Application and Challenges of Artificial Intelligence in the Care of Stroke Patients

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Abstract: Driven by the combined forces of social aging and digital transformation, the application of artificial intelligence (AI) in the care of stroke patients has become an inevitable trend. AI can serve patients through intelligent health monitoring, rehabilitation training assistance, and daily care, providing targeted and intelligent support that significantly improves patients' quality of life and the efficiency of caregivers. This article provides an overview of the application of AI in stroke care, explores the challenges encountered in technical bottlenecks, privacy data protection, and ethical considerations, and lays a theoretical foundation for the integration of AI into the care of stroke patients. In the future, AI will rely on technological updates, policy support, and ethical guidelines to promote sustainable development in the nursing industry.

Keywords: Artificial intelligence; Stroke; Intelligent health monitoring; Technical bottlenecks; Data privacy

1. Introduction

Stroke, commonly known as a "brain attack," is a major global public health issue and a serious acute cerebrovascular disease that threatens the health of Chinese citizens [1]. The "China Stroke Center Report 2022" indicates that stroke is characterized by high incidence, high prevalence, high mortality, and high recurrence rates [2]. Patients often experience impairments in movement, sensation, cognition, speech, urination, and defecation, as well as a decline in self-care ability [3]. In recent years, China has made some achievements in the care of stroke patients, but there are still challenges such as the lack of continuity in patient care services, poor rehabilitation effects, and the absence of psychological care. The application of AI technology has brought new solutions to these difficulties. This article aims to summarize the current status of AI application in stroke care, analyze the difficulties encountered, and provide an outlook on future development trends.

2. Artificial Intelligence

The term "Artificial Intelligence" (AI) was first proposed by McCarthy at a conference proposal held at Dartmouth

College in 1955, and its concept was defined as a new discipline [4]. AI refers to the simulation, extension, and expansion of human intelligence through computers to achieve abilities similar to human thinking, decision-making, language understanding, etc., exhibiting behaviors similar to humans [5]. In recent years, AI technology has continuously developed, integrating knowledge and disciplines from multiple fields, including medicine, computer science, statistics, mathematics, and others. It not only meets humans' needs for improved quality of life but also replaces or assists humans in completing complex tasks and solving problems faced by humanity. Currently, AI has penetrated into every aspect of human life, significantly changing lifestyles, improving quality of life, and ushering in an era of intelligence.

3. Application and background of AI in medicine

With changing lifestyles and the intensifying aging population, there has been an explosive growth in the number of disabled or semi-disabled elderly, rehabilitation, disabled, and chronic disease groups, leading to an upward trend in medical demand. China has elevated AI to a national strategy. In 2021, the State Council issued the "Opinions on Promoting the High-Quality Development of Public Hospitals," which clearly proposes promoting the construction of a "three-in-one" smart hospital integrating electronic health records, smart services, and smart management, elevating the integration of AI and healthcare to the national level [6,7]. In recent years, AI has developed rapidly in the medical industry, with applications in intelligent health monitoring, intelligent rehabilitation training and assistance, and daily care. This has significantly improved medical efficiency, reduced the workload of caregivers, and brought transformative and innovative changes to the nursing model. Through big data analysis, AI utilizes machine learning and intelligent rehabilitation monitoring equipment, significantly improving patients' rehabilitation effects. This fully demonstrates the potential and broad development prospects of AI application in the field of stroke care.

4. Current status of AI application in stroke patient care

4.1. Intelligent health monitoring

4.1.1. Vital data collection

Traditional vital data collection relies on pulse diagnosis methods, relying on the experience and knowledge of caregivers, which can easily lead to misjudgment. However, intelligent devices such as smart bracelets and watches, supported by high-precision sensors and advanced detection technology, can monitor patients' heart rate, blood pressure, blood sugar, blood oxygen saturation, and pulse at any time, efficiently and accurately collecting vital data [8,9]. Previously, vital data was primarily recorded through manual paper documentation by caregivers, which was then entered into a computer and transmitted to the hospital information system. This process was time-consuming and prone to errors [10]. Currently, an artificial intelligence voice recording system is applied to input vital signs data from hospitalized patients into the hospital information system, reducing the time required for data entry [11]. The reduction in time spent on vital data collection benefits patient safety. Additionally, the application of AI has significantly improved the accuracy of data collection and reduced the workload of caregivers [12].

4.1.2. Disease risk warning

Utilizing deep learning and machine learning algorithms, AI technology can automatically extract features from

medical images such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). This enables quantitative analysis of lesion size and location, aids in predicting disease progression trends, and facilitates early detection and intervention [13]. Post-surgical patients wearing smart devices can promptly predict bleeding conditions and infection risks, informing caregivers to take intervention measures and avoid the risk of secondary stroke. Stroke patients often experience confusion and weakened sensory function, leading to local tissue compression. Monitoring patient turning frequency and compression situations using smart beds can effectively prevent pressure injuries.

4.1.3. Health status evaluation

Previously, patient health assessments relied heavily on subjective observations by medical staff. Nowadays, AI motion capture technology allows for comprehensive evaluations of patients' gait, movement trajectories, strength, and other aspects, providing scientific guidance for their rehabilitation training [14]. Many patients experience language dysfunction, such as aphasia, after onset. AI's speech analysis tools can analyze various dimensions of patient speech, including vocabulary and speaking rate, to accurately assess the degree of language impairment and assist caregivers in developing more reasonable care plans [15]. Stroke patients often experience anxiety and depression due to impaired physical function and psychological stress. AI's facial recognition technology can detect patients' emotional fluctuations, facilitating timely psychological counseling by caregivers and helping patients maintain a positive attitude during rehabilitation [16]. AI's motion capture, language analysis, and facial recognition technologies have ushered in a new era of health assessment for stroke patients.

4.2. Intelligent rehabilitation training and assistance

4.2.1. Personalized rehabilitation

By analyzing patients' psychological changes, physiological conditions, and behaviors, AI creates assistive technologies such as Brain-Computer Interfaces (BMI), Virtual Reality (VR), and rehabilitation robots to achieve personalized rehabilitation programs and training plans for patients [17]. Through digital model algorithms, AI comprehensively evaluates patients' individual basic conditions and then uses BMI technology, VR motion-sensing games, and other methods to recognize patients' movement intentions and formulate personalized plans [18]. This not only completes rehabilitation training for stroke patients but also adds fun, promotes the recovery of limb movement function, and improves the effectiveness of rehabilitation treatment [19,20].

4.2.2. Cognitive impairment training

Stroke can cause neurological deficits, leading to cognitive dysfunction such as agnosia, apraxia, memory impairment, and visuospatial disorders, which have a significant impact on patients' lives [21]. Healthcare workers utilize AI-assisted cognitive training, remote rehabilitation systems, and companion robots as new methods to help patients with cognitive rehabilitation training and improve their quality of life [22–24].

4.2.3. Smart health education

Through AI video information technology, mobile applications, and virtual classrooms, disease-related health knowledge can be conveyed intuitively and vividly, thereby enhancing patients' awareness of the disease [25]. Smart health education technology imaginatively elucidates key knowledge points, which not only improves patients' cognitive level of stroke but also enhances the work quality of nursing staff [26].

4.3. Smart daily care

Relying on smart devices and precise algorithms, AI can provide prompts and guidelines tailored to patients' exercise levels, excretion patterns, and nutritional intake after comprehensively considering their self-care abilities and physical parameters. Currently, the probability of malnutrition among acute stroke patients reaches 36%, which increases the risk of complications and subsequently leads to a rise in mortality rates [27,28]. Therefore, it becomes crucial to provide care for patients in their daily lives. AI-dynamically adjusted dietary plans for patients can prevent malnutrition and related complications [29]. Additionally, smart assistive technologies can help stroke patients complete daily activities such as moving from bed to chair, dressing, and eating, effectively reducing the workload of family members and caregivers [30].

5. Challenges faced by artificial intelligence in stroke care

5.1. Technical bottlenecks

Currently, intelligent rehabilitation robots lack flexibility and precision in complex environments, making it difficult to meet diverse care needs. Life support equipment, on the other hand, needs improvement in force control to avoid causing secondary harm to patients [31]. Therefore, AI systems for stroke patients should have diverse functionalities to enhance their comprehensive capabilities.

5.2. Data privacy and security issues

During the nursing process, AI collects a large amount of sensitive data related to patients. If there are loopholes in the data storage process, data leakage, alteration, or misuse will likely occur, leading to serious security incidents. Therefore, to avoid the risk of patient privacy leakage, medical staff should carefully store health data to prevent data leakage and misuse [32]. Moreover, AI developers should develop robots in accordance with legal regulations and should not embed their own biases or values into robot algorithms to avoid unexpected data situations that could lead to adverse consequences for patient care decisions, infringe on patient rights, and delay treatment progress [33].

5.3. Ethical dilemmas

Overreliance on AI by humans may weaken the emotional connection between patients and their family members, leading to ethical controversies. Although some nursing robots can provide continuous companionship and care for patients, they cannot fully understand patients' emotional needs and psychological states like nursing staff, and cannot provide emotional support to meet patients' emotional needs [34,35].

6. Conclusion

The application of artificial intelligence in stroke care has significantly improved nursing efficiency and quality, providing patients with precise and personalized nursing experiences. However, challenges in technology, privacy, and ethics still need to be further addressed. In the future, collaboration between researchers, healthcare teams, and policymakers is needed to overcome the technical bottlenecks of AI and provide comprehensive, high-quality nursing services to patients, improving their prognosis and quality of life.

Disclosure statement

The authors declare no conflict of interest.

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