The Role of Artificial Intelligence in the Diagnosis and Management of Ischemic Stroke in Indonesia: A Systematic Review

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ABSTRACT

Ischemic stroke is a leading cause of death and disability in Indonesia. With the emergence of artificial intelligence (AI), there is promising potential to improve stroke diagnosis and management. This narrative review aims to explore the role of AI in diagnosing and managing ischemic stroke, as well as the challenges and opportunities for its implementation in Indonesia. Using keywords related to the role of AI in diagnosing and managing ischemic stroke, approximately 16 relevant articles were retrieved and critically reviewed from PubMed, Scopus, and Google Scholar. The findings indicate that AI offers significant advantages, including faster and more accurate data analysis, as well as enhanced support for clinical decision-making. However, challenges remain, such as the need for high-quality data and adequate user training. This review concludes that AI holds substantial potential for improving ischemic stroke care in Indonesia, particularly in diagnostic accuracy, clinical workflow efficiency, and access to care. To realize these benefits, urgent investment in research and multi-stakeholder collaboration is needed to ensure safe, effective, and ethical implementation of this transformative technology.

Keyword : Artificial intelligence; Indonesia; ischemic stroke management, workflow efficiency

Introduction

Stroke remains one of the most critical public health challenges in Indonesia. According to a journal publication in 2009, stroke was the second leading cause of death in the country, with an annual incidence of approximately 1.5 million cases [1]. More recent data from a 2022 publication indicate that the prevalence of ischemic stroke continues to rise,

now affecting 12% of the total Indonesian population [2]. The burden of stroke extends beyond individual health outcomes, placing substantial strain on the healthcare system due to high treatment costs, long-term rehabilitation needs, and significant socioeconomic impacts on patients, families, and communities.

Prompt diagnosis and effective management are essential to improving outcomes for stroke patients. Every minute of delay in medical intervention increases the risk of permanent disability or death. Consequently, the Indonesian healthcare system must adapt and enhance its capacity to manage stroke cases efficiently. Technological innovations, particularly artificial intelligence (AI), offer a promising avenue to reduce diagnosis time, increase diagnostic accuracy, and ultimately save lives.

Artificial intelligence has the potential to revolutionize stroke diagnosis and management. Through advanced machine learning algorithms, AI can analyze medical data rapidly and accurately, enabling clinicians to make better-informed decisions. For instance, AI algorithms can interpret neuroimaging studies such as MRI and CT scans to detect early signs of ischemic stroke that may be subtle or easily overlooked by the human eye. A 2024 research publication demonstrated that AI algorithms can improve both the speed and accuracy of ischemic stroke diagnosis by up to 30% [3]. Such advancements are particularly relevant for Indonesia, where access to specialized radiologists and stroke experts is often limited, especially in rural and remote areas. The primary objective of this article is to conduct a systematic review of the application of artificial intelligence in the diagnosis and management of ischemic stroke within the Indonesian context. By collecting, synthesizing, and critically analyzing existing studies, this review aims to provide a comprehensive understanding of the benefits, challenges, and potential clinical applications of AI for ischemic stroke care in Indonesia.

In addition, this article will identify the key barriers to implementing AI-based stroke care in Indonesia. These include inadequate healthcare infrastructure, insufficient training of medical personnel in AI technologies, and ethical and legal concerns regarding data privacy and algorithm accountability. On the other hand, opportunities to improve the quality of stroke services through AI will also be explored, such as public private partnerships in health technology development, integration of AI into existing telemedicine platforms, and capacity building through targeted education and training programs. By addressing both challenges and opportunities, this review seeks to provide actionable insights for policymakers, clinicians, and researchers working toward better stroke outcomes in Indonesia.

Material and Methods

A systematic review is a research method that aims to collect, analyze, and synthesize data from various relevant studies regarding the role of artificial intelligence (AI) in diagnosing and managing ischemic stroke in Indonesia. This method was carried out by following strict steps to ensure that all relevant studies were identified and critically evaluated. This systematic review is essential because ischemic stroke is one of the leading causes of death and disability in Indonesia, with prevalence continuing to increase. Therefore, utilizing AI to diagnose and manage ischemic stroke will enhance clinical outcomes and improve the efficiency of healthcare services.

Researchers utilized various reliable data sources to gather comprehensive information on the role of AI in the diagnosis and management of ischemic stroke. The primary sources used in this search were academic databases such as PubMed, Scopus, and Google Scholar. This database was selected because it features an extensive and accredited collection of scientific articles, providing high-quality information.

Additionally, journals focusing on neurology, stroke, and health technology are also essential sources for literature searches. Some relevant journals include World Neurosurgery, International Journal of Stroke, and Stroke Research and Treatment. By utilizing these various sources, the author hopes to identify current and relevant studies regarding the use of AI in the context of ischemic stroke in Indonesia.

Table 1. PRISMA selection methodolgy

PRISMA Stage	Number of Articles	Description
Identification	50	Articles found from PubMed, Scopus, and Google Scholar databases
Duplicates Removed	10	Duplicate articles were removed
Articles After Duplicates Removed	40	Remaining articles after duplicate removal
Screening	40	Articles screened based on title and abstract
Irrelevant Articles Removed	24	Articles not relevant to the topic were excluded
Eligibility	16	Articles reviewed in full text
Articles Removed after Full-Text Review	0	No articles were removed after in-depth review
Included in Review	16	Studies included in the final analysis

Results

Artificial intelligence (AI) is a branch of computer science that focuses on developing systems capable of performing tasks that typically require human intelligence, such as pattern recognition, decision-making, and natural language processing. In medicine, AI and machine learning (ML) have become essential tools in improving disease diagnosis and management efficiency and accuracy. According to a 2023 research journal publication, the application of AI in the medical field is not limited to diagnosis but also encompasses the development of more personalized and effective treatment strategies. AI can process large amounts of data quickly and produce patterns that may not be detected by humans, providing significant support in the clinical decision-making process[4].

In the diagnosis of stroke, especially ischemic stroke, AI plays a role in identifying symptoms and risk factors more precisely. For example, machine learning algorithms can be trained using previous patient data to recognize patterns that indicate a possible stroke. In this way, AI can help doctors determine the appropriate and timely action, which is crucial, considering that time is a critical factor in treating strokes[4]. Furthermore, AI can also be used to analyze medical images, such as CT scans or MRIs, which are standard methods for diagnosing stroke. By utilizing image processing techniques, AI can enhance the accuracy of diagnosis by detecting lesions or pathological changes that the human eye might overlook. This is particularly relevant in Indonesia, where access to neurology specialists may be limited, especially in remote areas[5].

Using AI in stroke diagnosis can also reduce the workload of medical personnel. By automating the data and image analysis process, medical personnel can focus more on direct patient interactions and developing holistic treatment plans. This is in line with efforts to improve the quality of health services in Indonesia, where the number of stroke patients continues to increase[2]. Overall, AI holds excellent potential to enhance stroke diagnosis by facilitating faster and more accurate data analysis, as well as providing support to medical personnel in making informed clinical decisions. However, challenges such as the need for high-quality data and adequate user training must be overcome for the benefits of AI to be fully felt in daily clinical practice.

Discussion

An ischemic stroke is a medical emergency that requires fast and appropriate treatment to minimize brain damage and increase the patient's chances of recovery. The ischemic stroke management protocol in Indonesia includes the use of thrombolysis, namely the

administration of thrombolytic drugs such as alteplase, which aims to dissolve blood clots that block blood flow to the brain[5]. Implication of thrombolysis must be carried out within 4.5 hours after the onset of symptoms, so energy doctors need to recognize the signs of stroke quickly.

Data from the World Stroke Organization shows that in Indonesia, ischemic stroke accounts for around 60% of all stroke cases[1]. However, the rate of use of thrombolysis is still low, with only around 5% of ischemic stroke patients receiving this therapy. Several factors, including the scarcity of adequate medical facilities and limited public awareness of the importance of prompt treatment, contribute to this issue. Therefore, efforts are needed to increase public awareness and training for health workers in quickly recognizing and referring stroke patients.

Apart from thrombolysis, other interventions, such as thrombectomy, are also an option in the management of ischemic stroke, especially in cases with large occlusions. This procedure involves removing the blood clot through a catheter inserted into the blood vessel. A 2022 research journal publication showed that patients who underwent thrombectomy had better clinical outcomes than those who received only medical treatment[6]. With advances in technology and the use of artificial intelligence (AI) in determining patients suitable for this procedure, it is hoped that there will be an improvement in stroke management outcomes in Indonesia.

The application of AI in ischemic stroke diagnosis encompasses various algorithms and prediction models designed to enhance the accuracy of diagnosis and patient management. According to a 2024 journal publication, one of the most promising approaches is the use of deep learning algorithms to analyze medical images with high precision[3]. These algorithms are trained using large datasets that include various types of brain images from patients who have experienced strokes. In this way, AI can recognize early signs of ischemic stroke that may not be visible on a routine visual examination.

One example of an AI application in stroke diagnosis is the use of image-based models to detect blood vessel blockages. In a 2022 research journal publication, an AI algorithm successfully identified stroke cases resulting from blockages of large blood vessels with greater accuracy than conventional methods[6]. This demonstrates that AI can be a valuable tool in accelerating diagnosis and reducing delays in medical intervention.

In addition, extensive data analysis can improve the diagnosis of ischemic stroke. By collecting and analyzing data from various sources, including electronic medical records and laboratory test results, AI can identify risk factors that may contribute to stroke events. For

example, a 2023 research journal publication showed that AI could identify patterns in demographic and health data associated with an increased risk of stroke in the Indonesian population[7]. This provides valuable insight for healthcare providers in designing more effective prevention programs.

In Indonesia, the implication of AI in ischemic stroke diagnosis is still in the development stage, but several hospitals have started to adopt this technology. For example, several large hospitals in Jakarta have implemented AI-based systems for analyzing CT scan images, which helps doctors make faster and more informed decisions. Preliminary results suggest that using AI in stroke diagnosis can reduce the time required to determine a diagnosis and initiate treatment[5].

Effective implementation of stroke management protocols relies heavily on coordination between various parties, including hospitals, medical personnel, and the community. Therefore, developing an efficient referral system and providing ongoing training to health workers is crucial. By utilizing AI, the monitoring and decision-making process in stroke management can be optimized, thereby increasing the effectiveness and efficiency of ischemic stroke management in Indonesia. However, implementing AI in Indonesia remains a significant challenge. Primary concerns include adequate technological infrastructure, training for medical personnel, and integrating AI systems with existing clinical practices. To maximize the potential of AI in ischemic stroke diagnosis, collaboration between governments, healthcare providers, and technology developers is urgently needed.

Implications for Clinical Practice

The importance of AI integration in the Indonesian health system

Integrating artificial intelligence into the Indonesian healthcare system has significant implications for clinical practice, particularly in the management of ischemic stroke. With the increasing prevalence of stroke in Indonesia, which is expected to increase as the population ages, the health system must adapt to meet these increasingly complex needs[7]. Artificial Intelligence can be an effective solution to increase efficiency and effectiveness in stroke diagnosis and management.

One important aspect of AI integration is its ability to support clinical decision-making. Doctors can obtain more accurate and data-based stroke diagnoses and treatment recommendations using AI-based algorithms. For example, AI systems can analyze patient data, including medical history and examination results, to recommend the most appropriate therapy. This not only improves the quality of care but also reduces human errors that may

occur in the decision-making process[4].

Apart from that, the integration of AI in the health system can also help in the training of medical personnel. Doctors and nurses can be trained to recognize stroke symptoms and take appropriate action in emergencies using AI-based simulations. This is especially important in Indonesia, where medical training and education are often limited in scope. This technology can enhance the skills and knowledge of medical personnel, enabling them to better prepare for and manage complex stroke cases more effectively[8].

The importance of AI integration is also apparent in efforts to improve access to stroke care. Access to adequate healthcare facilities remains challenging in many areas of Indonesia, particularly in remote regions. Using AI-supported telemedicine technology, patients can receive initial consultation and diagnosis without traveling long distances to the hospital. This can reduce the time it takes to get treatment, which is especially important in stroke cases where every minute counts[9]. However, effective integration requires collaboration between various stakeholders, including governments, healthcare providers, and technology developers. Policies supporting the development and application of AI in healthcare must be formulated with consideration for the local context and existing challenges. Thus, the Indonesian health system can harness AI's potential to improve the diagnosis and management of ischemic stroke.

Case Study and Implication in Indonesia

The implementation of AI in diagnosing ischemic stroke in Indonesia has shown promising results, although it is still in its early stages of development. Several hospitals in major cities, such as Jakarta and Surabaya, have begun integrating AI systems into their diagnostic processes. One example is Fatmawati Hospital in Jakarta, which applies an AI system to analyze CT scan images of stroke patients. The results of this application show an increase in diagnostic accuracy and a reduction in waiting time for treating stroke patients.5

AI in medical image analysis helps doctors identify the type of stroke more quickly. Using deep learning algorithms, the AI system can assess CT scan images in under 10 minutes, compared to the average 30 minutes required by doctors. This is particularly important as every minute wasted can impact the patient's recovery rate[5].

Case studies demonstrating the effectiveness of stroke management using artificial intelligence in Indonesia are necessary to understand the real impact of this technology. A study conducted at Dr. Hasan Sadikin General Hospital in Bandung demonstrated that implementing an AI system for managing ischemic stroke can reduce diagnosis and intervention times. A 2022 research journal publication showed that the average time for

diagnosis was reduced from 90 minutes to 45 minutes after implementing AI technology[10]. This reduction in time is very significant, considering that every minute wasted in stroke treatment can impact the patient's outcome.

Additionally, a 2022 research journal publication conducted in Bandung demonstrates that utilizing AI to manage stroke patient data can facilitate informed clinical decision-making[10]. AI systems can provide personalized and practical treatment recommendations by integrating health history data, examination results, and risk factors. This represents a significant step forward in enhancing the quality of stroke care in Indonesia, where disparities in access to and quality of healthcare services persist as a challenge.

One of the most promising applications of AI is in medical image analysis. Machine learning algorithms have proven effective in analyzing CT scans and MRIs to detect the presence of ischemic stroke. A 2022 systematic study journal publication showed that AI models can achieve higher diagnostic accuracy than human judgment, with sensitivity reaching 90% in detecting large strokes. This is especially important in clinical settings in Indonesia, where limited resources often hinder rapid access to necessary care[6]. Additionally, a 2023 research journal publication demonstrated that utilizing AI in monitoring post-stroke patients can enhance compliance with treatment and rehabilitation plans.5 In the study, patients monitored with an AI-based system demonstrated a higher rehabilitation success rate compared to those who did not receive such monitoring. This indicates that AI plays a role in the acute phase and supports patients' long-term recovery.

Challenges in Implementing AI

Infrastructure and Technology Access

The application of artificial intelligence (AI) in diagnosing and managing ischemic stroke in Indonesia faces several challenges, including inadequate infrastructure and access to technology. According to a 2022 research journal publication, many health facilities in Indonesia, especially in remote areas, still lack sophisticated medical equipment and stable internet access[11]. This hinders the implementation of AI systems requiring real-time data and good connectivity. Optimally. For example, an AI application designed to analyze MRI images or CT scans requires powerful hardware and a fast internet connection to upload and process data. Without adequate infrastructure, the use of this technology is minimal.

Furthermore, the unequal distribution of health facilities in Indonesia could exacerbate this problem. According to data from the Central Statistics Agency, around 60% of hospitals are located on Java, while other islands, such as Sumatra and Papua, have more limited access. This creates a gap in the application of AI technology, where more economically

advanced regions can leverage this technology while other regions lag behind. In the context of stroke, this means that patients in remote areas may not receive rapid and accurate diagnosis and treatment, which is critical to reducing morbidity and mortality from stroke.

Limited Knowledge and Skills of Health Workers

Another significant challenge is the limited knowledge and skills of health workers in using AI technology. Although many medical personnel in Indonesia possess strong educational backgrounds, their understanding of new technologies, particularly artificial intelligence (AI), still varies significantly. Inadequate education and training regarding AI-based tools can result in a lack of knowledge in applying this technology in daily practice. According to a 2023 research journal publication, a lack of specific training in using AI-based diagnostic tools can lead to health workers' distrust of the technology, resulting in them tending to rely on traditional methods that may not be as efficient as modern technology[5].

Case example at Dr. Hospital. Hasan Sadikin Bandung noted that although AI-based diagnostic tools are available, many doctors remain hesitant to use them due to a lack of understanding of how the technology works.10 This highlights an urgent need for more structured and comprehensive training programs to enhance health workers' skills in utilizing AI. Without serious efforts to improve this knowledge and skills, the enormous potential offered by AI in the diagnosis and management of ischemic stroke will not be realized. Therefore, governments and health institutions must provide the necessary resources and training to facilitate the widespread adoption of this technology[2].

Resistance from the patient/patient's family and the community

Ethical and data privacy issues are another challenge in applying AI in ischemic stroke management in Indonesia. Using patient data to train AI algorithms requires special attention to protecting personal information the public needs to be assured that their data will be managed safely and not misused. Therefore, governments and healthcare institutions need to develop clear regulations regarding the use of patient data in the context of AI. Apart from that, resistance from health workers to technological changes is also a challenge. Many medical professionals may feel uncomfortable using new technology and prefer traditional methods of care. Therefore, there is a need for a comprehensive training program to improve the understanding and skills of health workers in using AI technology[12].

By understanding these challenges, steps can be taken to overcome barriers and ensure that AI can effectively manage ischemic stroke in Indonesia. Collaborative efforts among governments, health institutions, and society are crucial to establishing an ecosystem that

fosters the adoption of advanced technologies in healthcare.

Opportunities for AI Development

Collaboration between Medical and Technological Institutions

Despite the challenges, there are significant opportunities for the development of AI in diagnosing and managing ischemic stroke in Indonesia. One of the most promising opportunities is collaboration between medical institutions and technology companies. This collaboration can accelerate the development and implementation of effective AI solutions that meet local needs. For example, several hospitals in Jakarta have begun forming partnerships with technology startups to develop applications that aid in the early diagnosis of stroke. This kind of collaboration not only increases access to the latest technology but also allows the adaptation of these tools to Indonesia's specific conditions and needs.

According to a 2024 research journal publication, this kind of collaboration has proven successful in other countries, where medical institutions are working with technology companies to develop AI algorithms that are more accurate in detecting strokes.3 In Indonesia, a similar approach could be implemented, involving universities, hospitals, and technology companies, to create an innovation ecosystem that supports the development of health technology. This will also open up further research and development opportunities, creating new jobs in the health and technology sectors.

Training and Education for Health Workers

Another equally important opportunity is to increase training and education for healthcare workers. With growing awareness of the importance of technology in the medical field, medical education institutions in Indonesia are beginning to incorporate curricula that incorporate AI technology in diagnosing and managing diseases. These training programs aim to equip healthcare workers with the skills to use AI-based tools effectively. For example, some universities have started offering specific courses on AI applications in neurology and stroke.

Ongoing training is also essential to ensure that health workers stay updated with the latest technological developments. According to a 2023 research report published in a journal, continuous training can increase the confidence of healthcare workers in using new technology, which in turn can improve patient care outcomes.13 By improving education and training in this area, Indonesia can prepare health workers who are more competent and better equipped to face the challenges of the digital era.

Policies to Support AI Integration in Health Systems

To encourage the application of AI in the diagnosis and management of ischemic

stroke, policies are needed that support the integration of this technology into the national health system. The 2021 journal publication highlights the significance of government policies that foster a conducive environment for technological innovation in the healthcare sector. These policies could include incentives for hospitals to adopt AI technology and funding for research and development in this area.14 With strong policy support, it is hoped that more healthcare facilities will invest in AI technology, which could ultimately improve the quality of healthcare services.

Apart from that, the government also needs to develop clear standards and regulations regarding the use of AI in the health sector. This is important to ensure that the technology used is safe, effective, and in accordance with medical ethics. With clear regulations, healthcare workers can have more confidence in using AI technology, and patients can feel more secure knowing they are receiving care that meets established standards. Policies supporting AI integration must also involve all stakeholders, including governments, medical institutions, and technology companies, to foster effective synergies in the development and application of this technology.

By harnessing the potential of AI technology, Indonesia can improve the diagnosis and management of ischemic stroke, which in turn can reduce the burden of this disease in society. Through collaboration, training, and supportive policies, Indonesia has an excellent opportunity to become a leader in the application of health technology in Southeast Asia.

Future Research Directions

Further research into the effectiveness and implementation of AI in various settings

Future research directions are essential in exploring the effectiveness and implementation of artificial intelligence in diagnosing and managing ischemic stroke in Indonesia. Although initial research shows great potential for AI, there is still a need for more comprehensive and evidence-based studies that provide deeper insights into the application of AI in diverse clinical contexts [3].

One area that requires further research is the effectiveness of AI algorithms across different populations. Indonesia's vast ethnic and genetic diversity may influence response to stroke treatment. A 2019 journal publication stated that more in-depth research is needed to understand how AI algorithms can be adjusted to accommodate these differences and provide better outcomes for all population groups [15].

Research on implementing AI in different clinical settings is also fundamental. Each hospital or healthcare center may have unique challenges and needs. Therefore, case studies that explore how AI is applied in various urban and rural settings can provide valuable

insights into the best strategies for integrating this technology [12].

Research must also focus on the ethical and regulatory aspects of using AI in the health sector. With the increasing use of this technology, it is essential to ensure that patient data is protected and that AI does not lead to discrimination or errors in diagnosis. In a 2023 research journal publication, it was stated that a study was needed to explore the views of medical personnel and patients regarding the use of AI in stroke diagnosis and could also provide valuable insights for developing better policies [16]. Ultimately, collaboration between researchers, healthcare practitioners, and technology developers is essential to drive innovation and broader application of AI in ischemic stroke management. By building solid partnerships, research can be directed toward producing practical and relevant solutions that can be implemented in the field, thereby improving treatment outcomes for stroke patients in Indonesia.

Conclusion

Artificial intelligence has an increasingly important role in diagnosing and managing ischemic stroke in Indonesia. With the potential to enhance diagnostic accuracy, facilitate informed clinical decision-making, and expand access to care, AI is expected to be a powerful tool in addressing the challenges facing Indonesia's healthcare system. However, to achieve its full potential, further research and collaboration among various stakeholders are needed to ensure that this technology is implemented safely, effectively, and ethically. Indonesia has an excellent opportunity to become a leader in the application of health technology in the Southeast Asia region.

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