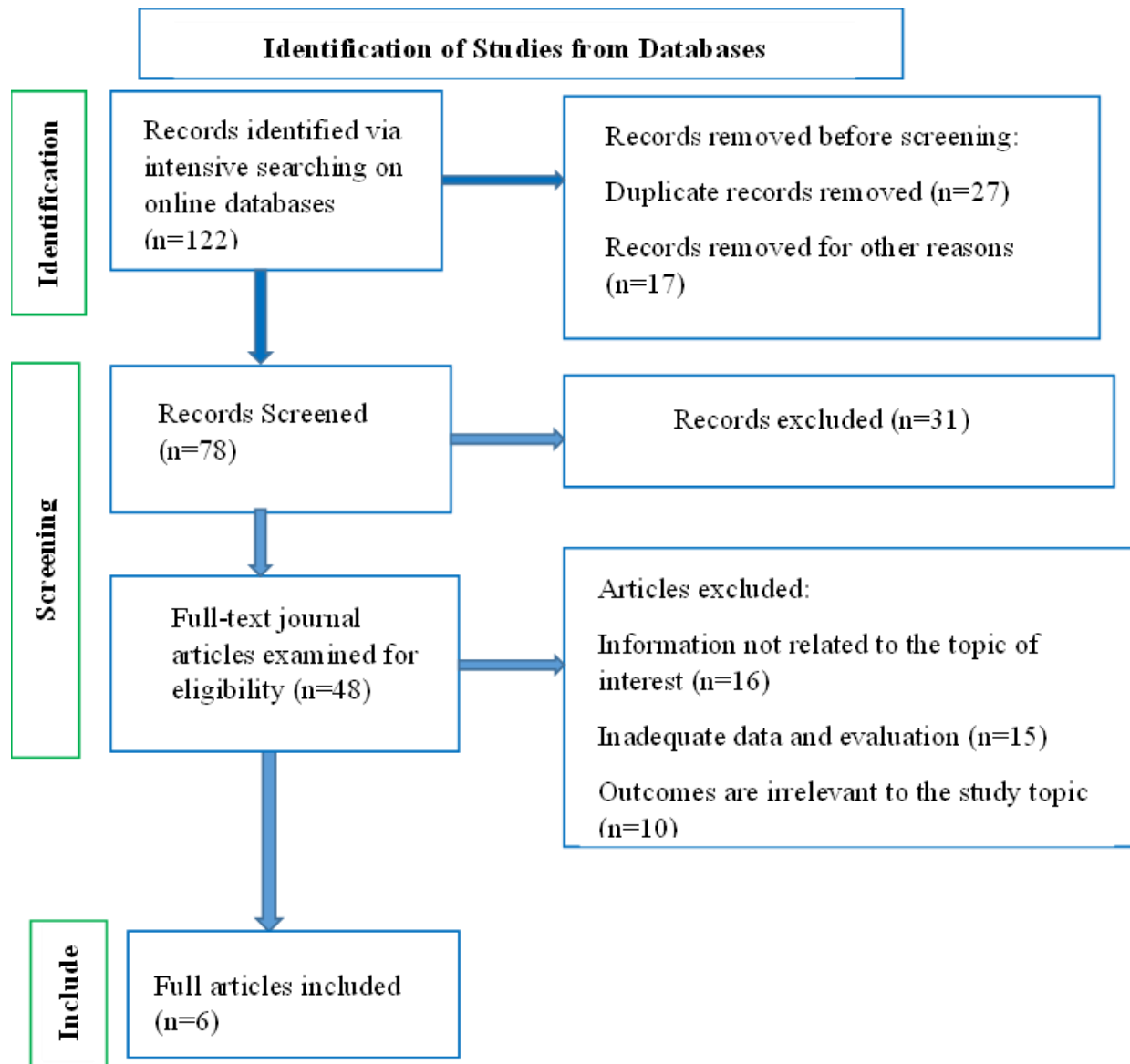


Figure 2 shows the PRISMA Flow Diagram for the articles search

Critical Appraisal

The 6 peer-reviewed journal articles that met the relevant PRISMA criteria were subjected to a rigorous critical analysis process that was based on the Critical Appraisal Skills Programme (CASP) checklist. The CASP checklist entails a series of checklists that are formulated as questions designed to examine the validity of the studies and results hence ensuring that the empirical evidence employed in the discussion is valid. Evaluating the publications using the CASP checklist also ensures that the sources used met the relevant validity aspect when it comes to answering the research questions that were initially formulated. The systematic analysis included 6 articles whereby 2 were qualitative studies while the remaining were based on quantitative. The CASP Randomized Controlled Trial Checklist was applied to test the validity of the quantitative research while the CASP Qualitative Studies checklist was adopted to test the rest.

CASP Randomized Trial Checklist

	Criteria	Buabbas, Aldousari & Shehab, (2020)	Heiden, et al., (2021)	Perrakis, et al., (2021)	Esmacilzadeh, Mirzaei & Dharanikota, (2021)
1	Did the study address a focused research question?	yes	yes	Yes	yes
2	Was the assignment of participants to interventions randomized?	yes	yes	Yes	yes
3	Were all the participants who entered the study accounted for at its conclusion?	yes	yes	Yes	yes
4	Were the participants, investigators, and people analyzing outcomes blind to the intervention?	yes	yes	Yes	yes
5	Were the study groups similar at the start of the randomized controlled trial?	yes	yes	Yes	yes

6	Apart from the experimental intervention, did each study group receive the same level of care?	yes	yes	Yes	yes
7	Were the effects of the intervention reported comprehensively?	yes	no	yes	yes
8	Was the precision of the estimate of the intervention or treatment effect reported	yes	yes	no	yes
9	Do the benefits of the experimental intervention outweigh the harms and costs?	yes	yes	yes	yes
10	Can the results be applied to your local population/ in your context?	no	yes	no	yes
11	Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?	yes	yes	yes	no
		90.9%	90.9%	81.8%	100%

Figure 3 shows the CASP Randomized Trial Checklist used in the critical appraisal

CASP Qualitative Studies Checklist

Criteria	Sujan, et al., (2022)	Gondocs & Dorfler, (2024)
1 Was there a clear statement of the aims of the research?	Yes	yes
2 Is a qualitative methodology appropriate?	Yes	yes
3 Was the research design appropriate to address the aims of the research?	Yes	yes
4 Was the recruitment strategy appropriate to the aims of the research?	Yes	yes
5 Was the data collected in a way that addressed the research issue?	Yes	yes
6 Has the relationship between the researcher and participants been adequately considered?	Not sure	Not sure
7 Have ethical issues been taken into consideration?	Yes	yes
8 Was the data analysis sufficiently rigorous?	Yes	yes

9 Is there a clear statement of findings?	Yes	yes
10 Is the research valuable to your research?	yes	yes
	90%	90%

Figure 4 shows the CASP Qualitative Studies Checklist

RESULTS

Publication	Aim	Methodology	Findings
Sujan, et al., (2022)	The main aim of the research was to explore the perceptions of different stakeholders including the patients, hospital staff, regulators, and technology developers relating to the safety and safety assurance of medical artificial intelligence.	Interviews	The results indicated that the application of AI technology in the healthcare sector is associated with positive implications including improving the quality of services rendered to the patient and the patient experience. The research also established that there exist gaps in the safety assurance practices and regulatory frameworks when it comes to the use of technology to deliver crucial medical services.

Buabbas, Aldousari & Shehab, (2020)	The main objective of the study was to comprehensively examine the public's level of understanding, awareness, and perceptions towards the application of robotic-assisted surgery (RAS) in Kuwait.	Cross-sectional study	The results showed that only a minimum number of people in the country had adequate knowledge regarding applying RAS. The findings also indicated that a significant number of respondents believed that RAS was faster and more precise when compared with conventional surgical procedures.
Heiden, et al., (2021)	The purpose of conducting the study was to examine the cost-effectiveness of robotic-assisted lobectomy (RAL) as compared to open lobectomy and video-assisted thoracic surgery (VATS) when attending to adults suffering from non-	Decision analysis model	The results showed that the application of RAL to attend to patients with NSCLC was relatively expensive when compared to VATS. However, the study findings also indicated that the application of RAL was cost-effective by reducing the time spent

	small cell lung cancer (NSCLC)		in operating rooms, lowering the conversion rates, shortening the length of hospital stay, improving quality of life, and higher hospital volumes.
Perrakis, et al., (2021)	The main objective of the research was to examine the advantages of adopting robots in liver surgery as compared to conventional techniques including open and laparoscopic methodologies	A novel technique for the transection of liver parenchyma during robotic surgery	The findings showed that the application of the 3D technique for parenchyma dissection in robotic surgery was a feasible and safe procedure and had positive implications on the quality of services offered including minimizing intraoperative blood loss, the length of postoperative stay, and the liver surgery-related morbidity.
Esmaeilzadeh, Mirzaei &	The main objective was to assess the perception of patients about the	2x3 experiment using online survey	The findings indicated that the health care services encounters and

Dharanikota, (2021)	benefits, risks, and application of AI-based technology and various healthcare services encounter scenarios change their perception.		medical conditions influenced the patient's perceptions regarding aspects such as risks and benefits associated with the technology use.
Gondocs &Dorfler, (2024)	The main purpose of the study was to examine the critical aspects that should be present for the effective adoption of artificial intelligence to enhance decision-making in diagnosis according to the dermatologists	Semi-structured research interviews	The results indicated that the application of AI in the diagnosis process enhances decision-making by providing supporting information among other aspects

Figure 5 shows the results from the systematic analysis

DISCUSSION

Objective 1: To determine how AI has improved medical imaging and diagnostics

The findings indicated that the integration of artificial intelligence into the healthcare delivery system positively the quality of services rendered during diagnostic diagnosis processes.

According to Gondocs & Dorfler, (2024), the application of AI-based systems in healthcare reduced the implications of human limitations such as the availability of information on the diagnosis process ensuring that treatments administered were by the specific patient needs.

For instance, the application of algorithmic analysis makes artificial intelligence a useful tool to support decision-making according to the views of the dermatologists involved in the study. The artificial intelligence systems also contain the predictive analytics function which involves utilizing the available data to make accurate analyses and predictions about the current health situation for a patient or community and how various interventions might impact the infection progress (Göndöcs & Dörfler, 2024). The diagnosis process can also be conducted virtually minimizing the need for physical contact between the healthcare professionals and the patients. However, Esmaeilzadeh, Mirzaei & Dharanikota, (2021) argue that it is important to include physician recommendations and insights when providing diagnostic services virtually through AI-enabled systems to minimize the risks associated with the technology. Thus, the use of artificial intelligence improves the quality of diagnosis services rendered which enhances patient experience and satisfaction.

Another way that AI-based systems enhance diagnosis and disease detection and analysis is by promoting the effectiveness of medical imaging practices. Gondocs & Dorfler, (2024), explain that the application of AI in medical imaging has numerous benefits including making the work relatively easier for healthcare professionals by organizing images and checking the quality which enables the practitioners to focus on other critical and demanding aspects of care delivery. The system also engages in image analysis and interpretation when dealing with issues such as tumors and other health conditions that require imaging.

According to Heiden, et al., (2021), the application of robot technology increases the number of minimally invasive lobectomies in surgery since the practitioner can utilize the medical imaging function minimizing the need for invasive surgical procedures.

Objective 2: To how AI has improved virtual patient care, medical research and drug discovery, patient engagement and compliance, rehabilitation, and administrative applications

The findings from the systematic analysis indicate that the adoption of AI-based systems in any healthcare setting promotes the application of virtual and remote patient care. According to Sujana, et al., (2022), one of the ways that AI technology is being increasingly utilized in healthcare is the automation of services and processes in situations that do not require the intervention of trained medical professionals. Processes such as diagnosis, follow-ups, scheduling, and engaging with and answering patient questions can be done remotely which promotes accessibility, convenience, and patient experience and minimizes the involvement of medical professionals. AI-based systems are also being increasingly utilized to provide personalized advice, answer patient questions, and provide reminders and encouragement as a way of promoting patient engagement and compliance (Almass, et al., 2022). Through the AI-based technology, the patients are regularly reminded to take their medications or attend appointments with health care professionals which ensures adherence to the adopted disease management plan. The patients can also easily access credible and evidence-based information on the health care artificial intelligence systems which answers the questions they have about their health and treatments which makes it easier for them to understand and follow the physician's recommendations.

Another benefit of adopting technological innovation in healthcare settings is that it enhances medical research, drug discovery, and patient rehabilitation. According to Buabbas, Alsousari & Shehab, (2020), various AI-based systems such as robotic-assisted surgery are revolutionizing the healthcare delivery processes by providing more precise and faster ways of engaging in various practices including complicated ones such as performing surgery. The systems are usually based on big data analytics particularly image and speech processing whereby data from clinical applications, empirical evidence, and other credible sources is utilized to enhance care delivery and patient outcomes. The analysis of medical big data analysis adopts various machine learning techniques including convolutional neural networks and vector machines which enable the delivery system to utilize the available information to

enable informed decision-making (Gondocs & Dorfler, 2024). Perrakis, et al., (2021), provide an excellent example of how the application of artificial intelligence improves medical research and drug discovery. The application of three-dimensional (3D) techniques when performing parenchyma dissection in robotic liver surgery proves beneficial and effective when compared to conventional open and laparoscopic techniques.

The findings from available empirical literature also indicate that the application of AI-based systems also positively impacts the effectiveness of various administrative practices in healthcare settings. Heiden, et al., (2021), argue that the application of robotic-assisted lobectomy when dealing with non-small cell lung cancer is cost-effective since the robotic instruments have a marginally low cost, the application of the technology minimizes the time spent in operating rooms and significantly reduce the length of hospital stay for the patients. Another administrative application of AI is the recording, storage, and management of patient data (Heiden, et al., 2022). The AI-based system is designed in a way that it collects, stores, and organizes medical information in a manner that can be easy to retrieve and understand for medical professionals, patients, and other authorized personnel. The technology is also being utilized to manage billing and payments which promotes the efficiency and effectiveness of the healthcare delivery system.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Therefore, the application of AI-based systems in healthcare promotes patient experience and satisfaction according to the existing empirical evidence. Patient satisfaction involves the degree to which the patient's expectations are met by the quality of healthcare services received. Technological innovation is increasingly being utilized in the health care settings for various purposes including providing virtual care, and medical imaging, used in surgical practices, and can be used as a support tool for decision making. The results from the

systematic review indicate that the integration of AI-based technology into the delivery systems positively impacts patient satisfaction by influencing various aspects of healthcare delivery including diagnostics, medical research and drug discovery, patient engagement and compliance, and administrative applications.

According to the existing empirical evidence, the adoption of artificial intelligence in healthcare enhances the diagnosis process and ensures that the treatment plan adopted resonates with the individual needs of a given patient. The system provides the appropriate information for medical professionals to make informed decisions and may be utilized to make predictions relating to the suitability of various interventions that may be adopted. The technological resource is also used in analyzing and interpreting medical images which enhances the diagnosis process and makes the work of the practitioners relatively simple. The innovation also promotes medical research and drug discovery which positively influences patient outcomes and experience when engaging with the health delivery system. The AI systems are usually based on big data analytics function which involves collecting, analyzing, and interpreting the medical and empirical data available to enhance practices and come up with new ways to administer services to the patients. Another patient satisfaction aspect influenced by the application of contemporary innovation is the efficiency and effectiveness of administrative practices such as billing and payments, managing records, and coming up with solutions to common issues in healthcare facilities. Thus, effective integration of artificial intelligence in healthcare settings positively impacts patient satisfaction by influencing various aspects associated with quality care delivery including diagnosis, medical research drug discovery, and administrative functions.

Recommendations

There is a need for more empirical evidence relating to the application of artificial intelligence in the country and the implications it has on the level of patient satisfaction achieved. Patient satisfaction is an important indicator of the effectiveness and efficiency of

the service delivery system since it indicates the level at which the health services received meet the patient's expectations. However, there is inadequate evidence relating to the effectiveness of the technological innovations on the quality of services rendered to patients in the KSA and how doing so will promote patient experience and ensure that the medical attention offered resonates with the patient's needs. Conducting studies on the topic will significantly increase the available empirical-based knowledge about the application of AI technology and how it helps transform the health sector in the KSA thus ensuring that the country can attain its objectives contained in the Vision 2030 framework.

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