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Construction of a Health Management Model for Early Identification of Ischaemic Stroke in Cloud Computing

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Abstract: Knowledge discovery and cloud computing can help early identification of ischaemic stroke and provide intelligent, humane, and preventive healthcare services for patients at high risk of stroke. This study proposes constructing a health management model for early identification and warning of ischaemic stroke based on IoT and cloud computing, and discusses its connotation, constructive ideas, and research content so as to provide reference for its health management in order to develop and implement countermeasures and to compare the awareness of early stroke symptoms and first aid knowledge among stroke patients and their families before and after the activity. The rate of awareness of early symptoms and first aid among stroke patients and their families increased from 36% to 78%, and the difference was statistically significant ($P < 0.05$) before and after the activity.

Keywords : Knowledge discovery, ischaemic stroke, IoT, Cloud computing

1. Introduction

To encourage early symptom recognition and first aid expertise, the departments of emergency medicine and neurology developed a health education team. A clear line of responsibility and standardised teaching materials also produced a conducive environment for instruction [1-3]. The "Green Health" WeChat public number was also established to spread awareness of stroke and first aid through the Internet in the form of graphics and videos, which not only improved the quality of education on stroke

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disease and first aid knowledge but also expanded the publicity channels and supported the promotion of education of stroke patients and their families on stroke disease and first aid knowledge. This is conducive to the homogenisation of stroke patients' and families' knowledge of stroke disease and first aid, and can improve the effectiveness of education [4–6].

WeChat is a new communication tool that not only transcends time and space but also allows for the instantaneous dissemination of new knowledge and information, enabling interactive communication between healthcare professionals and patients and their families [3], increasing the level of knowledge of stroke disease and first aid among patients. Stroke patients and their families can learn about stroke disease and first aid at anytime, anywhere by using WeChat.

A combination of leaders, technicians, and employees carry out quality management in an instinctive and spontaneous manner at the workplace or in connected areas [8], and people feel a feeling of ownership and accomplishment in their work [9]. At the same time, circle activities boost team morale, motivate circle participants, and advance the advancement and development of the stroke patient team. Therefore, quality management circle activities can enhance each member's capacity for work and encourage the formation of teams for stroke patients [10].

In conclusion, the implementation of quality management circles not only helps stroke patients and their families recognise early signs, but also maximises each circle member's potential, enhances each person's capacity for work, and supports the growth of the stroke patient workforce.

2. Stroke Management Model

A. Internet of Things

The Internet of Things (IoT) management approach is built on IoT technology, which has superior bionic properties. It is an effective tool for advancing societal progress, broadening human thought, and releasing human labour. In conclusion, the Internet of Things (IoT) management model is a four-sided linkage between the sensing side (radio frequency identification, sensors, etc.), the transmission side (Internet, mobile Internet, and 5G technology, etc.) [1], the cloud side (cloud computing, big data technology, artificial intelligence, etc.), and the application side (different network platforms), with each side integrating technological innovation, management innovation, and institutional innovation to form a framework.

The transmitting end functions as both the IoT management model's foundational layer and the required information exchange gateway in both the model's virtual and physical worlds [14]. In other words, the information technology primarily depends on its various sensing devices that identify and capture information, such as radio frequency identification (RFID) technology and wearable devices. The sensing side is the input side of the IoT management model system, which directly affects the environment.

The "brain" of the Internet of Things management model is the cloud, which depends on robust comprehensive analytic functions to continuously output power for the model's survival [15]. The cloud conducts a thorough analysis using contemporary information technology after receiving the data gathered by the sensing end and using big data technology and management cloud computing. Decision-makers may concentrate on making wise choices thanks to this approach, which frees them from the laborious task of information analysis [16]. The IoT management model's "trinity" innovation system, with its "four-end linkage" organisational structure, only serves as a realistic framework for the IoT management model. “Trinity” system guarantees to clear the realistic obstacles for the IoT management model [17–19].

B. Health Management

Comprehensively managing a person's or a population's health risk factors is known as health management [20]. Through the collection of health information, testing, assessment, individualised health management plans, and health interventions, professionals carry out this process to enable individuals to receive comprehensive health maintenance and protection services in multiple dimensions, including social, psychological, environmental, nutritional, and exercise [21].

3. Building Ideas

Data collection: Lower limb muscle monitors, voice recognition technology, and other sign monitoring equipment are used to capture the signs of patients who are at risk of stroke [22]. Operation and monitoring: The stroke cloud platform organises the data into a database for monitoring, calculation, and analysis. The data are wirelessly transferred to the user's terminal access device and application software. The monitored indicators will send out an alert signal through GPS whenever they hit the threshold, and medical personnel will respond right away to make sure the stroke sufferer receives treatment within a limited and crucial window of time (see Figure 1).

To achieve partial encryption of medical stroke patient privacy information based on cloud computing, a data transfer model for encrypting medical stroke patient privacy information is constructed in a finite domain [23]. The ciphertext transfer protocol is

Decrypt t (sk, c*)A−1 = T = ( ), the encrypted transfer control of the medical stroke patient privacy information system is performed using public key cryptography, the system master key is constructed, and the dynamic key for encrypting medical stroke patient privacy information safely is as follows:

$$TA = (\quad)(\quad) \tag{1}$$

The unscripted data in the medical stroke patient privacy information are authorised to be encrypted using a random variable signed encryption algorithm using the security parameter as input. Additionally, a user authentication protocol for encrypting medical stroke patient privacy information is established, an encapsulation protocol for partially encrypting medical stroke patient privacy information is built [24], and the entropy and minimum entropy for encrypting medical stroke patient privacy information are calculated.

$$\begin{aligned} &\text{Decrypt}\,(\text{sk}, c^*)A(\alpha_1, \ldots, \alpha_m)\left(A^{-1}\right)^{\left(\alpha_1^{-1},\ldots,\alpha_m^{-1}\right)^{T}} \\ &= \left(\alpha_1^{-1}t_{1,1}, \ldots, \alpha_m^{-1}t_{m,m}\right)\left(\alpha_1 a_{1,1}, \ldots \alpha_m a_{m,m}\right) \\ &= E. \end{aligned} \tag{2}$$

The security parameter K and symmetric key K of medical stroke patient privacy information encryption are entered for the identity user, taking into account the randomness of the output certificate, and the Through the key expansion method, the key expansion sequence.

$$X = \ ,\quad ,\ldots,$$

Of medical stroke patient privacy information is obtained. The method of p-order cyclic group mapping is adopted. The weighted vectors ⃗ and ⃗ of medical stroke patients' privacy information with a length of √ bits are generated, and the encrypted ciphertext sequence of medical stroke patients' privacy information is = , , . . . ,+ .

The user IDi and message M are entered, and the following equation shows the ciphertext of layer $L + 1$ of medical stroke patients' privacy information transmission data:

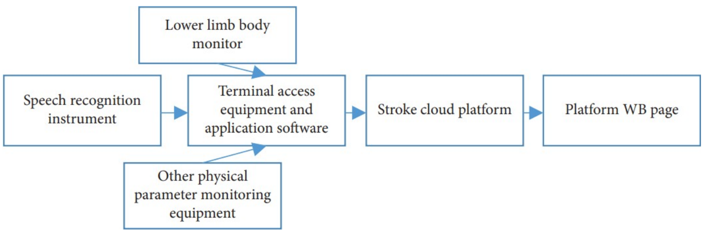

Figure 1. IoT and cloud-based health management model for early identification and warning of ischaemic stroke.

$$\text{Decrypt (sk, } c^*) \quad = (\qquad) = E \tag{3}$$

Using the keyword encryption algorithm, the user ID_i private key sk_{IDi} and two identities ID_i, ID_j are entered and the output sequence of plaintext medical stroke patient privacy information is as follows:

$$\text{Decrypt}\left(\text{sk}, c^*\right)\left[A\left(\alpha_1, \cdots, \alpha_m\right)\right]^{-1} = \begin{pmatrix} \alpha_1^{-1} & t_{1,1}, & \cdots, \\ \alpha_m^{-1} t_{m,m} & = \left(A^{-1}\right)\left(\alpha_1^{-1}, \ldots, \alpha_m^{-1}\right)^{\mathrm{T}}. \end{pmatrix} \tag{4}$$

Figure 2 displays the final arithmetic coding model for scrambling personal data of stroke patients. In order to construct an arithmetic coding model and create a key for stroke patient privacy information, this research suggests a cloud-based data encryption technique [25].

$$\begin{aligned} P - \text{value} &= 2 + \frac{1}{\varphi\left(S_{\text{obs}}\right)} \\ &= 2 + \left(1 - 2\pi \sum_{-\infty}^{\text{Sobs}} \mathrm{e}^{-2u^2}\right) = 3 - 2\pi \sum_{-\infty}^{\text{Sobs}} \mathrm{e}^{-2u^2}. \end{aligned} \tag{5}$$

The decrypted private key of IDi is used for key resigning to obtain a statistic P value ≥ 0.01 for the decrypted key, and the transformed ciphertext is processed for cloud information fusion when it satisfies KS ∈ { } 0, 1, by generating four empty lists H1 − list, H2 − list, ds k − list, and rsk − list to obtain a linear encoding distribution function for the privacy information of medical stroke patients, as shown in the following equation:

$$f^{-1}(I) = \begin{cases} p + I, & s = 0, \\ \dfrac{1}{(1 + p) * I'} & s = 1, \end{cases} \tag{6}$$

Where I denotes the private key of the medical care private message sender; the initial value I = [0, 1] is set, f is rewritten as ∑ to obtain the feature vector , the public key of the medical care private message transmission private key is calculated to obtain the medical stroke patient privacy information encryption and decryption protocol [24, 26]. ∈ * is randomly selected to achieve key construction of private information for medical stroke patients, as shown in Figure 3.

4. Case Studies

A. Object

For the preprotocol circle activity, 110 stroke patients and their families who visited the Emergency Medicine and Neurology Departments between 18 March 2020 and 18

April 2020. were chosen, and 110 stroke patients and their families who were admitted to the hospital between 25 April 2020 and 25 June 2020 were chosen for the postprotocol circle activity.

With a 23.7% awareness rate of stroke warning symptoms, stroke patients and their families have limited knowledge of stroke risk factors and early warning indicators [27]. The majority of stroke patients in China postpone receiving treatment at the best time possible because they do not recognise stroke symptoms at an early stage, which has a significant impact on the prognosis and result of stroke patients. In order to improve stroke patients' ability to recognise stroke symptoms and their knowledge of first aid, as well as to enable them to seek timely medical attention and receive effective treatment, the theme of this campaign is to raise awareness of early warning for stroke patients and their families [28].

B. Results

Based on the following equation: target achievement rate = (post improvement data – pre improvement data)/(target value – pre improvement data) x 100%, resulting in a target achievement rate of 116.7%, the awareness rate of patients and family members about early stroke symptoms and first aid was 78% after the campaign's implementation. Table 1 displays how stroke victims and their families were informed about early stroke symptoms and first assistance both before and after the incident.

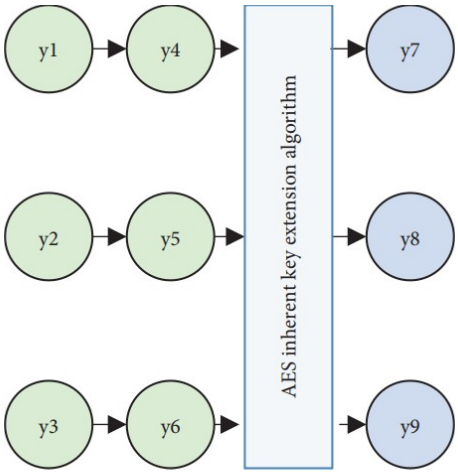

Figure 2. Arithmetic coding model for encryption of private information of medical stroke patients.

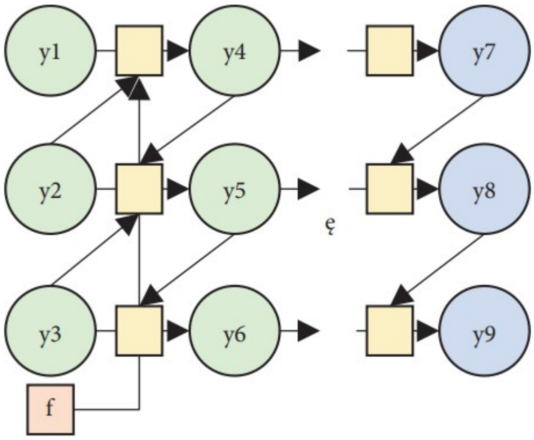

Figure 3. Key design for private information of medical stroke patients.

Table 1. COMPARISON OF STROKE PATIENTS' AND FAMILIES' KNOWLEDGE OF EARLY STROKE SYMPTOM RECOGNITION AND FIRST AID.

Time	Number of people	Know (person)	Awareness rate (%)
Before development	110	40	36
After development	110	86	78

The circle members have improved in their application of quality control procedures, sense of teamwork, sense of responsibility and honour, communication and coordination, motivation, logical reasoning, professional knowledge, and personal potential, particularly in the last two areas (see Figure 4).

5. Simulation Test Analysis

Based on the aforementioned parameter choices, the time-domain distribution of the original encrypted data was achieved [29, 30] and the partial encryption of sensitive data pertaining to medical stroke patients was acquired.

In order to partially encrypt the personal data of stroke patients, the data in Figure 5 was used as the study object. The outcomes of the partial encryption are shown in Figure 6, along with the results.

The partial encryption of the private information of medical stroke patients using the method described in this research can be accomplished successfully and with good encryption resistance to attacks, as demonstrated by an analysis of Figure 6. As stated in Table 3, the encryption depth was evaluated, and comparison results were produced.

According to Table 3, the test results obtained by using this paper for the encryption depth of medical stroke patients' privacy information are higher than those obtained by using traditional methods when the number of iterations is 100, 200, 300, 400, etc., and when the number of iterations is 400, the encryption depth of medical stroke patients' privacy information by using this paper is as high as 400 dB. Both the encryption depth and the attack resistance of the encryption have increased.

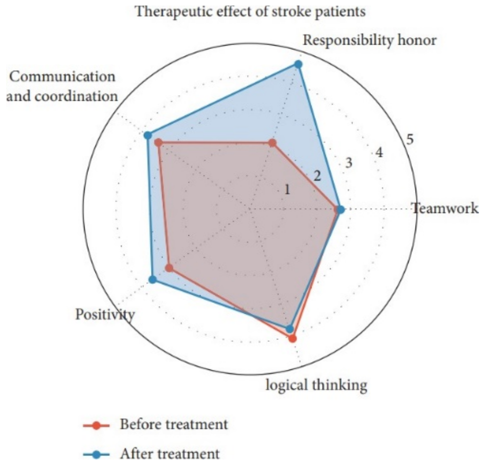

Figure 4. Five star result radar map.

Table 2. EXPERIMENTAL PARAMETER SETTINGS.

Parameter setting	tmax	M	L	Pm	Pc
Parameter value	12	26	13	0.45	0.79

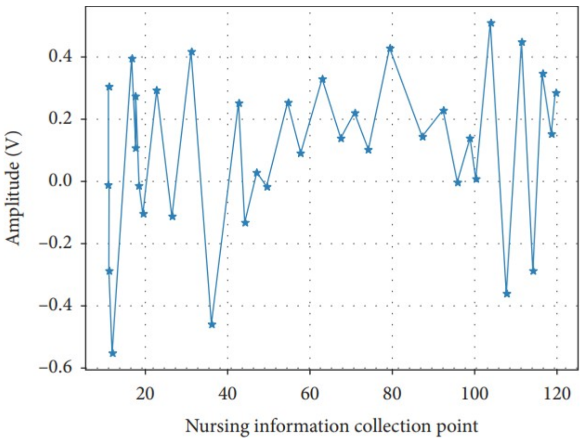

Figure 5. Time-domain distribution of data encryption.

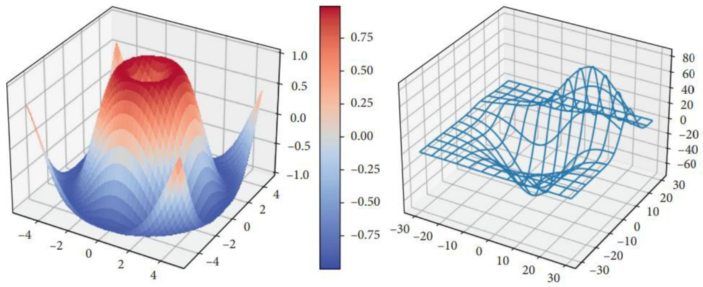

Figure 6. Encrypted data output.

Table 3. MEDICAL STROKE PATIENT PRIVACY INFORMATION ENCRYPTION DEPTH TEST.

Iterations (time)	This method/dB	Reference [4] (dB)	Reference [5] (dB)
100	13.57	8.21	11.76
200	24.75	11.46	13.54
300	32.44	15.53	22.53
400	42.65	20.46	25.57

6. Conclusions

Stroke incidence is rising right now, yet it's concerning how early stroke identification is being implemented. With an attendance rate of roughly 60%, the delay in admitting stroke patients is problematic. There is an urgent need to enhance the process of identifying ischemic stroke patients early. The use of this model, which consists of voice and muscle force acquisition sensors, network data storage, cloud processing, mobile cloud clients, and network transmission, can identify ischaemic stroke patients who have just experienced a stroke accurately and promptly at any time or location and send out timely alerts via the Internet of Things and cloud platform [29, 30].

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