AI Doctors in Healthcare: A Comparative Journey through Diagnosis, Treatment, Care, Drug Development, and Health Analysis

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***Abstract*—**

The integration of Artificial Intelligence (AI) in healthcare represents a transformative shift, offering unprecedented opportunities to revolutionize diagnostics, treatment, and patient care. It is a paradigm change in the healthcare industry. This study offers a thorough analysis of current developments in AI applications in a range of healthcare fields. Key findings are revealed through a review of groundbreaking research, demonstrating AI's capacity to improve clinical decision-making, customize therapies, and improve diagnostic accuracy. From using deep learning for drug development to using explainable AI for leukemia diagnosis, each paper clarifies specific approaches and difficulties. This study highlights the enormous potential of AI to enhance patient outcomes and transform healthcare delivery paradigms by looking at its role in treatment optimization, clinical decision support, and healthcare data analysis.

Keywords—Artificial Intelligence, Diagnosis, Precision Medicine, Clinical Decision Support, Drug Development.

I. INTRODUCTION

In healthcare today, Artificial Intelligence (AI) and Machine Learning (ML) are taking the lead, promising exciting transformations. Imagine a doctor using a stethoscope that acts like a conductor, guided by precise algorithms. Instead of traditional diagnoses, AI provides insightful information on screens. AI is not just a futuristic idea; it's actively shaping medicine. It influences everything, from diagnosing conditions to creating personalized treatments, developing drugs, and assisting clinical decisions [1, 2].

With technology developing at a rapid pace, there is a rising interest in using artificial intelligence (AI) to improve healthcare results. Fig.1 illustrates the increasing trend in interest regarding AI applications in healthcare from the start of 2019 through the end of November 2023. The data for this analysis was collected using "Google Trends," focusing on the search phrase "application of AI in healthcare" as the primary search object. This increase in interest is a reflection of the realization that artificial intelligence (AI) has the ability to completely alter a number of areas of healthcare, including clinical decision support, customized medicine, and diagnosis and treatment. In an effort to enhance patient care and general wellbeing as the healthcare landscape changes, both individuals and experts are closely examining the potential that artificial intelligence (AI) offers.

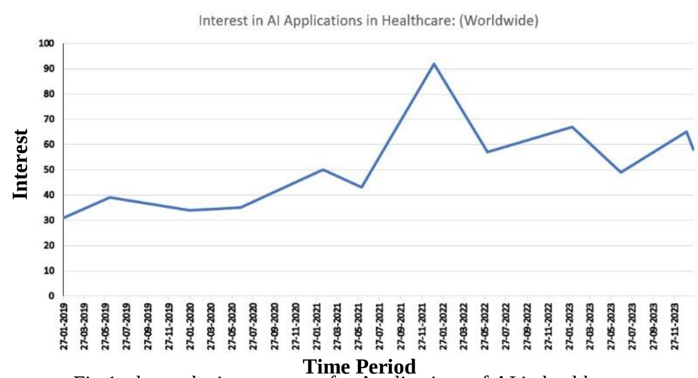

Fig.1: shows the interest rates for Applications of AI in healthcare

Let's focus on how AI is redefining the diagnostics landscape. AI algorithms are essential for identifying minute irregularities in medical scans, as demonstrated by [3] Abir et al.'s work on leukemia diagnosis. This goes beyond only increasing accuracy; it also highlights the need for openness when making important decisions pertaining to patients' health. Then there is the field of personalized medicine, as evidenced by [5] CURATE by Blasiak et al.AI. It promises a future in which each patient will receive a treatment that is specifically customized for them, akin to a dance between human skill and AI's computational capability .

AI's influence goes beyond the confines of the physician's workspace, reaching into the realms of drug discovery and development. Lv et al.'s [4] exploration of AI's role in designing vaccines for COVID-19 offers a glimpse into a faster and more efficient way of discovering life-saving medicines . And this is just the beginning; AI is diving into the complexities of genomic data, seeking hidden treasures that might hold the key to curing diseases we once thought were untreatable.

The revolutionary impact of AI extends beyond medication creation, diagnosis, and treatment. We can now model and analyze patterns with previously unheard-of precision thanks to its whispering insights into the very pulse of health itself. . Daungsupawong and Wiwanitkit's work [7] on applying Natural Language Processing to vascular surgery is a prime example, revealing a future where AI dissects the intricacies of medical literature and patient data, guiding us to a deeper understanding of human health .

To provide a comprehensive assessment of the current landscape of Artificial Intelligence (AI) applications in healthcare, this review article examines recent advancements in AI-based healthcare technologies. The focus encompasses studies on AI-integrated diagnostic tools, machine learning-driven predictive models, and applications utilizing smartphones for healthcare purposes. The structure of the paper unfolds as follows: Section II delves into related work, Section III presents a comparative analysis, and the concluding remarks are encapsulated in Section IV.

II. Related Work

Exploring how Artificial Intelligence (AI) transforms healthcare requires us to dive into related studies. AI's applications in healthcare span five key areas: Diagnosis and Prognosis, Drug Discovery and Development, Treatment and Care, Clinical Decision Support, and Healthcare Data Analysis and Modelling. Each area shows how AI has the potential to change how we approach healthcare.

A. Diagnosis and Prognosis

The focus of the study [3] by Abir et al. (2022) centers around utilizing Explainable artificial intellect with a transfer learning approach to identify and foresee leukaemia. The methodology employed involves training a model to recognize patterns in medical data, specifically targeting leukemia cases. Transfer learning, a technique where a model trained on one task is adapted for a different but related task, is employed to enhance the efficiency of the AI system. Medical practitioners can comprehend and analyze the model's choice-making procedure by utilizing the implementation of explainable AI. The findings demonstrate the efficacy of the suggested method in correctly identifying and forecasting leukaemia, offering an open and comprehensible artificial intelligence solution to enhance hematologic disorders-related healthcare outcomes.

Using Deep Learning-Based Attenuation Correction, the authors of the study [28] by Shanbhag et al. (2023) aimed to improve the diagnostic accuracy of cardiac single-photon emission computed tomography (SPECT). The methodology involved implementing advanced deep learning algorithms to correct for attenuation in cardiac SPECT images. The technique employed convolutional neural networks and intricate learning models to refine the accuracy of attenuation correction, thereby improving the overall diagnostic precision. The results demonstrated a significant enhancement in diagnostic accuracy, as evidenced by a comprehensive analysis of images and interpretations. This innovative approach showcases the potential of deep learning techniques in refining cardiac imaging modalities, offering promising advancements in the field of nuclear medicine.

B. Drug Discovery and Development

In the paper [17] titled "Artificial Intelligence to Deep Learning: Machine Intelligence Approach for Drug Discovery", Gupta et al. (2021) embark on a comprehensive exploration of the application of artificial intelligence (AI) and deep learning in drug discovery. The study encompasses various methodologies and techniques within the realm of machine intelligence, shedding light on the evolving landscape of drug development. The authors employ advanced computational approaches to leverage the power of AI, particularly deep learning, in the identification and optimization of potential drug candidates. Through a detailed examination of diverse datasets and computational models, the paper aims to unravel the intricate relationships between molecular structures and drug efficacy. The methodology involves the integration of machine intelligence algorithms for predictive modeling, allowing for the efficient screening of compounds with therapeutic potential. The results of their study contribute valuable insights into the transformative role of AI and deep learning in expediting drug discovery processes, potentially revolutionizing the field with innovative and more effective therapeutic solutions.

Tsuji et al. (2021) [14] have presented a novel computational paradigm for drug-target prioritization in the context of Alzheimer's disease, based on the use of machine learning in their study . The methodology employed in this study involves leveraging AI algorithms to prioritize potential drug targets and infer novel repositionable drugs for the treatment of Alzheimer's. The techniques encompass a comprehensive analysis of biological data, utilizing machine learning and computational approaches to identify promising candidates. The results of their approach demonstrate the effectiveness of the AI-driven framework in suggesting potential drugs for Alzheimer's disease, providing valuable insights for future research and drug discovery efforts in the field. The study highlights the potential of computational methods in identifying therapeutic strategies and represents a major contribution to the junction of AI and Alzheimer's research.

C. Treatment and Care

In the paper [5] titled "CURATE. AI: Optimizing Personalized Treatment/Medicines with Artificial Intelligence" by Blasiak, Khong, and Kee (2020), the authors delve into the application of Artificial Intelligence (AI) in tailoring personalized treatment plans. The paper outlines the methodology employed to optimize medical interventions using the CURATE. AI system. The technique involves leveraging AI algorithms to analyze individual patient characteristics and customize treatment strategies accordingly. The authors present results that demonstrate the effectiveness of CURATE. AI is improving personalized medicine and demonstrating how it may transform healthcare by offering individualized treatment plans based on individual patient circumstances. The study contributes to the growing field of AI in healthcare, offering insights into the practical implementation of AI for optimizing personalized treatment and fostering a more patient-centric approach to medical care.

In [27] Kasula's groundbreaking paper titled "Harnessing Machine Learning for Personalized Patient Care" the author delves into the transformative intersection of machine learning and healthcare. The paper explores innovative methods and techniques aimed at tailoring patient care to individual needs. Kasula's methodology involves a comprehensive review and analysis of existing machine learning applications in healthcare, highlighting the diverse approaches employed in personalized patient care. The author scrutinizes the effectiveness of these techniques in enhancing diagnostic accuracy, treatment planning, and overall healthcare outcomes. The results presented in the paper underscore the promising potential of machine learning in revolutionizing patient-centric healthcare, paving the way for a future where medical interventions are uniquely tailored to each individual, thereby optimizing overall health and well-being.

D. Clinical Decision Support

Obayya et al. (2023) [6] present a revolutionary method in their ground-breaking paper to improve the identification of histological breast cancer by combining deep learning-based decision-making systems with a hyper parameter optimizer. The methodology employed involves developing and fine-tuning hyperparameters, optimizing the performance of deep learning models specifically tailored for histopathological analysis. Leveraging a comprehensive dataset, the researchers meticulously trained the model, allowing it to learn intricate patterns associated with breast cancer pathology. The results demonstrate a significant improvement in the accuracy and efficiency of breast cancer detection, showcasing the potential of this innovative approach to revolutionize histopathological diagnostics. This pioneering research holds promise for advancing the field of cancer detection and opens new avenues for the integration of hyperparameter optimization in deep learning-based decision support for improved clinical outcomes.

The IEEE/CAA Journal of Automatica Sinica released an article by Liu et al. [23] that examines the use of multi-modal data-driven reinforcement modeling to improve operational choices in processes in industry. The study employs a comprehensive methodology that involves the integration of various data modalities to inform the reinforcement learning model. The suggested method seeks to streamline decision-making procedures in industrial settings by merging data from various places, including sensor data and operational characteristics. The technique leverages reinforcement learning, a machine learning paradigm focused on learning optimal decision strategies through interaction with the environment. Their study's findings provide evidence of the effectiveness of the multi-modal data-driven reinforcement learning technique in enhancing operational decision-making and provide an understanding of its possible uses in industrial operations.

E. Healthcare Data Analysis and Modelling

In the revolutionary study[24], Lin and Ngiam (2023) delve into the profound impact of data science and AI-based technologies on genomics, as documented in the Singapore Medical Journal. The authors adopt a comprehensive approach, exploring the intersection of data science and genomics to unravel the transformative potential of AI in the realm of medical genetics. The methodology employed in this study involves a meticulous review of existing literature, cutting-edge technologies, and emerging trends at the crossroads of data science and genomics. Leveraging advanced computational techniques, the authors dissect the ways in which AI is revolutionizing the analysis and interpretation of genomic data. The results of their investigation shed light on the unprecedented advancements and implications of integrating data science and AI technologies into genomics, paving the way for a deeper understanding of genetic information and its applications in the field of medicine.

In the paper [24], "Critical Success Index or F measure to validate the accuracy of administrative healthcare data identifying epilepsy in deceased adults in Scotland," Mbizvo et al. (2024) employ a methodological approach to validate the accuracy of administrative healthcare data in identifying epilepsy among deceased adults in Scotland. The critical success index and F measure are employed as validation techniques to assess the precision and accuracy of the data. The critical success index gauges the overall correctness of positive and negative classifications, while the F measure provides a balanced assessment of precision and recall. Through their methodology, the researchers aim to ensure the reliability of administrative healthcare data in capturing instances of epilepsy among deceased adults. The results of their study, detailed in the paper, shed light on the effectiveness of these validation techniques and contribute valuable insights to the enhancement of accuracy in healthcare data related to epilepsy identification.

III. COMPARITATIVE ANALYSIS

In five areas—diagnosis and prognosis, drug discovery and development, treatment and care, clinical decision support, and healthcare data analysis and modeling—this analysis seeks to analyze and assess various uses of artificially intelligent technology (AI). The goal is to highlight the strengths and weaknesses of each application based on specific parameters.

In the first category, Diagnosis and Prognosis, the focus is on understanding the task or disease, key findings, techniques employed, data types used, challenges faced, and unique features in Table I.

TABLE I. DIAGNOSIS AND PROGNOSIS

REF	DISEASE/TASK	AI TECHNIQUES	DATA TYPES	KEY FINDINGS	CHALLENGES
[3]	Disease progression prediction (Leukemia)	• Explainable AI • Transfer Learning	• Medical imaging • Patient Records	• Outperforms baselines in accuracy and calibration	• Data access • training cost
[9]	Brain tumor detection	• Convolutional Neural Networks (CNNs)	• Magnetic Resonance Imaging	• High accuracy, precision, recall and specificity	• Diverse tumor appearances • data heterogeneity
[28]	Cardiac SPECT Diagnosis	• Deep Learning, Attenuation Correction	• Single-Photon Emission Computed Tomography (SPECT) Data	• Improved Diagnostic Accuracy	• Training Data Variability
[29]	Medical Diagnosis	• Machine Learning, Data Modeling	• Patient Health Data • Diagnostic Data	• Enhanced Diagnostic Capability	• Data Quality • Model Interpretability
[31]	Breast Cancer Detection	• Optimized Neural Network • Whale Optimization Algorithm	• Mammography Images	• Automatic Detection Success	• Parameter Optimization
[32]	Early diagnosis of oral cancer	• Image Processing, Artificial Intelligence	• Oral Cancer Imaging Data	• Improved accuracy and efficiency in detecting early-stage oral cancer	• Image quality variations, data limitations • model interpretability

Moving on to Drug Discovery and Development, the analysis explores how AI is utilized in the pharmaceutical realm. Table. II covers key findings, techniques applied, the nature of data involved, challenges encountered, and any distinctive features in the process of discovering and developing new drugs.

TABLE II. DRUG DISCOVERY AND DEVELOPMENT

REF	DISEASE/TASK	AI TECHNIQUES	DATA TYPES	KEY FINDINGS	CHALLENGES
[4]	COVID-19 Drug Discovery, Vaccine Design	• Artificial Intelligence, Machine Learning	• Chemical Databases • Omics Data	• Drug and Vaccine Candidates	• Rapid Development • Validation
[14]	Identify drug targets & repurpose drugs	• AI algorithms & network analysis on gene/protein/drug data	• Surgical Robotics	• Novel drug targets • promising repurposable drugs • improved accuracy over traditional methods	• Clinical trial validation • AD complexity
[16]	Predict drug exposure changes due to DDIs	• Machine Learning • Quantitative Prediction	• Healthcare Data	• Accurate quantitative prediction of DDI-induced exposure changes	• Limited data, complex biological factors

[17]	Drug discovery (unspecified)	• Deep Learning	• Drug Labels • Pharmacokinetic Data	• Improved accuracy in predicting drug properties and interactions	• Data integration • interpretability • model bias
[18]	Drug discovery for central nervous system diseases	• Artificial Intelligence, Machine Learning	• Omics Data • Clinical Trials	• Potential of AI for target identification, lead optimization, drug repurposing	• Data integration • model explainability • regulatory frameworks
[21]	Cancer Precision Medicine	• Deep Learning, Multi-Data Analysis,	• Genomic Proteomic • Metabolomic Data	• Predictive Biomarker Discovery	• Integration Complexity, Validation

The third category, Treatment and Care, examines how AI plays a role in enhancing patient care. Table III evaluates the methods, data types, challenges, and distinctive features associated with using AI to optimize treatment plans and overall healthcare.

TABLE III. Treatment and Care

ref	**Disease/Task**	**AI Techniques**	**Data Types**	**Key Findings**	**Challenges**
[5]	Personalized treatment optimization for various diseases	• Curate.AI, Machine Intelligence	• Patient Health Records • Treatment Data	• Improved drug efficacy and reduced side effects in personalized treatment plans	• Data integration across different sources and model explainability
[12]	Cardiac rehabilitation for heart failure & ischemic heart disease	• Virtual Assistant • Remote Cardiac Rehabilitation	• Medical Imaging • Surgical Data	• Similar exercise capacity & better quality of life for virtual assistant group	• Limited sample size, long-term effects unclear
[19]	Integrating AI into healthcare for better patient care & operational efficiency	• Machine Learning	• Healthcare Data • Operational Data	• Framework bridges the gap between AI potential & practical implementation in healthcare settings	• Data privacy & security • ethical considerations
[20]	Perinatology Precision Medicine	• Multiomics, Artificial Intelligence	• Multiomics Data • Clinical Data	• Enhanced Predictive Capabilities	• Data Integration • Ethical Considerations
[27]	Personalized Patient Care	• Machine Learning	• Patient Health Records	• Improved Personalization	• Data Privacy • Model Interpretability
[30]	Healthcare treatment planning (various)	• Machine Learning	• Patient Health Records • Treatment Plans	• Improved accuracy, personalization, and efficiency in treatment planning	• Data integration • model explainability • algorithmic bias

Clinical Decision Support is the fourth category, addressing how AI aids healthcare professionals in making informed decisions. Table IV analysis assesses the task at hand, key findings, techniques utilized, types of data employed, challenges faced, and any unique features contributing to clinical decision-making.

TABLE IV. CLINICAL DECISION SUPPORT

REF	DISEASE/TASK	AI TECHNIQUES	DATA TYPES	KEY FINDINGS	CHALLENGES
[6]	Breast cancer detection	• Hyperparameter Optimization • Deep Learning	• Histopathological Images Patient Records	• Improved accuracy	• Data explainability
[8]	Disease Trajectory Forecasting	• Multi-Agent Transformers	• Clinical Data • Imaging	• Clinical Inspiration • Multimodal Data	• Integration Complexity • Data Fusion
[11]	Spinal Surgery	• Artificial Intelligence	• Robotic Systems	• Clinical Application Success	• Surgical Integration • Precision
[13]	Assisting surgeons during minimally invasive procedures	• Combining AI and robotics for enhanced precision and control	• Patient Health Records, Wearables	• Improved accuracy, tremor reduction, fatigue mitigation, and access to difficult areas	• Regulatory requirements • ethical considerations • cost • human-robot collaboration
[22]	Precision medicine in cancer & other diseases	• Combining deep learning with radiomics (medical image analysis)	• Medical Imaging • Radiomics Data	• Improved diagnosis, prognostication, and treatment prediction	• Data quality & quantity • model explainability
[23]	Operational decisions in industry	• Multimodal Data-Driven Reinforcement Learning	• Industrial Process Data	• Improved efficiency & flexibility	• Real-time data, model stability

Lastly, the focus shifts to Healthcare Data Analysis and Modeling, delving into how AI is employed to analyze and model healthcare data. Table V covers the various parameters such as techniques used, data types involved, challenges encountered, and any unique features in leveraging AI for data analysis in the healthcare domain.

TABLE V. HEALTHCARE DATA ANALYSIS

REF	DISEASE/TASK	AI TECHNIQUES	DATA TYPES	KEY FINDINGS	CHALLENGES
[7]	Vascular surgery	• Natural Language Processing	• Surgical Reports • Medical Text	• Potential for patient education, medical education • administrative tasks • research, and clinical care	• Data availability • model explainability,integration into workflows
[10]	Medical Named Entity Recognition (NER)	• Named Entity Recognition	• Electronic Health Records	• High accuracy,recall, and F1 score	• Context dependence • rare entities

[15]	MEDICAL DATA ANALYSIS (UNSPECIFIED)	• AMBIGUITY-AWARE AI ASSISTANTS • TEXT MINING	• BIOLOGICAL DATABASES • DRUG DATA	• INCREASED ATTENTION TO CONTENTIOUS CASES BY EXPERTS • IMPROVED ACCURACY WITH EXPERT-SELECTED ARGUMENTS	• REQUIRES EXPERT-CURATED ARGUMENTS FOR DIFFERENT INTERPRETATIONS
[24]	UNIFYING DATA SCIENCE AND AI WITH GENOMICS RESEARCH	• APPLYING AI ALGORITHMS TO MASSIVE GENOMIC DATASETS, INCLUDING DEEP LEARNING FOR VARIANT INTERPRETATION AND DRUG TARGET IDENTIFICATION	• GENOMIC DATA	• INCREASED ACCURACY AND EFFICIENCY IN GENOME ANALYSIS • IMPROVED DISEASE PREDICTION AND PERSONALIZED MEDICINE • FASTER DRUG DISCOVERY AND REPURPOSING	• DATA PRIVACY AND SECURITY CONCERNS • ENSURING TRANSPARENCY AND EXPLAINABILITY OF AI MODELS • NAVIGATING REGULATORY FRAMEWORKS FOR CLINICAL APPLICATIONS
[25]	ANALYZE HEALTHCARE PROCUREMENT DATA	• TEXT MINING, NATURAL LANGUAGE PROCESSING	• HEALTHCARE PROCUREMENT DATA	• IMPROVED COST ANALYSIS • SUPPLIER IDENTIFICATION & MARKET TREND INSIGHTS	• DATA QUALITY • DOMAIN KNOWLEDGE INTEGRATION • SCALABILITY
[26]	IDENTIFYING EPILEPSY IN DECEASED ADULTS	• VALIDATION METRICS,	• ADMINISTRATIVE HEALTH DATA	• CRITICAL SUCCESS INDEX EVALUATION	• ACCURACY VALIDATION, DATA COMPLETENESS

IV. CONCLUSION

In conclusion, artificial intelligence (AI) in healthcare has brought about big changes, transforming patient care, diagnostics, and how healthcare is managed. AI tools, like machine learning and natural language processing, give healthcare professionals better accuracy and efficiency. AI shines in early disease detection and creating personalized treatment plans, making healthcare better. The mix of big data analytics and AI speeds up research and opens the door to precision medicine. Even though there's been great progress, we need to tackle challenges like ethics, data privacy, and rules to responsibly implement AI in healthcare. Exploring and improving AI applications in healthcare promise to make patient outcomes better and reshape the healthcare landscape in the future.

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