Research Article

Exploring Artificial Intelligence Applications in Managing Cerebrovascular and Cardiovascular Diseases: A Bibliometric and Content Analysis

Yahya Abdul Rehman Shah, Sara Muddassir Qureshi, Hamza Ahmed Qureshi, Saad Ur Rehman Shah

1National University of Sciences and Technology, Pakistan
2* Deggendorf Institute of Technology, Germany
3 Mercer University, USA
4 University of Illinois - Urbana Champaign USA

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Abstract: The fast progression of artificial intelligence (AI) systems created massive changes to medical practice which improved diagnosis alongside treating and administrating cerebrovascular and cardiovascular diseases (CVDs). The study performs a bibliometric analysis in combination with content evaluation to show how AI applications help manage CVDs and cerebrovascular diseases. This study investigates publication patterns through author identification combined with research paper impact analysis to reveal prevalent themes and clinical deployment shortcomings. The study demonstrates the ability of artificial intelligence to help detect diseases early with enhanced personalized interventions as well as better prediction results for vital medical conditions. Data collection biases alongside ethical complexities and clinical practice integration obstacles continue to be major impediments for AI application success. The goal of this research is to present detailed analysis about AI's current state of practice in cerebrovascular and cardiovascular medical care while creating a foundation for both practical research and clinical development.

Keywords: Artificial Intelligence, Cardiovascular Diseases, Cerebrovascular Diseases, Bibliometric Analysis, Predictive Healthcare

I. INTRODUCTION

Heart diseases along with brain vascular diseases represent the primary causes of worldwide mortality which leads to multiple million annual deaths. The advancement of medical technology has not solved early detection nor diagnosis nor effective management of these diseases which continue to pose significant challenges for healthcare providers. These complex medical conditions involve multiple factors requiring sophisticated instruments to study comprehensive datasets that include medical images accompanied by genetic evaluation data along with complete patient records [1]. The emergence of artificial intelligence (AI) during recent years has transformed clinical practice for CVDs with cerebrovascular diseases through updated methods of diagnosis and treatment and disease management. AI meets its strength from rapid precise data processing which leads to major healthcare advancements throughout critical disease sectors including heart disease and stroke treatment. Science-derived artificial intelligence solutions involving machine learning (ML) along with deep learning (DL) and natural language processing (NLP) demonstrate exceptional effectiveness in processing complex dataset analysis [2].

The application of these advanced technologies provides clinical practitioners with tools which boost diagnostic precision together with outcome forecasts while leveraging treatment suitability assessments. The abilities of ML algorithms to detect minor visual anomalies in medical images result in enhanced early-stage disease identification including strokes and myocardial infarctions. Using deep learning algorithms trained on electronic health records (EHRs) and real-time patient data allows health providers to detect and prevent potential heart failure adverse events by performing risk stratification [3]. The value of AI capabilities increases because Natural language processing extracts meaningful information from both clinical notes and medical literature which supports evidence-based decisions. Numerous application areas exist where artificial intelligence supports cerebrovascular and cardiovascular care through stroke emergency discoveries and arrhythmia tracking and risk assessment and distance patient care supervision.

Acute strokes benefit significantly from AI-based diagnosis systems because they provide essential rapid and accurate identification needed for successful stroke interventions. Technologies augmented by artificial intelligence transform the time it takes to review CT or MRI brain scans into seconds allowing doctors to generate critical damage measurement results for immediate clinical action. Concurrently the integration of AI algorithms in wearable devices transformed cardiac health monitoring because they detect arrhythmias such as atrial fibrillation in real-time then notify patients and physicians about potential problems [4]. Through the application of this technology healthcare providers can prevent life-threatening events including strokes alongside cardiac arrest. AI adoption for disease management in cerebrovascular and cardiovascular medicine faces multiple implementation hurdles despite current progress achievements. Data bias represents a key problem during AI analysis because it causes inaccurate prediction results that lead to unfair treatment of patients [5]. The training datasets AI models use typically have limited diversity making them unable to handle differences among genders or ethnicities and geographic distributions. The current limited data representation during AI training raises critical ethical problems that demonstrate the importance of using more comprehensive data. Our healthcare faces substantial risks because AI systems need to use delicate patient data while raising important questions regarding both privacy protection and system security. Achieving synchronized protection for patient information and maintaining robust data collection represents an ongoing critical problem. AI technology integration into clinical systems poses complexities because it demands substantial modifications in current practice and system operations [2].

Healthcare organizations resist using AI technologies because their staff lacks skills to decode AI analysis results. Furthermore, doctors need to analyse the moral issues associated with machine-generated clinical choices. Conceptual "black-box" analysis of numerous AI models without visible prediction reasoning sources generates doubts about clinical professionals' and individual patients' trust. XAI technology serves as an active research solution to solve interpretability challenges by providing transparent analytical results for both patient trust and organizational accountability. Standardization within the healthcare AI development and deployment faces significant hurdles because the regulatory framework continues to develop [5]. The application of AI in healthcare demands complete guidelines which must specify how to secure algorithmic transparency, validate performance methods, and prove clinical outcome capabilities. This study analyses contemporary AI CVD and cerebrovascular disease management research through bibliometric and content qualitative methods. Through analysis of publication trends coupled with assessments of important authors and impactful research papers and identified thematic content the study reveals patterns and missing elements from the current literature base [3].

This analysis reveals how Artificial Intelligence represents a transformative tool for better early disease detection while also serving to individualize care and predict results in critical disease spaces it targets. However, the report also details the challenges that researchers must overcome for AI to reach its maximum potential. Research findings will guide upcoming scientific inquiries about how to design equitable ethical AI solutions which integrate into medical practices for improved management of cerebrovascular conditions and cardiovascular diseases. The field's evolution demands essential collaboration between data scientists and healthcare professionals and policymakers because this team will be needed to break through barriers so AI-driven healthcare innovations reach their maximum potential.

I. Methodology

A. Data Collection

The researchers conducted systematic database searches through PubMed Scopus and Web of Science for current literature research. The research analysis targeted articles from 2010 to 2023 which appeared in peer-reviewed journals to examine contemporary AI strategies in CVDs and cerebrovascular diseases management. The research utilised "artificial intelligence" and "machine learning" along with "deep learning" and "cardiovascular diseases" and "cerebrovascular diseases" and "stroke" and "predictive analytics" search terms. The research incorporated studies focused on diagnostic instrumentation together with therapeutic practices as well as predictive modelling and patient monitoring systems. Only English-language articles with fully accessible content were included in this study [6].

i. Bibliometric Analysis

The study analysed research trends and significant publications alongside academic collaboration patterns through a bibliometric method using tools VOS viewer along with Bibliophagy. Research ecosystem evaluation used metrics that included citation counts alongside keyword co-occurrence and geographic study distribution. The analysis showed which authors produced the most research contributions alongside which institutions and countries drive research innovation [7].

ii. Content Analysis

Content analysis was performed to categorize the selected studies into thematic areas: early diagnosis, risk prediction, treatment optimization, and remote monitoring. Researchers identified several emerging trends together with research gaps and clinical application possibilities. A systematic breakdown of identified themes established the key barriers and possibilities regarding AI systems implementation in medical care processes.

a. Results and Discussion:

The bibliometric analysis revealed a sharp increase in research output on AI applications for CVDs and cerebrovascular diseases over the past decade, reflecting the growing interest in this field. The majority of contributions came from countries like the United States, China, and the United Kingdom, with collaborations between academic institutions, hospitals, and technology firms driving innovation. Journals such as *Nature Medicine*, *Circulation*, and *Journal of the American College of Cardiology* were identified as key platforms for publishing influential studies [8].

b. Bibliometric Insights

The annual number of publications has consistently increased since 2015, with a significant rise during the COVID-19 pandemic due to the focus on remote monitoring and AI-driven diagnostic tools [9].

iii. Key Contributors

Authors such as Esteva and Rajkumar, who have extensively worked on machine learning in healthcare, were frequently cited. Major institutions contributing to the field include Stanford University, Harvard Medical School, and Tsinghua University. Commonly occurring keywords included "deep learning," "stroke detection," "risk stratification," and "wearable technology." The frequent co-occurrence of terms like “personalized medicine” and “predictive analytics” highlighted the thematic focus on precision healthcare [10].

B. Keyword Analysis

The healthcare industry has a strong social impact on the well-being of individuals, communities, and societies. Social responsibility in this industry includes fair labour practices, community outreach, patient care, diversity, and health equity [2]. As closely related to human life, healthcare organizations are uniquely positioned to lead in addressing social challenges while fostering trust and stronger relationships with stakeholders.

i. Thematic Areas in AI Applications

Healthcare applications of Artificial Intelligence (AI) continue to improve significantly through management solutions designed for cerebrovascular and cardiovascular diseases (CVDs). Its transformative potential can be categorized into four key thematic areas: early diagnosis, risk prediction, treatment optimization, and remote monitoring and management. AI solutions through these areas change clinical care by delivering precision medicine and decreasing diagnostic errors while improving patient outcomes [11].

ii. Early Diagnosis

Detecting cerebrovascular and cardiovascular diseases early enables timely medical interventions which both eliminate major complications and produce better treatment results. Advanced AI analytical tools now enable rapid and precise detection of two important medical conditions such as ischemic stroke alongside myocardial infarction. The merger of magnetic resonance imaging (MRI), computed tomography (CT) with advanced AI algorithms shows powerful identification capability for brain and heart structure abnormalities [12]. Medical imaging data analysis leverages convolutional neural networks (referred to as CNNs) for extensive research applications. The ability of CNNs to analyse brain scans allows health professionals to find delicate imaging patterns suggesting ischemic strokes while simultaneously locating the thrombus and predicting affected outcomes in under a second. The precision of this technique enables clinicians to respond rapidly by administering treatments including thrombolysis and thrombectomy when compliance with therapeutic time constraints becomes necessary. AI detection models currently assist in analysing electrocardiograms and imaging results to identify myocardial infarction thus offering physicians trustworthy additional medical insights. AI-based tools enable researchers to discover biomarkers alongside molecular signatures that assist doctors during early condition diagnosis before clinical symptoms appear [13].

iii. Risk Prediction

The transformative potential of AI technology can be found in risk prediction applications. Machine learning algorithms that use specific patient data create predictive models which detect likely occurrences of conditions like stroke recurrence together with heart failure and sudden cardiac arrest. Computational systems review numerous variables combining vital signs alongside medical backgrounds and genetic attributes together with life habits to recognize at-risk populations. The utilization of artificial intelligence for risk prediction tools provides disease management infrastructures that operate from a predictive standpoint. Large datasets of patient information can be assessed with machine learning algorithms to detect patterns which signal increased complications risk [11]. After high-risk patients have been identified through these tools they can access specific therapeutic approaches like precision medication refinement or structured lifestyle modifications combined with intensified follow-up care to reduce their potential exposure. Artificial Intelligence has proven powerful for heart failure prediction within clinical settings. AI models trained with EHR information conduct analysis of patient health records through time to detect heart-failure indications before standard diagnosis methods are able to identify these signs. AI has proven effective for stroke risk recurrence assessment through its evaluation of imaging results together with blood test indicators and patient health profiles which enables precise individual patient preventive planning. Medical organizations using AI-enhanced risk assessment solutions achieve optimal resource management along with lower mortality rates and decreased morbidity because their systems direct interventions to patients showing the highest potential for benefit [12].

C. Treatment Optimization

Modern disease management depends heavily on proper treatment protocol optimization through artificial intelligence systems. Tools that operate through artificial intelligence analyse immediate patient information to develop personalized medical plans which adapt treatment to unique patient profiles. Emerging evidence demonstrates that AI technology achieves excellent results for optimizing treatment sequences across arrhythmia management particularly in atrial fibrillation conditions. The use of reinforcement learning algorithms enables procedural guidance during catheter ablation treatments that help clinicians fight arrhythmias through minimally invasive procedures. These predictive algorithms process patient records combined with treatment outcomes to generate precise recommendations that drive better treatment precision and improved success ratios. A new form of medication enhancement along with procedural optimization is enabled through AI technology [13]. AI systems use genetic profiles alongside medical histories alongside associated clinical elements to make forecasts about drug reactions for individual patients. Physicians can achieve maximum treatment results with reduced adverse medication effects using this method for drug selection. AI-based decision support systems now improve patient results and quality of life by making heart failure treatment adjustments while enforcing lifestyle modifications in healthcare approaches. Furthermore, AI applications perform analysis of real-time hemodynamic parameters which aid in direct patient interventions in critical care environments. A blend of AI technology and computerized analysis has led to its application in intensive care unit (ICU) settings for monitoring acute coronary syndrome patients with automated risk warning capabilities and digital treatment suggestion algorithms [14].

i. Remote Monitoring and Management

AI-powered wearable devices when combined with digital health technologies revolutionize both remote patient monitoring and management services. Modern health tools track patient vital signals automatically and continuously which leads to better health status information through monitoring devices that measure heart rate and blood pressure and oxygen saturation levels and electrocardiogram signals. Wearable devices utilization of AI algorithms aids detection of medical anomalies in real time which generates patient and health provider alerts to avoid serious medical complications. Smartwatches equipped with AI-powered ECG technology identify heart rhythm abnormalities as arrhythmias through accurate interpretations and trigger early treatments which lower stroke risk [15]. Convertible blood pressure monitoring systems allow ongoing measurement that helps enhance hypertension treatment for both patients and clinical staff. Summary data from chronic condition patients especially heart failure is managed through remote monitoring technologies. The combination of AI-driven platforms links information from wearable devices and EHRs and patient-reported outcomes which builds an extensive health overview for patients. Predictive analytics tools on these platforms reveal health patterns which trigger prompt adjustments to therapeutic strategies. Energy-mediated scale data revealing weight shifts signals heart failure fluid accumulation so medical treatment can begin before hospital admission becomes necessary. Remote monitoring systems simultaneously improve individual patient care while minimizing institution-based healthcare demands through reduced repetition of in-person facility visits. During the COVID-19 pandemic the ability to use telemedicine and remote care proved essential for sustaining healthcare continuity through the pandemic [16].

ii. Challenges in Clinical Implementation

a. Accountability towards Efficient Performance:

While Artificial Intelligence (AI) holds immense promise in managing cerebrovascular and cardiovascular diseases (CVDs), its implementation in clinical settings is fraught with challenges. These obstacles stem from technical, ethical, and infrastructural issues that must be addressed to unlock the full potential of AI in healthcare.

b. Data Bias and Diversity:

The implementation of AI for CVDs and cerebrovascular diseases faces major challenges because training datasets for AI models lack sufficient diversity in representation. Today's medical datasets include mostly single demographic populations which reflect predominantly residents of high-income nations but fail to represent globally diverse demographics. The resulting bias from these data representations produces inaccurate AI-produced results which disproportionately impact ethnic and geographic and socioeconomic minority persons. When Artificial Intelligence algorithms receive training from datasets with minimal minority population representation, they show deficiencies in spotting diseases widespread in such groups which creates poor diagnosis outcomes and deficient care quality [17]. These systemic gaps alongside healthcare inequalities find continued perpetuation through biased AI systems which also destroy public trust. Healthcare researchers must develop all-inclusive datasets which present a wide range of demographic characteristics combined with ethnic groups and regional areas. The essential process for collecting diverse medical datasets depends on active collaboration between entities that include medical organizations and governmental institutions with technology companies. AI developers require active implementation of bias detection algorithms together with fairness-enhancing interventions for detecting and minimizing biases throughout the model training process. Greater visibility about data-collection processes and usage mechanisms helps strengthen both trust and fairness in AI application domains [18].

iii. Ethical and Privacy Concerns

Healthcare AI systems operate through comprehensive patient data systems yet this process produces major privacy and security risks. The General Data Protection Regulation (GDPR) serves European patients while the Health Insurance Portability and Accountability Act (HIPAA) protects U.S. patient privacy along with data completeness. Meeting regulatory standards representing a persistent challenge when scientists attempt to gather large datasets for healthcare AI systems. Several ethical issues stem from AI algorithms' black-box functionality because they generate unknown explanations about how the underlying decisions are formed. Healthcare providers and patients develop mistrust of AI-driven results when systems lack transparency because these systems produce outputs whose reliability and fairness remain opaque. A moral obligation exists to make sure AI systems support doctors' decision processes instead of replacing their judgment to preserve the role of medical expertise [19]. Healthcare organizations need to invest in strong cybersecurity solutions because they must safeguard both patient data privacy and prevent unauthorized breaches and unauthorized access. Healthcare organizations must prioritize XAI systems because they provide crucial transparency about process decisions which enables both patients and clinicians to grasp clinical decision-making methods. The responsible advancement of AI in healthcare requires ethical guidelines that defend patient rights and patient autonomy.

D. Integration into Clinical Workflows

Current clinical operations face implementation difficulties when they adopt AI systems. Most healthcare institutions face an infrastructure shortage because they need interoperable electronic health record (EHR) systems to effortlessly integrate AI tools. The workforce in healthcare lacks adequate training to properly understand and effectively use AI-based insights which directs clinical practice. The reluctance of healthcare providers to embrace change becomes a major obstacle because they doubt AI system accuracy and worry technology will seek to replace human roles [20]. Healthcare professionals maintain their hesitance because of both the data entry requirements and the time needed to understand how to effectively use AI systems in practice. Success in handling these obstacles demands a comprehensive multiple-step solution. Tech developers must work together with clinicians and administrators through interdisciplinary collaboration to build useful AI systems which support clinical workflows. Organizations need to establish complete training frameworks that instruct health care providers to understand and successfully use insights generated by AI processes. The design of AI tools needs to better existing clinical workflows by creating smooth transitions into daily medical operational frameworks [21].

i. Regulatory and Validation Challenges

AI tools used in healthcare face challenges because the regulatory system remains in development and lacks complete standards for AI device validation and approval processes. Developers along with healthcare providers face an unpredictable situation that slows down new solution deployments. When evaluating AI systems in situations where technology rapidly advances stakeholders often face confusion about how to assess safety alongside efficacy and ethical behaviour. The development of thorough regulatory guidelines represents an essential requirement to solve current issues. The regulatory frameworks should define normal procedures which validate AI models by conducting thorough clinical testing for assessing performance alongside safety assessments. AI systems require oversight from regulatory bodies to establish standards which establish transparency and accounting methods and ethical guidelines. Global acceptance of AI applications in healthcare depends heavily on international collaborative efforts toward standardized regulatory systems [22].

E. Future Directions

Future research and development efforts in cerebrovascular and cardiovascular care must focus on developing advanced technologies and equitable policies along with setting ethical and regulatory frameworks to address implementation challenges. The following chapters propose essential exploratory areas for upcoming research together with innovation methods.

i. Advancing Explainable AI

a. Greenwashing in Healthcare:

Explainable AI (XAI) serves as the foundation for clinician and patient trust because it renders AI-driven decisions transparent through understandable explanations. Future work needs to focus on constructing XAI models which properly explain the decision processes to let clinicians check and have confidence in AI system outputs. AI systems gain better acceptance from clinicians through visual diagnosis explanations that display how imaging features helped them determine stroke diagnosis. Future XAI system developments must establish models that deliver both transparency and practical decision-making insights that clinicians can directly implement. Company success depends on XAI model development since these models help solve the black-box limitations of typical AI evaluations [2].

b. Enhancing Dataset Diversity:

The success of AI healthcare delivery requires datasets which incorporate diverse populations to yield equitable medical outcomes. Teams should develop future initiatives to gather population data from all demographics including poor and middle-class citizens within developing nations because this method repairs existing prejudice. Healthcare organizations together with governments and academic institutions should join forces to create global datasets which include comprehensive representation of diverse patient populations. Synthetic data generation and federated learning represent key methods which AI developers need to implement to increase the diversity of their datasets. Representative datasets are developed through methods which protect patient privacy and resolve population diversity alongside ethical requirements [5].

c. Promoting Interdisciplinary Collaboration:

Efforts to deploy AI systems effectively require combined participation of healthcare providers with data specialists and policy developers and ethical researchers. Future work must focus on developing active collaboration between health professionals and researchers with data scientists alongside ethicists and regulatory experts to create systems that meet medical requirements while upholding ethical standards. The development and validation of AI tools becomes faster with hospital-technology company partnerships as professional input from ethicists aids the creation of regulation frameworks for ethical use of AI systems. Such partnerships represent a vital foundation for advancing AI-driven healthcare innovation together with increasing public trust in AI-based healthcare solutions [16].

F. Conducting Large-Scale Clinical Trials

Clinical research on a broad scale must occur to confirm AI systems' safety levels and effectiveness as well as their real-world practicality within cerebrovascular and cardiovascular treatment settings. The trials need to examine the benefits of AI toward patient results in combination with cost efficiency throughout healthcare service operations. The creation of strong trial data enables healthcare providers to trust AI systems which subsequently enables their implementation throughout standard care procedures [7]. The development of complete ethical guidelines must remain a priority because these standards will help resolve concerns about system accountability and healthcare data security as well as Patient consent. As our next step we need to create multinational standards that clearly define ethical practices for AI applications during healthcare delivery. Proof-of-concept regulatory models need to focus on patient empowerment alongside data privacy laws as well as equal access to AI-supported solutions. Through systematic resolution of recommended next steps AI systems will enter cerebrovascular and cardiovascular medicine to drive more precise medical care with enhanced efficacy and universal healthcare access.

II. Conclusion

Cerebrovascular and cardiovascular disease management has successfully transformed through artificial intelligence by improving early detection and risk forecasting and treatment refinement and remote health monitoring capabilities. Although promising the future remains challenged by data biases and ethical problems and clinician workflow compatibility. These barriers need solutions through discipline-harnessing teamwork alongside strong moral guidelines and diverse population-oriented datasets construction. The widespread acceptance of AI tools by clinicians and patients depends on explainable AI technology combined with extensive clinical trials which validate safety and effectiveness, together with transparency measures. The ongoing development of research and technology positions AI as a revolutionary force to transform cardiovascular and cerebrovascular treatment alongside enhanced patient outcomes and diminished health inequalities and advanced global health equity.

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