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Review Article

The Current State of Artificial Intelligence in Healthcare: A Narrative Review of Opportunities and Challenges

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Abstract

Context: The use of artificial intelligence (AI) in healthcare presents exciting opportunities and significant challenges. The AI can improve the accuracy, efficiency, and personalization of treatment planning and patient care. However, it also raises concerns about data privacy, algorithmic bias, and the need for ethical frameworks to guide its development and responsible implementation. This article explores both the opportunities and challenges associated with the ongoing integration of AI into the healthcare landscape.

Methods: In this narrative review article, to identify relevant articles, we searched databases such as PubMed, Google Scholar, and Web of Science utilizing specific search terms like "Artificial Intelligence", "AI", "AI applications", "AI in healthcare", "AI applications in healthcare", "opportunities", "challenges", "future", and "future challenges" in July 2024. Articles published between January 1, 2017, and June 31, 2024, focusing on the opportunities and challenges associated with AI implementation in healthcare, were reviewed. Articles without available full texts, lacking published data, duplicated articles, case series, case reports, and conference abstracts were excluded.

Results: This investigation involved a comprehensive review of 18 relevant articles from diverse geographical regions, encompassing various medical specialties, predominantly comprising review studies alongside one original research article. We demonstrated that opportunities for AI in different fields of healthcare, including dentistry, ophthalmology, cardiology, urology, and radiology, are significant. The identified challenges included data provision challenges and privacy issues, as well as accountability and ethical issues, AI hallucinations, concerns related to relying on and trusting AI, AI management, and job/educational transformation.

Conclusions: As AI continues to shape the future of healthcare, challenges will emerge necessitating novel solutions; yet, amidst these challenges, prospects for enhanced patient care and professional expertise remain promising.

Keywords: Artificial Intelligence, Healthcare, Opportunities, Challenges

1. Context

The world has entered an era where the capacity to perform distinctive tasks and comprehend algorithms, previously possible only by humans, is now remarkably achievable through intelligent machines or computers, referred to as artificial intelligence (AI) (1-3). Given the substantial integration of AI into our daily lives, it is safe to say that it has made a remarkable departure from its futuristic notion. Its integration has already expanded across various sectors, leading to radical changes, particularly in the healthcare domain (4-6). The AI's

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utilization in healthcare was initially introduced in 1976 by employing an algorithm to detect the causes of acute abdominal pain (7, 8). Since then, the use of AI in the healthcare sector has expanded considerably over time. Ranging from assistance in disease identification, such as dermatological conditions or ophthalmology cases like diabetic retinopathy, to enhancing pathologic classifications in radiology scans or outlining electrocardiogram features in cardiology, the application of AI encompasses a wide range of tasks. Day by day, the healthcare industry is increasingly recognizing the significance of AI-driven tools in advancing next-generation healthcare technology. Furthermore, the need for healthcare services is continuously rising, and numerous countries are facing a range of issues, such as an insufficient healthcare workforce, particularly physicians. The AI could offer resolutions to the aforementioned problems (7, 9-11). However, ensuring patient data privacy and avoiding the perpetuation of social biases is vital for the accountable and equitable application of AI in healthcare. In other words, the use of AI in healthcare presents exciting opportunities and significant challenges. The AI can improve the accuracy, efficiency, and personalization of treatment planning and patient care, but it also raises concerns about data privacy, algorithmic bias, and the need for ethical frameworks to guide its development and responsible implementation (12).

Even though the employment of AI creates numerous opportunities, such as improved diagnostics, personalized treatment, and enhanced efficiency, and addresses many issues in the healthcare industry, it also brings about certain challenges, such as ethical concerns, data privacy issues, and the requirement for structured guidelines. The present article seeks to explore the future opportunities and challenges of AI utilization in healthcare.

2. Methods

This narrative review delves into both the opportunities and challenges inherent in the continued integration of AI into the healthcare industry. The resource search is performed to find studies that have assessed the opportunities and challenges of AI utilization in healthcare.

2.1. Data Sources

We searched PubMed, Google Scholar, and Web of Science in July 2024. This review included research articles published in English between January 1, 2017, and June 31, 2024. Relevant articles were identified using a combination of word searches for "Artificial Intelligence", "AI", "AI applications", "AI in healthcare", "AI applications in healthcare", "opportunities", "challenges", "future", and "future challenges".

2.2. Study Eligibility Criteria

Articles related to the purpose of our study were screened and selected. Papers that addressed the limitations and challenges of AI in healthcare, and were published in the English language, were included. Articles without available full texts, lacking published data, duplicated articles, case series, case reports, and conference abstracts were excluded.

2.3. Data Extraction

The titles and abstracts of the searched articles were reviewed to select those that closely aligned with the aim of this study. Furthermore, the authors read the conclusions of the selected papers to analyze and assess them for further relevance. The review process involved a single reviewer, who conducted the initial screening, data extraction, and analysis. If any uncertainties or questions arose during the review process, another author provided assistance to resolve them. Disagreements, if any, were discussed between the reviewers, and consensus was reached based on a review of the articles' content, ensuring the conclusions aligned with the focus of this study.

3. Results

We assessed the related resources to investigate future opportunities and challenges of AI in the healthcare industry. A total of 765 studies were identified through a rapid research strategy. After removing 156 duplicates, and 591 articles which were excluded during the title/abstract screening, finally, we included 18 for full-text review (Table 1). These 18 articles originated from various parts of the world, including different continents such as America, Europe (England, Spain, and Hungary), and Asia (Japan, Saudi Arabia, Korea, and Indonesia). These articles examined the potential of utilizing AI in various medical fields, with seven of them specifically focusing on a particular area of medicine. Most of them investigated the challenges of using AI.

3.1. Current Usage and Opportunities

3.1.1. Starting to Integrate Artificial Intelligence into Healthcare

The integration of AI into healthcare has progressed through several key epochs. The first, AI 1.0, was characterized by symbolic AI, which involved encoding human knowledge into computational rules and probabilistic models. The AI 2.0 era saw the rise of deep learning, leading to significant advancements in healthcare and everyday life worldwide. Currently, in the AI 3.0 era, we have innovative and potentially transformative models, but they also come with new risks, such as hallucinations. These models can perform a wide range of tasks without needing retraining on new data. For instance, a simple text instruction can alter the model's behavior, producing different content depending on the prompt, such as "Write this note for a specialist consultant" versus "Write this note for the patient's mother" (29).

3.1.2. Artificial Intelligence Applications Across Various Healthcare Sectors

Since its introduction into the healthcare domain, AI has influenced various aspects of this field. Given that AI can emulate human reasoning to some extent and provide unique outputs based on extensive databases, it can be said that only a few fields have remained exempt from the integration of AI. Subsequently, brief references will be made to the application of AI in some of these fields.

3.1.3. Artificial Intelligence in Dentistry

In the sector of dentistry, dentists can enhance diagnostic accuracy, treatment planning, and outcome prediction by utilizing AI. Automated technology has the potential to improve automatic filling in electronic dental records through tooth identification and numbering, thereby expediting clinical procedures and enhancing physician productivity (13). Additionally, robotics and AI can be incorporated with implant dentistry, which offers significant potential but also necessitates responsible handling of challenges and ethical considerations (14).

3.1.4. Artificial Intelligence in Ophthalmology

The AI can function as a disease screening platform or aid in clinical practices in the domain of the retina. On the other hand, the integration of telemedicine into clinical activities has developed and facilitated retinal home monitoring by certain devices for retinal diseases. The combined use of AI and telemedicine holds the potential to enhance the future landscape of retinal practice (15).

3.1.5. Artificial Intelligence in Cardiology

In this field, the use of AI in ECG analysis can enhance the interpretation of electrocardiograms and reduce the occurrence of misdiagnosed computerized ECG interpretations. Moreover, it can be more cost-effective and clinically efficient. However, in the realm of diagnosis, it has not shown a significant advantage or advancement compared to human expertise. It can also contribute to improvements in patient characterization, risk stratification, treatment selection, and optimization (16). Furthermore, AI systems have the potential to revolutionize the diagnosis and prediction of heart failure decompensation and mortality by serving as an assistive tool (17).

3.1.6. Artificial Intelligence in Urology

In the field of urology and specifically urological cancers, the use of AI holds great promise. Cancers with higher incidence rates, such as kidney, bladder, and prostate cancers, are the main focus of studies. The AI can surpass traditional methods in terms of speed and accuracy. Despite facing technical and ethical challenges in clinical applications, the era of AI integration in urological practice is rapidly approaching and attracting increasing attention. Through the use of AI, the whole process of urologic cancer diagnosis (pathological and imaging diagnosis) and treatment (clinical treatment and outcome prediction) could be revolutionized (18).

3.1.7. Artificial Intelligence in Radiology

In this field, AI algorithms can be employed to offer medical decisions regarding imaging requests. By analyzing a patient's medical record, AI tools can assess the suitability of imaging and provide recommendations on the most appropriate imaging examination. Moreover, AI can be used to enhance radiologists' workflow. The utilization of AI in this sector also centers on the automated interpretation of images. Enhanced precision in measurements could offer improvements when monitoring tumors and reduce the time required for imaging interpretation by radiologists (19). To date, the FDA has approved several AI applications in clinical practice. For instance, IDx-DR is an AI system used for diabetic retinopathy screening, while Paige.AI could aid in detecting cancer pathology (30, 31). Furthermore, BoneView can help in interpreting bone X-rays, LumineticsCore is utilized for retinal health screening, and DermoSensor assists in skin cancer detection (32-34). These FDA-approved applications

highlight the potential for AI to merge with healthcare, paving the way for improved patient care.

3.2. Challenges and Regulatory Considerations

3.2.1. The Prospective Role of Artificial Intelligence in the Healthcare Sector and Forthcoming Challenges in Artificial Intelligence for Healthcare

With this in mind, the primary objective of machine learning is to create algorithms that can enhance their performance through experience. The effectiveness of AI in enhancing health service administration has been demonstrated, and it is presumed that AI will be integrated into regular clinical care. Nevertheless, concerns have been raised about the potential challenges that the healthcare system might encounter if AI were to be employed within it (22, 23). Given the points mentioned earlier, some concerns will be addressed below.

3.2.2. Data Provision Challenges and Privacy Issues

Considering that AI requires access to extensive databases for its operations, procuring such databases within the healthcare system may pose challenges. The first point of discussion is privacy, as patient information is inherently confidential, giving rise to an ethical challenge. Additionally, given that patient data is stored within the datasets of a hospital and is considered one of its assets, sharing it between different hospitals might prove to be problematic. With all that said, companies establishing AI-based applications also need to adopt solutions to address these challenges (7, 24).

3.2.3. Accountability and Ethical Issues

If AI-based technologies were to be utilized for patient treatment and an accident or error occurred, who should be accountable for the resulting outcome: The medical staff and the hospital using such a system, or the firm designing the algorithm? With a lack of industry guidelines and universally accepted standards concerning the ethical utilization of AI and ML in healthcare, this matter becomes even more intricate, and it is unclear to what extent AI can be ethically implemented in hospitals (24, 25). Moreover, regulatory frameworks such as the European Union's AI Act (Regulation EU 2024/1689) address accountability in AI systems. Accordingly, certain AI systems, particularly in healthcare, are categorized as high-risk. This demands a strict focus and accountability measures in these areas. For instance, AI systems utilized for biometric identification or emotion recognition, which may have direct implications on patients' rights, are examples of these systems. This regulatory framework will likely play a significant role in defining the ethical and legal boundaries for AI usage in healthcare, particularly in patient treatment (35, 36).

3.2.4. Artificial Intelligence Hallucinations

The AI hallucinations refer to AI-generated content and data that appear realistic but are not based on actual data. In healthcare, these inaccuracies can cause harm if mistaken for factual information. To prevent this, professionals should verify AI outputs with trusted sources and remain cautious of AI's limitations (26).

3.2.5. Concerns Related to Relying on and Trusting Artificial Intelligence

The trust between a physician and a patient is a crucial and impactful aspect of treatment. Therefore, individuals with no prior experience with digital technologies, let alone with AI, may find it challenging to place trust in an AI system as the role of a doctor (24).

3.2.6. Artificial Intelligence Management and Job/Educational Transformation

Many experts in the field of AI believe that the continued expansion of AI usage and the broadening of its scope may completely transform fields such as radiology. This transformation could lead to the obsolescence of certain jobs, but conversely, the creation of new jobs that might significantly alter the existing structure. Moreover, with the use of intelligent applications in the diagnosis and treatment domain, even by the patients themselves, the supervision of the healthcare system will undergo substantial changes. Continuing this trend in the coming years, AI must also be integrated into the medical and paramedical education system (7, 24, 25, 37).

4. Discussion

The AI integration has expanded across many fields, making noteworthy contributions, particularly in healthcare. Its incorporation into the healthcare sector has resulted in substantial enhancements in diverse medical domains (4, 38). In medical practice, AI methods can be viewed as algorithms that learn from standardized input data to make precise predictions about outcomes when applied to new data (39, 40). Healthcare providers are welcoming AI with enthusiasm, and AI's application in different healthcare fields presents promising opportunities. The points

mentioned in this article are only a few aspects of the impact of AI in this field (24, 41, 42).

In dentistry, AI enhances diagnostic accuracy, treatment planning, and outcome prediction. The AI in implant dentistry can analyze extensive patient data to assist in diagnosis, treatment planning, and implant design, offering valuable support in various aspects of dental care (13, 14). In ophthalmology, AI serves as a disease screening platform and aids in clinical practices, especially in the analysis of optical coherence tomography and fundus photographs (15). Cardiology benefits from AI in ECG analysis, improving interpretation and clinical efficiency (16). Additionally, AI holds promise in efficiently processing raw image data from diverse cardiac imaging methods, and its crucial role in the early detection of heart failure-related mortality and destabilization episodes optimizes outcomes for cardiovascular diseases (17). Urology sees AI's potential in revolutionizing the diagnosis and treatment of cancers, while radiology benefits from enhanced decision support and workflow optimization through AI algorithms (18, 19).

Another significant application of AI is in low-resource settings. In environments where a high disease burden exists, exacerbated by a shortage of medical staff and inadequate healthcare infrastructures, such as in developing countries, AI can play a significant role (43). In such settings, AI can enhance healthcare system efficiency and quality by influencing diagnosis, early disease detection, and treatment. It can also act as a significant aid to lower medical costs and pave the way towards more efficient service provision (44).

Despite the remarkable opportunities, the integration of AI into healthcare poses challenges. Data provision challenges and privacy issues arise due to the need for extensive databases, leading to concerns about patient data privacy and confidentiality. Accountability and ethical issues, particularly in the event of errors or accidents, are complex, as there are no universally accepted standards for the ethical use of AI and machine learning in healthcare. Additionally, concerns about trust in AI systems, especially among individuals unfamiliar with digital technologies, and the potential transformation of jobs and educational systems in the healthcare sector are significant challenges to address (7, 24, 25). Striking a balance between human expertise and reliance on technology, along with AI's proper governance, are other issues that need to be addressed (7, 14). The AI models created for one healthcare system might not seamlessly transfer to others due to variations in available resources, healthcare priorities, societal norms, clinical practices, and funding structures, making their adaptation to diverse systems complex and challenging (45). Moreover, many healthcare professionals lack a thorough understanding of AI principles. Therefore, addressing this knowledge gap is crucial for the widespread integration of AI into practice and the broader use of AI. Certainly, in the future, there is a need for awareness and organizing training workshops for them (4).

Another challenge within the integration of AI in healthcare is legal issues. Currently, there exists no structured guideline or federal law in the U.S. regulating AI, leading to uncertainty in its governance. Another critical issue is determining liability for AI-related medical errors, as accountability remains unclear. Furthermore, ethical and legal concerns, such as obtaining informed patient consent and AI's role in insurance claims, highlight the need for comprehensive regulatory frameworks to address these complexities (46).

To prepare for AI integration in healthcare, we have to focus on education and training, ethical frameworks, data privacy, interdisciplinary collaboration, public trust, balancing human expertise with technology, and developing supportive policies and regulations.

4.1. Limitations

The limitation we faced in this study was that many original articles related to the future challenges and opportunities of AI were not published, and we had to include review articles, editorials, and book sections. It is also noteworthy that the articles were limited to those published only in the English language. Furthermore, our sample of reviewed articles was smaller in size, and most included articles were review articles. The conclusion of this study remains broad, stating that AI holds promise for enhancing healthcare systems; however, for further research, it would be beneficial to conduct specialized studies focusing on individual medical subspecialties.

5. Conclusions

Certainly, AI, and particularly its application in the healthcare system, has led to a transformation of this system, and this trend is expected to continue day by day. The future of the healthcare system will be significantly shaped by AI. While the occupations in the healthcare system, medical education, and treatment systems have already undergone considerable changes, it could be said that this might be just the beginning of a lengthy and challenging journey. Undoubtedly, as AI is increasingly employed in this domain, we will face new

challenges that will require innovative solutions. Although this revolution in the medical field may present these challenges, it is hoped that alongside these developments, the patient care experience and the expertise of healthcare professionals will also improve.

Footnotes

Authors' Contribution: The conception and design of the study: E. M. and N. A.; Drafting the article: E. M., N. A., S. P., A. A., and I. I. B.; Critical revision for important intellectual content: E. M., N. A., A. A., S. A. S. A., and I. I. B.; Final approval of the version to be submitted: S. A. S. A., E. M., and I. I. B.

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Table 1. Description of the Findings Reported in Eligible Studies

First Author (Ref.)	Country	Year of Publication	Aim of Study	AI Opportunities	AI Challenges	Main Findings	Studied Subspecialty	AI Models Utilized	Opportunity or Challenge
Agrawal (13) [a]	India	2022	Review study of utilization of AI across all dental specialties, with a particular emphasis on endodontics	AI models can be utilized in dental education, diagnosis, patient management, treatment, and prognosis. It can also be incorporated into dental radiology, oral and maxillofacial surgery, prosthetic dentistry, orthodontics, and forensic odontology.	It is essential to validate the AI application's generalizability and reliability.	Improvements in precision in diagnosis, planning treatments, and predicting outcomes.	Dentistry	Artificial neural network, convolutional neural networks, deep learning, electronic brain.	Opportunity
Saeed (14) [b]	Saudi Arabia	2023	Exploring the present status of robotic and AI-supported implant dentistry	AI models in implant dentistry can examine vast sets of patient data to aid in diagnosing, planning treatments, and designing implants.	Finding an equilibrium between human knowledge and dependence on technology and ethical issues must be addressed.	In implant dentistry, AI applications can provide improvements in precision in implant positioning, minimizing human error and enhancing the effectiveness of treatments.	Dentistry	Machine learning	Opportunity
Wu (15) [a]	Taiwan	2023	Exploring the implementation of AI and telemedicine in ophthalmology, and home monitoring devices in the context of retinal diseases	AI-based image interpretation in retinal diseases, particularly in the analysis of optical coherence tomography and fundus photographs, stands out as a unique utilization of AI in ophthalmology.	It is important to address the "black-box phenomenon" (AI algorithms categorize or diagnose diseases based on underlying features, not by specific criteria).	The swift progress in the creation of portable ocular monitoring devices and their combination with AI-informed interpretations enables potential home or remote monitoring of retinal diseases.	Ophthalmology	Deep learning, machine learning	Opportunity
Martinez-Selles (16) [a]	Spain	2023	Scrutinizing AI utilization for irregular ECG patterns detection and enhancing the diagnosis of cardiovascular diseases	In ECG interpretations, AI-driven ECG analyses have the potential to enhance diagnosis and patient care, offer cost-effective solutions, and reduce the incidence of misdiagnosed computerized ECG interpretations.	Many AI algorithms have been evaluated only by using highly controlled validation datasets and retrospective testing, so more efforts are required to assess these algorithms and their impact on real-world and real-time data.	As more data becomes accessible and more advanced algorithms are developed, AI models are assumed to play a significant role in ECG diagnosis and management.	Cardiology	Deep learning, machine learning	Opportunity
Yasmin (17) [a]	Pakistan	2021	Studying the significant accomplishments of AI in various aspects of heart failure prevention, diagnosis, and treatment	AI has the potential to provide significant assistance in processing unprocessed image data derived from various cardiac imaging methods. Furthermore, the role of AI in the early detection of potential mortality caused by heart failure and destabilization episodes has been instrumental in optimizing outcomes for cardiovascular diseases.	The effectiveness of AI is constrained by the lack of a supportive healthcare system and the lack of adequately trained clinicians proficient in incorporating AI models into their clinical decision-making and patient monitoring.	Significant progress has been achieved in the realm of cardiovascular medicine through the integration of AI into diagnostic methods, prognostic predictions, and the management of heart failure.	Cardiology	Artificial neural network, decision trees, deep learning	Opportunity
Liu (18) [a]	China	2023	Providing a summary of AI applications and research in prominent urological cancers, and addressing current challenges and potential future applications of AI in this context	AI has the potential to outperform traditional methods in terms of both speed and accuracy, and can play a significant role in the management of cancers with higher incidence rates (kidney, bladder, and prostate).	The practical implementation of AI in clinical settings is still in its early stages and faces challenges such as inadequate data and a shortage of prospective clinical trials.	AI models possess significant potential in detecting, treating, and predicting the prognosis of urological cancers.	Urology	Machine learning, deep learning, augmented reality, Convolutional neural networks, Artificial neural networks	Opportunity
Syed (19) [a]	USA	2018	Conducting a literature review to analyze the current impact of AI on radiology and exploring the anticipated future developments in the field	AI aids in medical imaging decision-making, analyzing patient records for suitable imaging, recommending examinations, improving radiologist workflow, and enhancing image interpretation, particularly in tumor monitoring.	-	Radiology has historically been at the forefront of medical technology advancements, and it is expected to maintain this role with the integration of AI.	Radiology	Deep learning, machine learning	Opportunity
Castagno (4) [c]	UK	2020	Evaluating health professionals' familiarity with AI technologies and exploring their attitudes toward the utilization of AI applications in medicine	Healthcare professionals are reaching an agreement on the efficacy and benefits of incorporating AI within the medical domain.	Lack of a comprehensive grasp of AI principles and understanding is common among many healthcare professionals, and it should be addressed for AI's extensive integration into practice.	Healthcare workers' cooperation is vital for incorporating AI into clinical practice	Nonclinical/no specific subspecialty	Not Specified	Challenge
Asai (20) [a]	Japan	2021	Evolution of AI and its applications, compares the pros and cons of traditional healthcare versus AI-driven healthcare, and contemplates the future trajectory of AI-based applications	The application of AI in medicine spans diagnosis, treatment, and follow-up. AI enhances diagnostic accuracy through imaging and blood component analysis, while surgical robots improve treatment precision.	Integrating AI into the healthcare system and society requires addressing challenges such as the development of leading companies and educating data scientists.	AI applications' utilization in drug development and healthcare is consistently yielding outcomes, and the integration of AI is gaining recognition and acceptance.	Nonclinical/no specific subspecialty (AI applications)	Convolutional neural networks, machine learning, natural language processing, deep learning, recurrent neural networks, artificial neural networks, adaptive algorithms, and automated voice dialogue systems	Challenge
Koski (21) [d]	USA	2021	Establishing a foundation in the origins and essential components of AI, its applications in healthcare and nursing, and addressing the key challenges associated with its implementation in the healthcare sector	AI aids in minimizing variability, enhancing precision, speeding up discoveries, and lessening disparities.	Challenges in AI utilization include addressing technological, systemic, and regulatory obstacles for its implementation and integrating these systems into the healthcare and societal framework.	With AI systems collecting accurate and comprehensive data from various aspects of health, the significant potential of AI applications is becoming widely acknowledged.	Nonclinical/no specific subspecialty (AI applications and risks)	Machine learning, natural language processing, artificial neural network, augmented intelligence	Challenge
Sunarti (22) [a]	Indonesia	2021	Exploring the potential and risks of implementing AI in healthcare services	AI models can play an essential role in healthcare services, particularly in healthcare management, for making medical decisions, and especially in predictive analysis for diagnosing and treating patients.	AI clinical applications face various ethical challenges, including issues related to safety, efficacy, privacy, information, and consent, as well as considerations of costs and access.	Enhancing patient diagnostics, preventive measures, and treatment, and promoting cost efficiency and equality in healthcare services are a few improvements that can be achieved by the implementation of AI in the healthcare sector.	Nonclinical/no specific subpecialty (AI risks)	Not specified	Opportunity
Noorbakhsh-sabet (23) [a]	USA	2019	Providing an overview of machine learning applications in healthcare, emphasizing clinical, translational, and public health uses	AI has the potential to assist in predicting and diagnosing diseases, determining the effectiveness of treatments and predicting outcomes, discovering and repurposing drugs, conducting clinical trials, in silico clinical trials, and predicting outbreaks of epidemics.	The challenges that AI's integration into the healthcare sector can raise include ethical dilemmas introduced by data science, privacy and confidentiality issues, establishing trust in both clinicians and patients,				

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					across technology platforms.	AI can reshape the future of healthcare by enhancing learning capabilities and offering decision support systems.	Nonclinical/no specific subspecialty (AI applications)	Machine learning	Opportunity
Aung (7) [a]	UK	2021	Examining the current applications of AI in healthcare, encompassing its advantages, constraints, and prospects	By assisting physicians, automating administrative tasks, and enhancing medical knowledge, AI has the potential to revolutionize both physician workflow and patient care.	Some challenges of AI utilization in healthcare include training machine learning systems, addressing accountability issues, and physicians' limited understanding of the potential implications of AI implementation.	AI holds great potential to transform the healthcare system, but it necessitates careful governance.	Nonclinical/no specific subspecialty (AI applications)	Machine learning	Opportunity and challenge
Lee (24) [a]	Korea	2021	Investigating the current status of applications employing AI technology and their influence on the healthcare sector	AI utilization opportunities include enhanced disease treatments, improved patient engagement, reduced medical errors using AI-supported systems in diagnostics, increased operational efficiency and cost reduction, productivity gains, and the potential for new job creation, savings in healthcare costs, and aligning to deliver quality, data-driven, and cost-effective healthcare services.	The main challenges include accountability for system use, an AI divide in patient trust, cybersecurity concerns, potential loss of managerial authority, job displacement, and the need for education and training to address the pain of transformation. These challenges emphasize the importance of ethical considerations, privacy, and the integration of AI into healthcare governance and education.	AI is positively embraced by healthcare providers, impacting and improving the efficiency of both nursing and managerial tasks within hospital settings.	Nonclinical/no specific subspecialty (AI applications)	Not specified	Opportunity and challenge
Elendu (25) [a]	USA	2023	Offering a thorough insight into the intricate ethical considerations concerning the use of AI and robotics within the healthcare sector	AI and robotics offer benefits like precision medicine for tailored treatment, early disease detection, and clinical decision support, enhancing patient care through remote monitoring, surgical precision, and personalized rehabilitation.	Some challenges of AI model utilization include ensuring the privacy and security of data, algorithmic bias, transparency and explainability in AI decision-making processes, establishing transparent frameworks, and ethical issues.	In the era of AI utilization, the healthcare industry must prioritize strategies for equal access and closing the digital gap, global collaboration for flexible regulations and addressing legal challenges, and finally maintaining ethical considerations.	Nonclinical/no specific subspecialty (ethical considerations)	Not specified	Opportunity and challenge
Hatem (26) [b]	USA	2023	This editorial sheds light on the concept of AI hallucinations and how to prevent them.	AI offers opportunities to enhance medicine via information access, improving productivity, supporting mental health care, and enhancing clinical decision-making by analyzing large datasets and improving diagnostic accuracy.	AI hallucinations are a major risk and pitfall that all healthcare workers utilizing this technology must be aware of.	AI hallucinations must be prevented by verifying AI outputs with trusted sources and remaining cautious of AI's limitations.	Nonclinical/no specific subpecialty (AI risks)	Not specified	Challenge
Omiyeh (27) [a]	USA	2024	This study provides an overview of large language models in medicine and also provides a tutorial for healthcare professionals to familiarize them with this emerging technology and its applications.	Large language models can be employed in various medical areas, including: Administrative tasks (eg, summarizing medical notes), clinician knowledge augmentation (eg, translating patient materials), medical education (eg, creating exam questions), and medical research (eg, generating novel research ideas).	Large language models can be limited by several challenges, including bias in databases, data quality, output unpredictability, and, finally, patient privacy and ethical concerns.	The study highlights the growing popularity and availability of large language models for public use, emphasizing their potential applications in the medical field.	Large language models and generative AI	Large language models and generative AI	Opportunity
Mesko (28) [a]	Hungary	2023	This paper explores generative AI's potential, focusing on multimodal large language models integrating text, images, and speech in healthcare scenarios.	AI and large language models can enhance patient-physician interactions, along with some other enhancements such as error reduction and administrative efficiency.	It is noteworthy that AI must be utilized as an augmenting tool in the field of medicine, and the human touch is irreplaceable.	The study identifies large language models as a transformative technology in healthcare, enhancing the analysis and interpretation of complex medical data, such as images, text, and videos.	Large language models and generative AI	Large language models and generative AI	Opportunity

Abbreviation: AI, artificial intelligence, ECG, electrocardiogram.

[a] Review.

[b] Editorial.

[c] Original research.

[d] Book section.