The Application Benefit of Stroke Early Warning Technology in Elderly People at Risk

Xiurong Zhang*, Yuan Xie, Yongping Yang

The Second People's Hospital of Yibin City, Yibin, Sichuan, China

Abstract: Stroke is one of the major diseases threatening the health of the elderly. Early warning is very important to reduce the risk of its occurrence and recurrence. The early warning system combines epidemiological and clinical data to monitor biomarkers, clinical indicators and lifestyle factors to effectively predict and prevent stroke. Modern technologies such as biomarker detection and artificial intelligence algorithms have advantages in early warning, but their applicability and accuracy need to be verified. While traditional methods rely on doctors' experience and basic physical examinations, modern technologies require a large amount of accurate data to support them. In order to reduce the incidence of stroke, regular monitoring of high-risk groups, risk assessment and precise intervention are recommended. Future research should explore technological innovation, build a comprehensive health management system, and strengthen policy support and public health education to improve the health management level of the elderly.

***Keywords*:** early warning of stroke, elderly at-risk population, biomarkers, artificial intelligence, health management

1. Introduction

Stroke is a major global public health problem, with high rates of morbidity, disability and mortality, especially in the elderly population. Early warning and prevention are critical to reducing the health burden of stroke, and a variety of early warning technologies and approaches are available[1]. Older people are more susceptible to stroke due to age and chronic disease, and risk can be detected early through a combination of biomarkers and clinical indicators[2-3]. AI technologies show potential for identifying at-risk individuals and optimizing early warning models, but their application faces applicability, privacy and operational challenges[4].The purpose of this study was to evaluate the application benefits of existing early warning technologies in elderly at-risk populations, and to propose recommendations and strategies for future research.

2. The importance of early warning of stroke

2.1 Overview and hazards of stroke

Stroke, also known as cerebrovascular accident, is an acute disease caused by the interruption or reduction of blood supply to the brain, which is divided into two major categories: hemorrhagic and ischemic. It is one of the leading causes of death and disability worldwide, posing challenges to public health. In China, stroke causes 2 million new cases and over 1.5 million deaths annually, resulting in economic and care burdens [5].Stroke is not only a medical problem, but also a social problem, with patients often suffering from language, motor and cognitive impairments that affect quality of life. Early warning and prevention strategies are critical to reducing morbidity and healthcare expenditures.

2.2 Definition and characteristics of elderly at-risk groups

The incidence of stroke is high in the elderly, mainly due to chronic diseases and poor lifestyle. Elderly people aged 65 and above account for the majority of patients. Hypertension and diabetes are risk factors for stroke. Elderly people often have problems such as lack of exercise, improper diet, smoking and drinking, which increase the risk of stroke[6]. Therefore, early warning and intervention for older adults is essential to reduce stroke risk.

2.3 Necessity and benefits of early warning

By identifying biomarkers and symptoms, early warning systems can detect

the risk of stroke before it occurs and take preventive measures. This is especially important for older people, who are more vulnerable to serious health effects. Early warning can help reduce stroke incidence, improve outcomes, and reduce sequelae. Clinical studies have shown that early screening and early warning can significantly reduce the incidence and recurrence of stroke. Measures include managing high blood pressure, controlling blood sugar and lipids, and encouraging healthy lifestyles. Early

warning can also prompt healthcare systems to intervene earlier, improving the timeliness and effectiveness of interventions and reducing the need for long term care. The early warning mechanism combined with artificial intelligence can improve the accuracy and efficiency of early warning, which is of great significance to high-risk groups and effectively supplement medical resources. Therefore, the implementation of early warning for stroke in the elderly is of great importance to both individual and public health management.

3. Current status of stroke early warning technology

Stroke is an acute cerebrovascular disease, which poses a threat to the health and life of the elderly. Early warning technology is essential to improve patient outcomes. Currently, these technologies include biomarker detection, clinical indicator monitoring and artificial intelligence applications, which together form an early warning system to support early intervention and treatment decisions.

3.1 Current approaches to early warning

Stroke early warning methods can be divided into traditional and modern technologies. Traditional methods rely on history analysis, imaging and neurological tests to provide a basic but preliminary diagnosis. Modern techniques such as Doppler ultrasound to monitor hemodynamics have improved the accuracy and efficiency of early warning, while MRI and CT techniques have provided high-resolution evidence of abnormal changes in the brain.

3.2 Application of biomarkers and clinical indicators

Biomarker detection is becoming increasingly important in the early warning of stroke. These markers, including proteins, nucleic acids and metabolites, can reveal pathological changes associated with stroke, provide early clinical indications, and monitoring these markers can help identify high risk patients for prospective management[7-8]. Meanwhile, an early warning system based on vital signs data, such as blood pressure and blood sugar, monitors stroke risk in real time through dynamic models. These models are combined with health record data and use multivariate analysis to improve prediction accuracy. This method is non-invasive and easy to operate, and is suitable for community screening and home monitoring.

3.3 The role of artificial intelligence in early warning

Using machine learning and deep learning algorithms, AI technology can extract patterns from medical data to predict stroke risk. It has excelled in processing medical data and identifying hidden risks, and has been used to develop risk prediction models, such as big data risk scoring systems[9]. These systems integrate a variety of information, accurately calculate stroke risk, and provide personalized intervention recommendations. The accuracy and efficiency of AI in medical imaging analysis also exceed traditional methods to support clinical decision making. Nevertheless, improving the accuracy and accessibility of stroke early warning technology will require continued efforts in technological innovation, interdisciplinary collaboration and health management strategies [10].

4. Problems faced by early warning of stroke in elderly at-risk population

The elderly are prone to stroke due to physiological degradation and a variety of chronic diseases, and are faced with challenges in early warning. Although modern technology has improved the possibility and accuracy of early warning, many problems still need to be solved when applied to the elderly.

4.1 Applicability and accuracy of early warning model

The development of stroke early warning models depends on advances in epidemiology and machine learning techniques[11]. The physiological and pathological complexity of the elderly population poses challenges to these models. Traditional models, based on static risk scoring systems, fail to fully consider the dynamic changes in individual risk factors, especially in the elderly, where multiple factors may affect the accuracy of results. To improve accuracy, researchers have begun to collect more detailed physiological data, such as continuous blood pressure and blood sugar monitoring data, to better reflect patients' health status and potential risks. Combining dynamic monitoring data and biomarkers to build personalized risk assessment models may effectively improve the accuracy of early warning. However, this approach is more dependent on technology and data acquisition equipment, and requires higher requirements in the clinical environment[12].

4.2 Data sources and privacy issues

In order to improve the reliability and accuracy of the stroke early warning model, a large amount of data is needed, such as patients' physiological parameters, living habits, and genetic information. However, data collection,storage and use

face privacy issues, especially in the elderly population. Establishing a trusted data management system with measures such as anony mization and data encryption is key to preventing privacy breaches. Meanwhile, ensuring the lawful use of data and informed consent of patients is crucial to protecting the data privacy of the elderly population. This requires further legal and ethical research to ensure that data use brings benefits to patients while not violating privacy.

4.3 Feasibility and accessibility of the technical operation

Although intelligent early warning technology has advantages, its complexity and high cost limit its popularization. High-end devices are mainly used in large hospitals and it is difficult to promote them at the grassroots level. Simplifying operations, developing friendly interfaces and training medical staff are key. Modular designs and wearables show promise. For example, small and medium-sized hospitals are using portable monitoring devices to analyze data through cloud computing, reducing dependence on professionals and improving decision-making efficiency. Despite the technology's potential in risk management, practical applications face challenges. In the future, issues of technological adaptability, data privacy protection, device operability and accessibility need to be addressed, and multiple parties should participate in promoting the clinical use of technology to improve the health management and prognosis of the elderly population.

5. Comparison and analysis of different early warning methods

5.1 Comparison between traditional methods and modern technologies

Traditional stroke early warning methods, including physical examinations, questionnaires and basic biomarker detection, are simple and low-cost, but rely on healthcare worker experience and have limited accuracy. They mainly test for known risk factors, take insufficient account of individual differences, and make it difficult to track changes in disease[13-14]. Modern technologies such as improved early Warning scoring systems (MEWS), advanced imaging techniques and artificial intelligence algorithms based on machine learning can analyze multiple biomarkers in greater detail, combining clinical data to provide accurate risk assessments. For example, integrated assessment methods of imaging and serum biomarkers can identify high-risk individuals before symptoms, improving the sensitivity and specificity of early warning[15].

5.2 Analysis of advantages and disadvantages of each approach

Traditional methods are widely used in stroke risk assessment in resource limited Settings, but lack individualization and accuracy, making it difficult to identify latent high-risk individuals. Modern technologies provide early warning through bioinformatics and big data analysis, and can process complex data sets to identify undetected risk factors and improve accuracy. But they are costly, require strict equipment, and raise data privacy and ethical concerns.

6. Research conclusions and suggestions

6.1 Overall evaluation of early warning technology

In recent years, the early warning technology of stroke has made remarkable progress, significantly improving the ability to detect events in high-risk populations. Through risk assessment tools, early warning scoring systems such as NEWS and MEWS, and biomarkers, clinicians are able to identify high risk patients in a more timely manner and implement early medical intervention. For example, the MEWS scoring system has shown effectiveness in primary hospital management and is of great valuein high-risk and critically ill patient management[16]. Combined with imaging analysis and AI-driven predictive models, we have made significant progress in identifying invisible stroke risk, improving diagnostic accuracy and reducing omissions from routine tests. Nonetheless, early warning technology still faces data processing, cost-effectiveness and standardization issues when applied on a large scale, and needs to be further optimized and standardized.

6.2 Suggestions and reflections for future research

Future research should improve the accuracy and personalized application of early warning models. Iteration of machine learning and artificial intelligence as research tools can improve the adaptability and accuracy of risk prediction models, integrate multi-dimensional data to build comprehensive prediction models, and support precision medicine. Strengthen multi-center research and international cooperation, promote technology transfer and sharing, narrow the technology gap, and realize the global application of early warning technology. Research also needs to introduce real-time monitoring and remote health management methods to improve the health management of patients with chronic diseases and the elderly[17]. Along with technological innovation, it is also crucial to study its long-term effects.

6.3 Implications and suggestions for the health management of elderly risk groups

To establish a comprehensive health monitoring system for the elderly at risk, the key lies in early identification and

management of risk factors, so as to reduce the incidence of stroke and improve the quality of life[18]. It is recommended to popularize health education, strengthen daily monitoring and guidance, and communities and families should use convenient facilities to track basic health indicators, such as blood pressure and blood sugar, and have regular physical examinations. At the same time, it is necessary to comprehensively manage nutrition, psychology, rehabilitation exercise, etc., to form a health care plan. We should promote cooperation between community health service centers and large hospitals, form a two-way referral and information sharing mechanism, and quickly provide necessary medical resources. This multi-faceted early warning and management model can help improve the elderly's ability to live independently, reduce the incidence of stroke and improve prognosis.

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