

Research on the Application of AI Computer-Aided Diagnosis in Dermatology

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Abstract: With the development of artificial intelligence technology, AI computer-aided diagnosis has found certain applications in the field of dermatology. However, due to the vast variety and complex manifestations of skin diseases, the specific mechanisms underlying AI computer-aided diagnosis in this context still require further exploration. Therefore, this paper, based on the imaging characteristics of skin diseases, elucidates the technical principles of AI computer-aided diagnosis and analyzes the practical application effects of AI in the diagnostic process of skin diseases. This provides new data support and methodological foundations for clinical teaching and research on skin diseases.

Keywords: AI computer-aided; Skin disease diagnosis; Image recognition; Deep learning; Intelligent healthcare

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1. Introduction

Skin diseases are a category of diseases characterized primarily by visible lesions, with the lesions often directly presenting on the patient's skin surface and displaying distinct visual features^[1]. Typically, the onset of skin diseases is accompanied by changes in skin morphology, such as pigmentation, texture alterations, and abnormal blood flow distribution, which clinicians analyze to diagnose the patient's condition^[2]. This visually observable form can be precisely captured by high-resolution imaging techniques and transformed into quantifiable image information, providing a rich data foundation for artificial intelligence (AI) image recognition algorithms^[3]. Today, with the mature development of AI technology, the medical field has begun to introduce AI techniques that can assist in medical work to aid doctors in clinical tasks^[4]. Among the various directions in the medical field, dermatology is one of the earliest and most active areas of application for AI-assisted computer diagnosis. AI can utilize deep learning algorithms to train and recognize a large number of dermatological images, extracting subtle features to automatically identify, segment, and classify skin lesions, thereby reducing the uncertainty of manual judgment and improving the objectivity and reproducibility of diagnosis^[5]. A systematic exploration of the application principles and practical value of AI-assisted computer diagnosis in dermatology will contribute to improving the intelligent diagnosis and treatment system and enhancing clinical decision-making capabilities.

2. Technical analysis of AI-assisted computer diagnosis in dermatology

2.1. Mechanisms of dermatological diagnosis

Clinically, the diagnosis of skin diseases essentially involves establishing a stable correspondence between visible phenotypes and histopathological changes. Specifically, diagnostic clues that can be captured by imaging techniques are comprehensively formed by the color differences in appearance, texture and boundary morphology, as well as the thickness or layer changes of the lesions in the vertical direction^[6]. In recent years, the multimodal skin imaging system established in clinical medicine (including dermoscopy, confocal microscopy, high-frequency ultrasound, OCT, etc.) was precisely based on the information collection of these features at different scales and depths, and the mapping between morphology, tissue, and pathology is completed by comparison with pathology^[7]. Based on this logic, doctors can make accurate judgments according to reproducible and verifiable imaging and pathological evidence.

Generally, pigment and blood vessels serve as the primary basis for comparison in the diagnosis of most skin diseases. The underlying principle is that different wavelengths exhibit significant absorption differences with respect to melanin/hemoglobin, which results in certain color and contrast patterns in the formation of images^[8]. Further combined with polarization-suppressed reflection and multispectral imaging, subtle changes such as pigment deposition and vasodilation can be significantly highlighted, thereby making these subepidermal diagnostic clues easier to identify and quantify. Meanwhile, dermoscopy can clearly present the grid of the epidermis and papillary layer of human skin, as well as the pigment network and vascular morphology, before the doctor's eyes. Confocal microscopy imaging can advance the doctor's observation scale to the cellular level, enabling them to see details such as the arrangement of prickle layer cells or the interface of tumor nests. Furthermore, by integrating information on lesion thickness, boundary continuity, and hierarchical structure provided by high-frequency ultrasound and OCT, a comprehensive assessment of the lesion's infiltration depth and extent of invasion can be made. This series of procedures represents the fundamental logic of mutual reference between imaging and pathology in modern dermatological diagnosis.

Essentially, in the diagnosis of skin diseases, the clinical diagnostic process typically begins with visual inspection and dermoscopy for identification and screening of risky features, followed by verification of the structure and extent using imaging techniques with higher resolution or greater depth. Finally, pathological diagnosis serves as the gold standard for final comparison.

2.2. Technical principles of AI computer-aided diagnosis for skin diseases

The technical basis of AI computer-aided diagnosis for skin diseases lies in utilizing computer vision and deep learning algorithms to digitally model pathological features in skin images, followed by classification and recognition^[9]. Its technical system consists of three main stages: image information processing, feature modeling, and diagnostic result output.

2.2.1. Image information processing

The image information used for AI diagnosis refers to skin images that have been collected and preprocessed through a standardized procedure. The system captures reflection signals from the skin's surface and the superficial dermis across different wavelengths using a multispectral light source, polarized illumination, and a high-resolution imaging unit. The raw images collected undergo processing measures such as grayscale equalization, noise filtering, edge enhancement, and color correction to obtain a standardized image matrix $I(x,y)$. Subsequently,

the algorithm employs threshold segmentation or region growing methods to locate the lesion areas in the image, forming a binary mask $M(x,y)$.

2.2.2. Feature modeling

The preprocessed images were input into a convolutional neural network model, where feature extraction was performed using multiple convolution kernels $K\{i,j\}$ across multiple layers^[10]. Each layer's convolution and nonlinear activation function work together to achieve a step-by-step abstraction from low-level edge information to high-level semantic patterns, as shown in Equation (1):

$$(1) \quad f_{l+1} = \sigma(f_l * K_l + b_l)$$

Here, f_l represents the feature map of the l^{th} layer, and σ represents the nonlinear activation function.

Meanwhile, in the image recognition of skin diseases, architectures such as U-Net, DenseNet, and ResNet were employed for lesion segmentation and feature aggregation. Among them, U-Net utilizes a symmetric encoder-decoder structure to capture both global and local information, making it well-suited for images with blurred lesion boundaries. DenseNet enhances feature reuse through dense inter-layer connections, improving its ability to learn from small datasets. The model ultimately yields a high-dimensional feature vector $F = [f_1, f_2, \dots, f_n]$.

2.2.3. Classification recognition and result output

During the result output phase, the system matches the feature vector with the disease label space using a fully connected layer or a Softmax classifier, outputting the probability distribution $P(c_i|F)$ for each disease type. The most likely diagnostic category was then determined based on threshold evaluation.

Overall, AI-assisted computer diagnosis builds upon existing skin imaging techniques, leveraging computer technology to enhance diagnostic precision. It transforms skin features such as color, texture, and morphology, which doctors rely on for observation, into quantifiable data. By continuously learning these features through algorithms, it forms an information system capable of simulating human judgment. After extensive training and validation, AI can identify abnormal regions in complex or subtle lesion images.

3. Case analysis of AI computer-aided acne diagnosis

3.1. Research design

This study selected 986 acne patients diagnosed at the dermatology outpatient department of Zhuhai Jiulong Hospital from March 2023 to June 2025, including 621 males and 365 females, aged between 15 and 43 years. Imaging was collected from all patients during the stable phase of their condition, and they all signed informed consent forms. Facial standardized images were collected from each patient during their initial visit and follow-up, resulting in a total of 8,740 image samples and 986 videos.

Each patient was photographed from five fixed angles: frontal view, 45° left rotation, 45° right rotation, 30° upward tilt, and 30° downward tilt. After image acquisition, operations such as brightness equalization, white balance correction, noise suppression, and skin tone standardization were uniformly performed. Subsequently, two dermatologists with extensive clinical experience independently interpreted the images and labeled the skin lesion areas, primarily identifying common types such as closed comedones, open comedones, inflammatory papules, pustules, nodules, cysts, scars, and hyperpigmentation. Cases with discrepancies were reviewed by a third

expert to form a unified labeling result. The criteria for the doctor’s diagnosis were based on the “Chinese Acne Treatment Guidelines (Revised 2019 Edition),” with the condition classified into four grades: Grade I (comedonal acne), Grade II (papular acne), Grade III (pustular acne), and Grade IV (nodular/cystic acne).

3.2. Clinical application method of AI computer-assisted technology

The AI computer-assisted tool used in the study was an artificial intelligence model built around a convolutional neural network, trained using supervised learning methods. The training data consists of two-dimensional facial image matrices that have undergone preliminary standardization processing, which were then normalized and input into the network structure. The network parameters were initialized using the He uniform distribution, and the optimization algorithm employs the Adam adaptive learning rate method, with the initial learning rate set at 1×10^{-4} . The loss function utilizes cross-entropy loss, aiming to minimize the discrepancy between the model’s predicted results and manually annotated labels. The batch size was set to 32, and the number of iterations was 100, with validation set evaluation conducted after each round of training. Additionally, the model incorporates a multi-scale convolutional kernel structure in its intermediate layers, with kernel sizes of 3×3 , 5×5 , and 7×7 , respectively.

The data was divided into a training set (70%), a validation set (20%), and a test set (10%). During the training process, the model updates its weight parameters through the backpropagation algorithm, using the trend of the loss function on the validation set as the convergence criterion. When there was no significant improvement in the accuracy of the validation set for ten consecutive rounds, training was automatically terminated, and the best weights were saved. Subsequently, the input image undergoes the same preprocessing and normalization steps before entering the model’s forward propagation path, generating feature maps and outputting corresponding classification probabilities. The system generates a binary mask image at the output to mark the lesion area and calculates the lesion area and distribution ratio based on the prediction results. Based on the number, density, and distribution characteristics of skin lesions, the system outputs the acne grading result. In clinical validation, doctors manually interpret the same images and compare the final results of the two methods.

3.3. Primary application modes of AI computer-assisted technology

The performance of the AI system was compared with that of manual evaluation by doctors, as shown in **Table 1**.

Table 1. Comparison of performance between AI system and manual interpretation

Metric	Identification accuracy (%)	Recall rate (%)	F1 score	Grading consistency rate (%)	Kappa coefficient	Average interpretation time (s/image)
AI system	89.73	87.28	0.88	88.87	0.81	2.46
Human physician	90.62	88.19	0.89	90.05	-	39.72

From the results, the AI system achieved an average recognition accuracy of 89.73% and a recall rate of 87.28% in recognition tasks, with an F1 score of 0.88. Moreover, the overall consistency rate with the disease severity grading results assessed by doctors reached 88.87%, and the Kappa coefficient was 0.81, indicating a high level of agreement between the model’s results and manual interpretation.

Meanwhile, the grading comparison results for acne samples of grades I to IV were shown in **Table 2**.

Table 2. Consistency rate results for grading of acne samples of different grades

Severity grade	AI consistency rate (%)	Physician consistency rate (%)	IoU
Grade I	92.36	94.72	0.83
Grade II	89.54	92.27	0.81
Grade III	86.74	90.08	0.78
Grade IV	81.93	87.42	0.75
Average	87.70	91.12	0.79

It can be observed that the AI system demonstrated a high consistency rate with the doctor's assessment results for mild to moderate acne (grades I and II) samples, both exceeding 89%. For grade III and IV cases, the consistency rates were 86.74% and 81.93%, respectively, primarily influenced by variations in the extent of subcutaneous inflammation and lighting conditions. The average Intersection over Union (IoU) was 0.79, indicating good stability of the model in identifying lesion boundaries.

Overall, the AI computer-aided system exhibits stable recognition accuracy and grading consistency in acne image recognition and grading detection, with a high degree of agreement with the results of manual assessment by doctors, demonstrating technical reliability suitable for clinical validation.

4. Conclusion

In the past, the methods used in clinical dermatological diagnosis relied on doctors' clinical experience for judgment, and this approach is highly dependent on the doctors' professional expertise. As the medical field has now entered a new stage of digitization and intelligence, technologies such as artificial intelligence (AI) have begun to play a supplementary role, to a certain extent, in improving and complementing the traditional experience-based clinical medical practices. For skin lesions, their image characteristics offer a distinct visual advantage, which serves as the primary basis for AI computer-assisted technology to achieve accurate diagnosis in dermatology. In terms of effectiveness, AI technology can significantly enhance doctors' efficiency in interpreting images and provide more objective and traceable evidence for the diagnostic process. Compared to traditional diagnostic methods, AI technology merely plays a supplementary role; its value lies in the system's ability to quickly screen suspicious areas from a large number of images. The generated saliency heatmaps and feature analysis results can also help doctors focus on abnormal issues, thereby aiding them in making more precise judgments.

In summary, AI computer-aided diagnosis has already made the process of diagnosing skin diseases more standardized and quantifiable in the current modern hospital system, and has also provided doctors with a new dimension for diagnosis. In the future, with continuous improvements in data quality, algorithm reliability, and clinical validation, AI is expected to play a more stable and comprehensive supporting role in the diagnosis and treatment system for skin diseases, truly achieving deep integration between intelligent technology and medical clinical practice.

Disclosure statement

The author declares no conflict of interest.

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Detection Rate and Characteristic Analysis of Color Doppler Ultrasound for Papillary Thyroid Microcarcinoma

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Abstract: *Objective:* To investigate the detection rate and sonographic characteristics of color Doppler ultrasound in the diagnosis of papillary thyroid microcarcinoma (PTMC). *Methods:* A retrospective analysis was conducted on 50 cases of PTMC confirmed by postoperative pathology from January 2020 to December 2024, all of which underwent preoperative color Doppler ultrasound examination. The detection rate was calculated, and the two-dimensional ultrasound characteristics and CDFI manifestations were analyzed. *Results:* Among the 50 cases of PTMC confirmed by pathology, the detection rate of color Doppler ultrasound was 88.00%, and the diagnostic accuracy rate was 96.00%. Two-dimensional ultrasound characteristics: The mean lesion size was (6.83 ± 1.51) mm; 42 cases (84.00%) had irregular shapes; 45 cases (90.00%) had unclear boundaries; 46 cases (92.00%) had hypoechoic lesions; 38 cases (76.00%) exhibited microcalcifications; and 40 cases (80.00%) had an aspect ratio ≥ 1 . CDFI characteristics: The highest proportion was grade II, with 23 cases (46.00%); 39 cases (78.00%) had an RI ≥ 0.7 , and the average RI value was (0.75 ± 0.06) . *Conclusion:* Color Doppler ultrasound demonstrates a high detection rate for PTMC, with typical features including hypoechoogenicity, irregular shape, microcalcifications, and high RI, making it the preferred imaging modality for early clinical diagnosis of PTMC.

Keywords: Color Doppler ultrasound; Papillary thyroid microcarcinoma; Detection rate; Ultrasonic features

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1. Introduction

Thyroid cancer is the most prevalent malignant tumor in the endocrine system, with papillary carcinoma accounting for the highest proportion. Papillary thyroid microcarcinoma (PTMC), a specific subtype of papillary carcinoma, is defined as papillary thyroid carcinoma with a maximum lesion diameter of ≤ 10 mm. It is characterized by relatively slow growth and a lower degree of malignancy^[1]. However, some patients may experience lymph node metastasis in the early stages, which can significantly impact their prognosis. Due to the extremely small size of the lesions, conventional palpation is prone to missed diagnoses, making imaging exploration a crucial window

for detecting lesions. High-frequency color Doppler ultrasound, relying on its non-invasive, cost-effective, and repeatable advantages, has become the primary tool for evaluating thyroid nodules ^[2]. Its grayscale imaging can analyze morphological indicators such as nodule margins, echogenicity, and microcalcifications, while CDFI can further depict blood flow distribution and resistance parameters, providing quantitative evidence for determining whether a nodule is benign or malignant ^[3]. In recent years, there have been a relatively large number of studies on the diagnosis of papillary thyroid microcarcinoma (PTMC) using color Doppler ultrasound. However, variations in sample sizes, instrumentation, and diagnostic criteria across different studies have led to inconsistent reports on detection rates. Based on this, this study included 50 patients with PTMC who were admitted and treated, systematically analyzing the detection rate and characteristic manifestations of color Doppler ultrasound to clarify its diagnostic value. The specific content is as follows.

2. Materials and methods

2.1. General information

A retrospective analysis was conducted on 50 cases pathologically confirmed from January 2020 to December 2024. Gender distribution: 12 males and 38 females; age range: 28 to 65 years, with a mean age of (45.6 ± 8.21) years; the interval from discovery to surgery ranged from 1 to 12 months, with an average of (5.3 ± 2.14) months. Three patients sought medical attention due to palpable neck lymphadenopathy, while the remaining 47 cases were further evaluated after thyroid nodules were detected by ultrasound during routine health check-ups.

2.1.1. Inclusion criteria

- (1) Histologically confirmed PTMC with a maximum lesion diameter ≤ 10 mm postoperatively ^[4]
- (2) Color Doppler ultrasound examination conducted within 7 days before surgery, with complete data and images
- (3) No prior history of thyroid surgery, radiation, or chemotherapy
- (4) No history of concurrent malignant tumors

2.1.2. Exclusion criteria

- (1) Missing ultrasound records or poor image quality that prevented interpretation
- (2) Significant thyroiditis (such as active Hashimoto's disease) that limited imaging assessment
- (3) Pregnancy or lactation

2.2. Methods

The examinees were not required to fast and were placed in a supine position with their heads and necks hyperextended. A soft pillow could be placed under their shoulders to fully expose the anterior cervical region. The Philips IU22 color Doppler ultrasound diagnostic instrument was selected, with a probe frequency of 5–12 MHz. The scanning sequence included longitudinal, transverse, and oblique sections, systematically covering the bilateral glandular lobes and the isthmus. First, grayscale imaging was performed to record characteristics such as glandular volume, echo background, and the location, maximum diameter, shape (regular/irregular), margin (well-defined/ill-defined), internal echo (hyperechoic/isoechoic/hypoechoic/anechoic), presence of calcification (microcalcification/macroclicification/no calcification), and aspect ratio (the ratio of the anteroposterior diameter

to the transverse diameter of the lesion) of the target nodules. Subsequently, the mode was switched to CDFI, and the blood flow within and around the nodules was evaluated and graded according to the Adler method. Arterial sampling was performed within the lesion to measure the resistance index (RI). All images were independently interpreted by two physicians with ≥ 5 years of experience in thyroid ultrasound, and in cases of disagreement, a consensus was reached through discussion.

2.3. Observation indicators

Using surgical pathology results as the gold standard, the following indicators were observed and recorded

- (1) The detection of PTMC by color Doppler ultrasound, calculating the detection rate (number of clearly diagnosed cases/total number of cases $\times 100\%$) and the diagnostic accuracy rate (number of clearly diagnosed cases + number of suspected cases/total number of cases $\times 100\%$)
- (2) The two-dimensional ultrasound characteristics of PTMC, including the maximum diameter of the lesion, shape (regular/irregular), margin (clear/unclear), internal echo (hyperechoic/isoechoic/hypoechoic), calcification status (microcalcification/macroclicification/ no calcification), and aspect ratio ($\geq 1/< 1$)
- (3) The CDFI characteristics of PTMC, including the grading of blood flow signals (using the Adler blood flow grading standard) and the resistance index (RI) of arterial blood flow within the lesion, calculating the proportion of different blood flow grades and the proportion of cases with an RI ≥ 0.7 .

2.4. Statistical methods

Comparisons were made using SPSS 23.0 software. Count data were expressed as percentages (%) and tested using the χ^2 test, while measurement data conforming to a normal distribution were expressed as mean \pm standard deviation and tested using the *t*-test. A statistically significant difference was considered when $p < 0.05$.

3. Results

3.1. Detection rate of color Doppler ultrasound

Using surgical pathology results as the gold standard, among the 50 patients with PTMC, color Doppler ultrasound definitively diagnosed 44 cases as PTMC before surgery, suspected 4 cases of PTMC, and misdiagnosed 2 cases as benign nodules (nodular goiter). The ultrasound detection rate was 88.00% (44/50), and the diagnostic accuracy rate was 96.00% (48/50).

3.2. Two-dimensional ultrasound characteristics of PTMC

Analysis of two-dimensional sonograms: The maximum diameter of the lesions ranged from 3 to 10 mm, with a mean of (6.83 ± 1.51) mm; 18 cases (36.00%) had lesions ≤ 5 mm, and 32 cases (64.00%) had lesions > 5 mm; The primary signs, in order, were hypoechoic (92.00%), ill-defined borders (90.00%), an aspect ratio ≥ 1 (80.00%), irregular shape (84.00%), and microcalcifications (76.00%). See **Table 1** for details.

Table 1. Distribution of two-dimensional ultrasound characteristics (n, %)

Feature	Category	Number of cases (n)	Percentage (%)
Maximum diameter	≤ 5 mm	18	36.00
	5–10 mm	32	64.00
Shape	Irregular	42	84.00
	Regular	8	16.00
Boundary	Unclear	45	90.00
	Clear	5	10.00
Internal echo	Hypoechoic	46	92.00
	Isoechoic	4	8.00
Calcification	Microcalcification	38	76.00
	Macrocalcification	2	4.00
	No calcification	10	20.00
A/T ratio	≥ 1	40	80.00
	< 1	10	20.00

3.3. CDFI characteristics of PTMC

The CDFI examination results revealed that among the 50 cases of PTMC lesions, the majority of blood flow signal grading was Grade II (46.00%), followed by Grade I (24.00%), Grade III (20.00%), and Grade 0 (10.00%). The RI value measurements indicated that 39 cases (78.00%) had an $RI \geq 0.7$, while 11 cases (22.00%) had an $RI < 0.7$, with an average RI value of (0.75 ± 0.06) . See **Table 2** for details.

Table 2. Distribution of CDFI characteristics (n, %)

CDFI feature	Category	Number of cases (n)	Percentage (%)
Blood flow grade	Grade 0 (No flow)	5	10.00
	Grade I (Minimal)	12	24.00
	Grade II (Moderate)	23	46.00
	Grade III (Abundant)	10	20.00
Resistive index (RI)	≥ 0.7	39	78.00
	< 0.7	11	22.00

4. Discussion

Due to the small size of PTMC lesions, clinical palpation is often ineffective in detecting them. Traditional imaging examinations such as CT and MRI have relatively low resolution for small lesions, limiting their diagnostic value. Color Doppler ultrasound, leveraging the high resolution of its high-frequency probe, can clearly display the morphological characteristics and hemodynamic changes of thyroid microlesions, making it a crucial tool for the early diagnosis of PTMC ^[5]. The results of this study demonstrate that the detection rate of PTMC by color Doppler ultrasound is 88.00%, with a diagnostic accuracy rate of 96.00%, which is generally consistent with previous research

findings^[6]. Meanwhile, the two misdiagnosed cases in this study were both tiny lesions with diameters ≤ 5 mm, and they did not exhibit characteristic manifestations such as microcalcifications or an aspect ratio ≥ 1 . Their ultrasound appearances were low-echoic nodules with relatively clear boundaries, making differentiation from benign nodules challenging. Therefore, for PTMC (Papillary Thyroid Microcarcinoma) with excessively small diameters and a lack of typical malignant features, ultrasound diagnosis still has certain limitations, necessitating the combination of other examination methods for a definitive diagnosis.

This study also found that PTMC exhibits typical two-dimensional ultrasound characteristics, with hypoechogenicity, ill-defined borders, irregular shapes, the presence of microcalcifications, and an aspect ratio ≥ 1 serving as primary diagnostic criteria. Among these, hypoechogenicity is the most common feature of PTMC. In this study, 92.00% of the lesions presented as hypoechoic, which is related to the pathological characteristics of PTMC, where tumor cells are densely arranged and have little interstitial tissue^[7]. The infiltrative growth of tumor cells results in ill-defined lesion borders, with 90.00% of the lesions in this study having ill-defined borders, which is a key manifestation of PTMC's malignant characteristics. Irregular shapes and an aspect ratio ≥ 1 are also typical features of PTMC, with 84.00% and 80.00% of the lesions, respectively, exhibiting these characteristics in this study. This is associated with the infiltrative growth of tumor cells into surrounding tissues, causing the lesion shape to lose its regularity^[8]. Meanwhile, microcalcification is one of the most specific ultrasonic features of PTMC, with 76.00% of the lesions in this study exhibiting microcalcification, which is associated with the formation of psammoma bodies within the tumor tissue. Psammoma bodies are characteristic pathological manifestations of PTMC, formed by the deposition of calcium secreted by tumor cells, and appear as punctate hyperechoic foci with a diameter ≤ 2 mm on ultrasound^[9]. However, microcalcification is not a specific manifestation of PTMC, as some benign nodules such as nodular goiter may also exhibit microcalcification, albeit at a lower incidence. Therefore, when ultrasound detects a hypoechoic thyroid nodule accompanied by microcalcification, the possibility of PTMC should be highly suspected^[10]. Furthermore, CDFI can reflect the hemodynamic changes of the lesion, providing important supplementary evidence for the diagnosis of PTMC. In this study, 46.00% of the lesions had a blood flow signal graded as Grade II, and 20.00% as Grade III, indicating that most PTMC lesions have moderate or higher blood flow signals, consistent with the pathological characteristic that tumor growth requires a rich blood supply. RI is an important indicator reflecting vascular resistance, and malignant tumors typically have higher RI values due to thickened vessel walls and narrowed lumens. In this study, 78.00% of the lesions had an RI ≥ 0.7 , with an average RI value of (0.75 ± 0.06) , which is basically consistent with the average RI value (0.74 ± 0.20) in PTMC patients reported by Chen Yongcheng et al., further confirming that a high resistance index is an important blood flow characteristic of PTMC^[11]. However, some benign nodules, such as thyroid adenomas, may also exhibit abundant blood flow signals, while some papillary thyroid microcarcinomas (PTMCs) may show inconspicuous blood flow signals due to their small lesion size. Therefore, the benign or malignant nature of a lesion cannot be solely determined based on the grading of blood flow signals; a comprehensive analysis incorporating two-dimensional ultrasound features is necessary^[12].

5. Conclusion

In summary, color Doppler ultrasound demonstrates high detection and diagnostic accuracy rates for papillary thyroid microcarcinoma, with characteristic manifestations including hypoechogenicity, irregular shape, ill-defined margins, the presence of microcalcifications, and an aspect ratio of ≥ 1 . CDFI typically reveals moderate to high blood flow signals and a high resistance index (RI ≥ 0.7). This method is non-invasive, quick to perform,

and repeatable, making it suitable as a preliminary screening tool. In cases where the lesion diameter is extremely small or the signs are atypical, it is advisable to supplement with elastography, contrast imaging, or fine-needle aspiration to further reduce the risk of missed diagnoses.

Disclosure statement

The authors declare no conflict of interest.

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Research on the Preventive Effect of Targeted Nursing Interventions on Deep Vein Thrombosis in Patients with Hemodialysis Catheter Indwelling

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Abstract: *Objective:* To investigate the preventive effect of targeted nursing interventions on deep vein thrombosis in patients with hemodialysis catheter indwelling. *Methods:* A prospective study was conducted involving patients who underwent hemodialysis catheter indwelling and were admitted between August 2023 and August 2025, totaling 108 cases. These patients were randomly divided into two groups using a random number table method, with 54 cases in each group. The control group received routine nursing interventions, while the observation group received targeted nursing interventions. The incidence of deep vein thrombosis and hemodynamic indicators were compared between the two groups. *Results:* The incidence of deep vein thrombosis in the observation group was lower than that in the control group ($p < 0.05$). After two weeks of nursing, the hemodynamic indicators in the observation group were higher than those in the control group ($p < 0.05$). *Conclusion:* Targeted nursing interventions can effectively prevent deep vein thrombosis and improve hemodynamics in patients with hemodialysis catheter indwelling, making them worthy of clinical promotion.

Keywords: Hemodialysis; Catheter indwelling; Routine nursing intervention; Targeted nursing intervention

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1. Introduction

Hemodialysis is a common treatment for end-stage renal disease (ESRD), with approximately 90% of ESRD patients receiving this therapy^[1]. Among them, most patients undergoing maintenance hemodialysis have temporary indwelling femoral vein central catheters, which are convenient for puncture, suitable for bedridden patients, and do not affect upper limb movement^[2]. However, the indwelling of hemodialysis catheters is an invasive procedure that can cause stress reactions and has a certain potential to induce deep vein thrombosis (DVT)^[3]. ESRD is often accompanied by hypercoagulability and platelet activation, making thrombosis relatively easy to occur. Once DVT develops, if effective intervention is not implemented as early as possible,

50–60% of cases will progress to pulmonary embolism, ultimately leading to death ^[4]. Therefore, it is essential to provide good nursing care during the indwelling period of hemodialysis catheters, shifting from a passive to an active approach, actively preventing complications such as DVT, and enhancing the safety of hemodialysis. Conventional nursing care places more emphasis on hemodialysis treatment and lacks awareness of proactive prevention of complications, thus having limitations. Targeted nursing care requires the development of individualized nursing plans based on patients' clinical characteristics, understanding their physical and psychological needs, meeting their various reasonable needs, and helping patients adapt to hemodialysis and catheter indwelling. This study investigated 108 patients with indwelling hemodialysis catheters to explore the value of targeted nursing interventions.

2. Materials and methods

2.1. General information

This study is a prospective study aimed at analyzing the impact of different nursing interventions on patients with indwelling hemodialysis catheters. The study involved 108 subjects who were admitted to the hospital between August 2023 and August 2025. The sample size calculation method utilized an expected effect size of 0.63 for efficacy, a test level of 0.05, and a power of 0.90. Sample size estimation was performed using G*Power 3.1 software, with initial estimates indicating a minimum sample size of 40 cases per group. However, due to issues such as case exclusion and loss to follow-up during the study period, the sample size was increased to 54 cases per group, resulting in a total sample size of 108 cases.

2.1.1. Control group

32 males and 22 females, aged 35–76 years (55.89 ± 5.46 years), with a disease duration of 1–7 years (4.37 ± 1.21 years).

2.1.2. Observation group

30 males and 24 females, aged 36–74 years (55.37 ± 5.31 years), with a disease duration of 1–8 years (4.69 ± 1.35 years). There were no significant differences in basic demographic data between the two groups ($p > 0.05$).

2.1.3. Inclusion criteria

- (1) Patients meeting the diagnostic criteria for end-stage renal disease as outlined in the “Clinical Management Guidelines for Slowing the Progression of Chronic Kidney Disease (2025 Edition)” ^[5];
- (2) Patients with indications for indwelling hemodialysis catheters;
- (3) Patients who are mentally alert and conscious;
- (4) Patients who provide informed consent to participate in the study.

2.1.4. Exclusion criteria

- (1) Patients with concurrent major diseases, including malignant tumors, organ dysfunction, heart disease, etc.;
- (2) Patients who underwent kidney transplantation within 6 months prior to the study or during the study period;

- (3) Patients with coagulation disorders or hematopoietic abnormalities;
- (4) Patients with mental disorders, unconsciousness, cognitive impairment, or lack of autonomy.

2.2. Methods

In the control group, routine nursing interventions were carried out in the hospital. After the placement of a hemodialysis catheter, patients were verbally informed about the reasons for catheter placement and precautions. They were instructed to maintain the correct body position, avoid compression, twisting, or displacement of the catheter, wear loose clothing, avoid compressing the limb with the catheter during sleep, protect the catheter during activities, and ensure that the catheter remained unobstructed at all times. Patients were encouraged to engage in appropriate physical activity, avoid prolonged bed rest or immobilization, promote blood circulation, and reduce blood stasis. During hospitalization, efforts were made to actively control underlying conditions such as blood glucose, blood lipids, and blood pressure to improve the overall health status of patients and reduce hypercoagulability. Patients were also provided with dietary guidance, emphasizing the necessity of regular meals, controlled fluid intake, and reduced sodium consumption.

In the observation group, targeted nursing interventions were implemented in the hospital:

(1) Thrombosis prevention

Patients were educated about the causes, symptoms, hazards, and prevention and treatment strategies for deep vein thrombosis, and encouraged to actively participate in prevention efforts. Elastic stockings were provided, and patients were instructed to wear them upon waking and remove them before going to bed, continuing this for a minimum of 8 weeks. If necessary, an intermittent pneumatic compression pump was used, with one to two sessions per day, each lasting 15–20 minutes. The patients' physical function was assessed, and their activity preferences were understood to jointly develop a targeted exercise plan with the patients, including aerobic exercises such as walking and brisk walking. If patients were severely ill and required prolonged bed rest, family members were involved to help the patients turn over regularly and move their limbs, with each exercise session lasting 20–30 minutes and conducted one to two times per day.

(2) Disease condition nursing

Closely monitor the patient's laboratory test results, particularly fibrinogen and fibrin degradation products, as well as coagulation function indicators. Promptly communicate with the doctor upon detecting any abnormalities and, if necessary, increase anticoagulant medication. Closely monitor the patient's symptoms, actively inquire about issues such as pain and abnormal leg circumference, and promptly conduct color Doppler ultrasound examinations. Upon detecting deep vein thrombosis, immediately implement effective interventions.

(3) Health education

Evaluate the patient's understanding of hemodialysis and catheter placement, taking into account their educational level. In addition to routinely distributing knowledge pamphlets and playing popular science videos, communicate with the patient one-on-one using simple and understandable language to gently and patiently explain the reasons, purposes, expected outcomes, common complications, prevention and treatment plans, and critical management methods by medical staff for hemodialysis catheter placement. After completing theoretical education, teach patients self-prevention and treatment skills for complications using models, and encourage patients to actively participate in nursing care.

(4) Psychological support

Pay attention to the patient's psychological state during hospitalization, identify negative emotions such as anxiety and depression, analyze the triggering causes, and actively communicate with the patient to answer every question. Patiently soothe the patient's fears and unease caused by the illness and hospitalization, and stabilize their psychological state. On the premise of not affecting the patient's emotions and treatment, encourage patients to engage in recreational activities that do not interfere with hemodialysis, including reading novels and watching TV. For patients with obvious negative emotions, patiently understand the reasons, carefully alleviate negative emotions, meet reasonable requests of patients to the best of their ability, and collaborate with family members to provide emotional support. Cite cases where hemodialysis has achieved ideal results without complications, use them as role models, and guide patients to learn from these examples and cooperate with treatment and nursing.

(5) Nutritional support

Analyze the patient's nutritional status using nutritional assessment tools to ensure fluid balance during hospitalization. If the patient has a fever, for every 1 °C increase in body temperature, the calorie intake needs to be increased by 10%. If the patient can eat orally, convert the required calorie intake into various foods, providing nutritious, light, and easily digestible foods that align with the patient's preferences, and encourage the patient to eat small, frequent meals. If oral intake is not possible, provide enteral or parenteral nutritional support by preparing nutritional solutions on-site based on calorie requirements.

(6) Regular monitoring and assessment

Conduct regular vascular ultrasounds, echocardiograms, and other examinations to promptly identify issues such as catheter-related thrombosis, fibrous sheaths, or vascular stenosis for early intervention. When the patient returns to the hemodialysis room, actively inquire about the catheter function during hemodialysis, such as dialysis blood flow, aspiration, and blood return conditions, and promptly address any abnormalities.

Both groups received nursing care for two weeks.

2.3. Observation indicators

2.3.1. Incidence of deep vein thrombosis

Record the number of cases with and without occurrence, and calculate the percentage.

2.3.2. Hemodynamic indicators

Perform color Doppler ultrasound examinations and record peak blood flow velocity and average blood flow velocity.

2.4. Statistical methods

Data analysis was performed using SPSS 27.0. After confirming normal distribution through the Shapiro-Wilk test, measurement data were expressed as $(\bar{x} \pm s)$ and analyzed using *t*-tests. Count data were expressed as frequencies (percentages) and analyzed using χ^2 tests. A *p*-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of the incidence of deep vein thrombosis between the two groups

As shown in **Table 1**, the incidence of deep vein thrombosis in the observation group was lower than that in the control group ($p < 0.05$).

Table 1. Incidence of deep vein thrombosis in both groups (n/%)

Group	Number of cases (n)	Incidence rate	Non-incidence rate
Observation group	54	1 (1.85%)	53 (98.15%)
Control group	54	7 (12.96%)	47 (87.04%)
χ^2 -value	-		4.860
p -value	-		0.027

3.2. Comparison of hemodynamic indicators between the two groups

As shown in **Table 2**, after two weeks of nursing care, the hemodynamic indicators in the observation group were higher than those in the control group ($p < 0.05$).

Table 2. Hemodynamic indicators in both groups ($\bar{x} \pm s$, cm/s)

Group	Number of cases (n)	Peak blood flow velocity (cm/s)		Mean blood flow velocity (cm/s)	
		Pre-care	2 weeks post-care	Pre-care	2 weeks post-care
Observation group	54	25.12 \pm 4.67	52.18 \pm 5.86 ^a	15.45 \pm 3.11	31.65 \pm 4.76 ^a
Control group	54	25.98 \pm 4.92	45.02 \pm 5.46 ^a	15.76 \pm 3.26	25.49 \pm 4.61 ^a
t -value	-	0.932	6.569	0.506	6.831
p -value	-	0.354	< 0.001	0.614	< 0.001

Note: Compared with the same group before nursing, ^a $p < 0.05$.

4. Discussion

Currently, maintenance hemodialysis is commonly used in clinical settings to treat end-stage renal disease. Through regular, timed, and effective hemodialysis, renal function can be maintained and survival time prolonged [6]. To preserve vascular access resources for long-term dialysis and reduce the adverse effects of long-term dialysis on blood vessels, clinical practice advocates for the placement of hemodialysis catheters. Due to the greater blood flow in the femoral vein compared to other vessels, lower puncture difficulty, and minimal impact on limb movement, temporary catheters are often placed in the femoral vein [7]. However, catheter placement also carries certain risks, with a certain probability of complications such as deep vein thrombosis and catheter-related infections.

In this study, the incidence of deep vein thrombosis was lower in the observation group compared to the control group. The reason for this is that deep vein thrombosis is a common complication of hemodialysis, characterized by abnormal blood coagulation in the deep veins. This pathological change can obstruct the venous lumen, severely impede venous blood flow, and, if the condition worsens, can progress to pulmonary embolism, threatening the patient's life safety [8]. Patients with hemodialysis catheter placement often develop thrombosis due to damage to the blood vessel wall caused by catheter insertion [9]. Conventional nursing places

greater emphasis on hemodialysis treatment than on the prevention and treatment of complications such as deep vein thrombosis, with limited nursing measures and scope, resulting in nursing outcomes that are unsatisfactory to both patients and clinicians. Targeted nursing differs from conventional nursing by shifting from a passive to an active approach. It requires healthcare professionals to proactively understand the causes of deep vein thrombosis (DVT) in patients with hemodialysis catheter placement and develop tailored nursing plans based on these causes. By focusing on health education, nutritional support, thrombosis prevention, and disease management, targeted nursing aims to improve the prevention and treatment outcomes of DVT, reduce its incidence, and enhance the physical and mental comfort of patients.

In this study, the observation group demonstrated higher levels of various hemodynamic indicators compared to the control group. The reason for this is that peak blood flow velocity and mean blood flow velocity can accurately reflect the hemodynamic stability of patients, aid in the clinical identification of abnormalities, and guide early and effective clinical interventions ^[10]. However, conventional nursing does not effectively address these relevant indicators, making it difficult to prevent thrombosis and resulting in only modest improvements in hemodynamics. Targeted nursing interventions can compensate for the shortcomings of conventional nursing by emphasizing health education to enhance patients' understanding of maintenance hemodialysis treatment, the reasons for catheter placement, and precautions. By changing patients' perceptions, their behaviors can be transformed, leading to improved compliance with catheter placement, local dressing changes, and aseptic techniques, thereby effectively preventing related complications. Psychological support can regulate patients' mental states, correct negative coping styles and emotions, and encourage active participation in hemodialysis treatment. Through health education and thrombosis prevention measures, patients' attention to DVT prevention can be further heightened, and a series of clinically validated effective nursing methods can be employed to reduce thrombosis formation, regulate hemodynamics, and accelerate peak and mean blood flow velocities. During the nursing process, effective communication between nurses and patients enables a thorough understanding of patients' nursing needs. After meeting patients' reasonable demands, the nurse-patient relationship can be improved, further enhancing nursing compliance and outcomes.

5. Conclusion

In summary, targeted nursing interventions can assist patients with indwelling hemodialysis catheters in preventing deep vein thrombosis, and accelerate the peak blood flow velocity and the average blood flow velocity. However, this study has certain limitations. It only recorded the incidence of deep vein thrombosis as a complication and did not document the occurrence of other complications such as catheter-related infections, making it impossible to comprehensively evaluate the preventive effect of targeted nursing on complications. Additionally, it only measured hemodynamic indicators without considering hemorheological indicators or quality of life, preventing verification of the positive impact of targeted nursing on other aspects of patients and hindering its clinical promotion. Therefore, clinical research should increase the number of case studies, extend observation periods, and enrich various indicators to comprehensively analyze the application value of targeted nursing.

Disclosure statement

The author declares no conflict of interest.

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Application of Mobile Interactive Platform Combining Games and Picture Books as Carriers in Speech-Language Therapy for Cleft Palate

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Abstract: Cleft palate is a common congenital malformation of the maxillofacial region, and its postoperative speech disorders (such as hypernasality, nasal emission, and articulation errors) can significantly impact patients' communication abilities and psychological well-being. Traditional speech-language therapy faces challenges such as insufficient personalization of training methods, limited scenarios, and low patient compliance, making it inadequate for long-term rehabilitation needs. The innovative intervention model of a mobile interactive platform combined with games and picture books, through immersive experiences, instant feedback, and engaging designs, holds promise for enhancing patient participation and overall treatment outcomes. Therefore, this paper provides a comprehensive review from five perspectives: the pathological mechanisms and treatment needs of cleft palate speech disorders, the advantages of games and picture books as carriers in cleft palate speech therapy, the technological implementation of mobile interactive platforms, clinical application effects, and current challenges and limitations. The aim is to offer valuable insights for clinical practice and technological development in cleft palate speech rehabilitation.

Keywords: Cleft palate; Speech-language therapy; Mobile interactive platform; Game carrier; Picture book carrier

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1. Introduction

Cleft palate is a congenital malformation caused by developmental disorders of the mesoderm in the oral palate during the 8–12th week of embryonic development. Cleft palate speech disorder is a common organic speech disorder in oral and maxillofacial surgery^[1]. It manifests as hypernasality, nasal emission, consonant omission, or compensatory articulation, which negatively impacts patients' verbal communication and social adaptation. Good velopharyngeal closure function is a prerequisite for achieving normal speech intelligibility^[2]. Currently, surgical repair of the palatal anatomical structure is commonly performed clinically to provide a favorable physiological basis for velopharyngeal closure, while speech therapy aims to correct patients' poor articulation

habits and improve their speech intelligibility. Traditional speech-language therapy relies on one-on-one face-to-face guidance from professional therapists (including velopharyngeal closure function training, articulatory organ movement training, and articulation correction). However, there is an extreme shortage of speech therapists in China, with most concentrated in provincial capitals and large medical universities. Patients in western and remote regions face high transportation, accommodation, and food costs, as well as long travel times when seeking medical treatment elsewhere. Moreover, pediatric patients are prone to psychological resistance, leading to low treatment compliance. Based on this, mobile interactive platforms, with their advantages of portability and accessibility, combined with the engaging carriers of games and picture books, hold promise for constructing a more scientific, effective, and personalized rehabilitation model to enhance the overall efficacy of cleft palate speech therapy.

2. Pathological mechanisms and therapeutic needs of cleft palate speech disorders

2.1. Pathophysiological basis

Speech production is a complex process involving the coordinated efforts of multiple aspects (cerebral cortex, respiratory muscles, oral and pharyngeal structures, and cognitive functions). Patients with cleft palate face two core issues in their speech disorders: defective velopharyngeal closure function, resulting in insufficient oral pressure during articulation, nasal emission, and excessive nasal resonance; and abnormal movement of the articulatory organs, with some patients exhibiting insufficient tongue muscle strength, oral muscle coordination issues, and fine differentiation movement disorders, which can affect the correct articulation of consonants or vowels.

2.2. Core therapeutic needs

Cleft palate speech therapy should follow a three-stage logic: functional reconstruction, skill training, and application consolidation. This involves conducting respiratory and soft palate movement training for patients to control nasal emission; carrying out tongue muscle strength and mouth shape control training, as well as articulation position induction, to correct articulation errors of target phonemes; and promoting better real-life application of speech skills through phrase and short sentence training. Children aged 3–6 years are the key population for treatment, and it is crucial to incorporate fun and interactive elements into the therapeutic process.

3. Advantages of games and picture books as media in cleft palate speech therapy

3.1. Rehabilitation mechanisms and application forms of game-based media

Game-based therapy aims to further activate patients' proactive participation by integrating speech training objectives into engaging scenarios. Its advantages are as follows: it provides multisensory integrated stimulation; for example, blowing paper pieces games can help patients better perceive and control the airflow of aspirated consonants, while using funny mirror games can distinguish the differences in air delivery between the oral and nasal cavities. It offers immediate feedback and reinforcement, employing positive incentives such as animated rewards and point systems to reinforce correct pronunciation behaviors. It can also reduce anxiety.

In clinical practice, the designed game-based media align with rehabilitation goals: for respiratory function training, patients are required to blow bubbles continuously for more than 15 seconds; for articulatory organ

training, patients are guided to engage in tactile feedback games such as licking lollipops to control tongue retraction; for speech clarity training, games such as syllable matching and speech challenges are designed to achieve step-by-step training (phonemes, phrases, short sentences).

3.2. Rehabilitation value and design principles of picture book-based media

As a narrative medium that combines images and text, picture books construct language application scenarios through situational storytelling. Their advantages lie in the following aspects: the everyday scenarios depicted in picture books provide a richer variety of phrases and short sentence materials for speech training; the vividly colored images and concise text are well-suited to the comprehension level of young patients; and by reading picture books together, parents can guide patients in imitating pronunciation, thereby enhancing parent-child interaction.

The principles to follow in designing picture books are as follows: select vocabulary centered around frequently mispronounced phonemes; progress from single characters and two-syllable words to short sentences and story retelling; encourage patients to imitate the dialogue of characters in the picture books, incorporating interactivity to further solidify pronunciation skills.

3.3. Technical implementation of mobile interactive platform

The mobile interactive platform integrates artificial intelligence (AI), the Internet of Things, and multimedia technologies to construct a comprehensive rehabilitation system (encompassing assessment, training, feedback, and management).

- (1) It employs Praat spectrogram analysis and AI voice feature extraction algorithms to objectively evaluate acoustic characteristics, pronunciation clarity, and the degree of nasal emission.
- (2) It combines various interactive forms such as touchscreens, voice commands, and animated displays to provide visual pronunciation guidance (e.g., through oral pronunciation animations that explain tongue movement principles).
- (3) Based on the patient's specific age, assessment results, training progress, and other factors, dynamically deliver suitable game and picture book materials; for the younger age group, focus on sensory exploratory games, while for the age-appropriate group, incorporate training content such as retelling picture book stories and voice-based obstacle-clearing challenges.
- (4) The platform records relevant data (training duration, accuracy rate, etc.), generates rehabilitation curves, provides strong support for therapists to remotely monitor progress and adjust plans, and offers real-time feedback through the parent portal.

4. Clinical application effects

4.1. Improving speech clarity

Zhang Qing et al. ^[3] concluded that the gamification method effectively improved the pronunciation clarity in children (with accuracy for alveolar sounds increasing from 8.4% to 98.2%, and for palatal sounds from 24.6% to 97.6%). Zhang Chunguang et al. ^[4] studied 40 children who underwent cleft palate repair surgery at their hospital from January 2018 to December 2018, all of whom received speech rehabilitation therapy one month after the surgery. The results showed a significant improvement in the vocal quality of the children. Liu Yinghua et al.

conducted an experiment on 80 children who received speech therapy after cleft palate surgery, with the control group receiving conventional intervention and the observation group receiving additional mobile interactive platform intervention ^[5]. The results showed significant differences in the average speech clarity between the two groups at 3, 6, and 9 months after training, with the observation group outperforming the control group ($p < 0.05$). Min Zhiyun et al. pointed out that combining dynamic motion diagrams, oral models, and demonstrated pronunciation can guide, correct, and reinforce the pronunciation of syllables ^[6].

4.2. Improving treatment adherence and quality of life

Fun-oriented design is crucial for enhancing adherence. In a related study, 86 patients with cleft palate were divided into a control group (receiving routine intervention) and a research group (receiving speech and voice therapy through games and picture books as carriers), with 43 patients in each group. The study found that the adherence rate in the research group (95.35%) was significantly higher than that in the control group (79.07%), with a notable difference ($p < 0.05$). Moreover, after the intervention, the research group had lower scores in psychological and behavioral status (all $p < 0.05$) and higher quality of life (all $p < 0.05$) ^[7]. The core reasons lie in the use of games and picture books as carriers, which reduced the monotony of training. The instant feedback mechanism enhanced patients' sense of accomplishment, and it was also beneficial in alleviating patients' social anxiety and improving their social participation abilities. Zou Pingping et al. ^[8] proposed in their article that speech therapists can fully mobilize children's interest in rehabilitation training by using pictures, animations, and other forms, and promptly encourage them when they make progress, thereby boosting their confidence in completing the treatment course. Yao Yuan et al. ^[9] took 60 children who had undergone cleft palate surgery as the experimental subjects and concluded that speech rehabilitation training helps restore normal voice in children after cleft palate surgery, improves their psychological state and quality of life, and is thus worthy of active promotion and application. Another report states that during the speech therapy process, in addition to conducting speech training, parents can also foster parent-child relationships, promoting family harmony and social harmony ^[10].

4.3. Enhancing resource accessibility

Mobile interactive platforms have broken through geographical limitations, providing a low-cost avenue for patients in remote areas to seek medical attention. In recent years, public welfare mini-programs such as "Guanghe Yuyan" have been launched, enabling patients to obtain AI speech assessments and customized training materials for free through platforms like Douyin and WeChat. This eliminates the need for patients to bear travel expenses and accommodation costs associated with seeking medical treatment in different locations, significantly improving the accessibility of rehabilitation resources.

5. Current challenges and limitations

5.1. Technology

For patients with severe nasal emission and low speech intelligibility, there is still a need to further optimize the accuracy of AI algorithms in identifying articulation errors. The intelligence level of personalized recommendation algorithms needs to be improved; current platforms mostly recommend relevant content based on patients' age and basic assessment results, without dynamically adapting to their learning progress, interests, and preferences. Current multimodal interaction technologies primarily rely on two-dimensional animations and lack immersive

experiences such as VR and AR, resulting in relatively low attractiveness for younger patients.

5.2. Clinical application

The existing research data is limited, with no long-term follow-up data available to confirm the durability of treatment efficacy. The applicable population is restricted, showing low adaptability for complex cases involving hearing impairments or neurological disorders. Additionally, variations in parents' guidance capabilities affect rehabilitation outcomes.

5.3. Industry standards

There is a lack of unified technical standards and efficacy evaluation systems. The design of training content and speech assessment metrics vary across different platforms, preventing cross-platform comparisons. Issues related to data security and privacy protection are becoming increasingly prominent.

6. Future development directions and prospects

6.1. Technological innovation and upgrading

Effectively integrate AI large models with speech rehabilitation technology to enhance the accuracy of pronunciation error identification. Promptly introduce VR/AR immersive technology to create virtual rehabilitation scenarios, providing three-dimensional visualization of speech organ movements to make training more intuitive and engaging. Develop wearable device connectivity features to obtain physiological data through oral pressure sensors and tongue position monitoring equipment.

6.2. Expanding clinical applications

Conduct multi-center, large-sample, long-term follow-up studies to further validate the efficacy of this model in cleft palate patients of different age groups and varying severities; broaden the range of suitable populations by designing multidisciplinary collaborative rehabilitation modules for special cleft palate patients; provide training for parents, offering speech knowledge courses and at-home training guidance videos through the platform to enhance their expertise.

6.3. Building an industry ecosystem

Establish technical standards and ethical guidelines for mobile rehabilitation platforms, unify speech assessment indicators and efficacy evaluation criteria; strengthen collaboration among hospitals, enterprises, and public welfare organizations to expand the coverage of public welfare platforms and reduce rehabilitation costs; establish regional rehabilitation data centers to integrate treatment data and provide strong support for scientific research innovation and policy formulation.

7. Conclusion

The innovative model combining mobile interactive platforms with games and picture books has improved treatment compliance, speech clarity, psychological well-being, and quality of life for cleft palate patients, while enhancing the accessibility of treatment resources. Going forward, further improvements in the model's efficacy

are needed through technological innovation, clinical validation, and industry standardization, with the goal of promoting the rehabilitation of more cleft palate patients.

Disclosure statement

The authors declare no conflict of interest.

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Investigation on the Cognitive Status of Community Medical Staff and Patients towards General Practitioners in Neijiang City

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Abstract: *Objective:* This study aims to investigate the cognitive status of community medical staff and patients in Neijiang City towards general practitioners, and analyze the current cognitive status, cognitive needs, and the importance of knowledge dissemination and intervention regarding general practitioners. *Methods:* A total of 50 community medical staff and patients in Neijiang City were selected for a questionnaire survey conducted from April 2023 to March 2025. A self-designed questionnaire on the concepts of multimorbidity and general practitioners was employed, and the survey was carried out twice, before and after the dissemination of general practice knowledge. Based on the demographic characteristics of the participants and the differences in survey results before and after the knowledge dissemination, the influencing factors and cognitive needs of community medical staff and patients towards general practitioners at this stage were analyzed. *Results:* Individuals under the age of 35 acquired knowledge mainly through community education (50.00%) and electronic media (50.00%), while those aged 35–65 and over 65 primarily learned through peers, accounting for 57.14% and 48.72%, respectively. After general practice education, among individuals aged ≤ 65 , those with a college degree or higher demonstrated higher rates of multimorbidity and met the criteria for family doctor awareness compared to those aged > 65 with a high school diploma or lower, with statistically significant differences ($p < 0.05$). Logistic regression analysis revealed that educational attainment (college degree or higher) served as a protective factor for high awareness levels among general practitioners, while age (> 65 years) emerged as a risk factor for high awareness levels among general practitioners, with statistically significant differences ($p < 0.05$). *Conclusion:* To enhance the knowledge and awareness levels of general practitioners among community medical staff and patients, it is imperative to actively expand channels for proactive acquisition of relevant knowledge through education and outreach. Additionally, targeted educational efforts should be intensified for individuals with lower educational attainment and older age groups to establish a public awareness foundation for the effective promotion of general practitioner-led healthcare initiatives at the grassroots level.

Keywords: General practitioners; Awareness status; Public perception; Influencing factors

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1. Introduction

General practitioners represent a grassroots healthcare service model promoted in China in recent years based on the development of general medicine. This model aims to provide comprehensive and individualized medical services, including preventive care, health management, medical treatment, and rehabilitation, to grassroots personnel.

As a result, general practitioners occupy a comprehensive and professional role in community and family health management, exerting a positive influence on the adjustment of the national future healthcare model and the alleviation of healthcare service pressures ^[1,2]. However, during the actual promotion of the general practitioner program, it was found that due to differences in social and economic development as well as medical resources across different regions, the program in our city is still at the basic promotion stage.

Moreover, from the summary of promotional experience at the current stage, it was observed that limitations in the cognitive level of general practitioners among primary-level medical staff and patients may affect the progress of program promotion. Therefore, it is necessary to refine the promotional content and format based on the analysis results of the current knowledge and awareness of general practitioners among primary-level medical staff and patients in our city ^[3,4]. Given the aforementioned background, a questionnaire survey was conducted among 50 medical staff and patients to analyze their current awareness and needs regarding general practitioners, as well as the importance of knowledge dissemination and intervention related to general practitioners. The details are as follows.

2. Materials and methods

2.1. Clinical data

A total of 50 medical staff and patients from communities in Neijiang City were selected for a questionnaire survey conducted from April 2023 to March 2025.

2.1.1. Inclusion criteria

The 50 medical personnel and patients were all from the outpatient and inpatient departments of Haozikou Community in Neijiang City, Baima Town Health Center, and Jiaotong Town Health Center, or are medical practitioners, all of whom are permanent residents. Patients were aged between 18 and 80 years old and have one or more types of chronic diseases. They possess intact cognitive and language communication functions, enabling them to complete questionnaires independently or with the assistance of researchers.

2.1.2. Exclusion criteria

Individuals who drop out of the study or were lost to follow-up during the research period; those unable to cooperate in completing the questionnaire; critically ill patients or those who die during the study period; individuals without smartphones or with severe visual or auditory impairments.

2.2. Methods

2.2.1. Questionnaire survey

(1) Demographic information

Prior to enrollment, researchers used electronic questionnaires to survey and recorded information such as

age, gender, occupation, and educational level of the study subjects.

(2) General practitioner questionnaire survey

A self-designed questionnaire on the concept of multimorbidity and general practitioners was used. Questionnaire surveys were conducted twice, before and after the dissemination of general practice knowledge.

2.2.2. General practice knowledge education

After the completion of the initial questionnaire survey, community hospitals, in collaboration with their respective communities, the education on general practitioner-related knowledge for the study participants was conducted within their jurisdiction. For medical professionals, each unit was responsible for completing relevant knowledge training and education. For community patients, hospitals and communities was collaborated to organize lectures on general practice knowledge and distribute promotional brochures.

During this period, hospitals was utilized their WeChat official accounts to regularly push relevant health education videos, requiring timely viewing. Additionally, hospitals and communities have actively utilized local bulletin boards to post relevant promotional content to enhance the accessibility of health-related knowledge. The general practice education required continuous intervention for six months.

2.3. Observation indicators

Based on the demographic characteristics of the study participants and the results of the questionnaire surveys conducted before and after the general practice knowledge education, analyze the influencing factors and cognitive needs regarding general practitioners among community medical staff and patients at the current stage.

2.4. Statistical methods

Data was analyzed using SPSS 23.0 software; all research data were qualitative and was expressed as n (%). Tests such as chi-square or rank-sum tests was used; a *p*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Analysis of demographic data

Analysis of the demographic data of the study subjects revealed that the main groups were females (56.00%) and individuals aged over 65 (78.00%). The predominant occupational category was public institutions (56.00%), and the majority of the subjects had a college or undergraduate education level (86.00%). The proportion of individuals with three types of comorbid chronic diseases reached 52.00%. See **Table 1** for details.

3.2. Analysis of knowledge acquisition channels for general practitioners

Analysis of the knowledge acquisition channels for general practitioners among the study subjects indicated that individuals under the age of 35 acquired knowledge through community education (50.00%) and electronic media (50.00%). For those aged between 35 and 65, as well as those over 65, the primary knowledge acquisition channel was through peers, with proportions of 57.14% and 48.72%, respectively. See **Table 2** for details.

Table 1. Analysis of demographic data (n, %)

Demographic data		n	Percentage (%)
Gender	Male	22	44.00
	Female	28	56.00
Age	< 35 years	4	8.00
	35–65 years	7	14.00
	> 65 years	39	78.00
Occupation	Medical practitioner	2	4.00
	Service industry	4	8.00
	Worker	5	10.00
	Company employee	9	18.00
	Public institution	28	56.00
	Family-run shop	1	2.00
	Unemployed	1	2.00
Education level	Bachelor's degree	18	36.00
	Associate degree	25	50.00
	High school	4	8.00
	Junior High school	1	2.00
	Primary school	1	2.00
	Incomplete primary	1	2.00
Chronic disease status	1 Type	6	12.00
	2 Types	14	28.00
	3 Types	26	52.00
	4 Types	2	4.00
	5 Types	2	4.00

Table 2. Analysis of knowledge acquisition channels for general practitioners (n, %)

Channel type / Age group	< 35 years (n = 4)	35–65 years (n = 7)	> 65 years (n = 39)
Community education	2 (50.00)	1 (14.29)	7 (17.95)
Digital media	2 (50.00)	1 (14.29)	3 (7.69)
Previous medical visits	0	0	4 (10.26)
Heard from peers	0	4 (57.14)	19 (48.72)
Heard from children/grandchildren	0	1 (14.29)	6 (15.38)
Total	4	7	39

3.3. Comparison of co-morbidity and cognitive compliance with family doctors before and after general practice education

There was no statistically significant difference in the comparison of co-morbidity and cognitive compliance with family doctors among individuals of different age groups and educational levels before general practice education ($p > 0.05$). After general practice education, among those aged ≤ 65 years, individuals with a college degree or higher demonstrated higher levels of co-morbidity awareness and cognitive compliance with family doctors compared to those aged > 65 years and those with a high school diploma or lower, with statistically significant differences ($p < 0.05$). See **Table 3**.

Table 3. Comparison of co-morbidity and cognitive compliance with family doctors before and after general practice education (n, %)

Grouping basis		Multimorbidity knowledge attainment rate		Family physician knowledge attainment rate	
		Before education	After education	Before education	After education
Age	≤ 65 years (n = 11)	3 (27.27)	11 (100.00)	2 (18.18)	11 (100.00)
	> 65 years (n = 39)	11 (28.21)	28 (71.79)	8 (20.51)	26 (66.67)
χ^2 -value		0.004	3.978	0.029	4.955
p -value		0.951	0.046	0.864	0.026
Education level	Associate degree or above (n = 43)	13 (30.23)	36 (83.72)	10 (23.26)	35 (81.40)
	High school or below (n = 7)	1 (14.29)	3 (42.86)	0 (0.00)	2 (28.57)
χ^2 -value		0.759	5.858	2.035	7.831
p -value		0.384	0.016	0.154	0.003

3.4. Analysis of factors influencing the cognitive level of general practitioners among community medical staff and patients

Logistic regression analysis revealed that educational level (college degree or higher) was a protective factor for a high cognitive level of general practitioners, while age (> 65 years) was a risk factor for a high cognitive level of general practitioners, with statistically significant differences ($p < 0.05$). See **Table 4** and **5**.

Table 4. Assignment method

Factor	Assignment
Age	≤ 65 years = 1, > 65 years = 0
Education level	Associate degree or above = 1, High school or below = 0

Table 5. Analysis of factors influencing the cognitive level of community medical staff and patients towards general practitioners

Factor type	β	Sx	Wald χ^2	p -value	OR	95% CI
Age	-0.57	0.24	5.91	< 0.01	0.57	0.35–0.94
Education level	0.68	0.18	12.36	< 0.01	1.95	1.32–2.84

4. Discussion

Based on this questionnaire survey, the following survey results were analyzed accordingly.

- (1) People under 35 years old acquire knowledge through community outreach (50.00%) and electronic media (50.00%), while those aged 35–65 and over 65 primarily rely on hearing about it from their peers, with proportions of 57.14% and 48.72%, respectively. The analysis reveals that, influenced by factors such as the current development of communication technology and the widespread use of smartphones, in addition to disseminating information through traditional media such as television and newspapers, electronic media has become the primary medium for information dissemination in the context of the national healthcare reform efforts. However, among the elderly population, limitations related to their ability to independently use network information technology and smartphones prevent them from actively acquiring knowledge about general practitioners through relevant channels, thereby restricting their overall cognitive level due to passive acquisition^[5,6].
- (2) After general practice education, among individuals aged ≤ 65 years, those with a college degree or above demonstrated higher rates of multimorbidity coexistence and met the standards for family doctor awareness compared to those aged > 65 years with a high school education or below, with statistically significant differences ($p < 0.05$). Logistic regression analysis revealed that educational attainment (college degree or above) served as a protective factor for high awareness levels among general practitioners, while age (> 65 years) emerged as a risk factor, with statistically significant differences ($p < 0.05$). Analysis indicates that elderly populations generally have lower educational levels and exhibit notable degenerative changes in visual, auditory, and cognitive functions, resulting in lower information absorption during general practice education and limited practical educational outcomes. Therefore, feasible educational approaches should be tailored to the characteristics of this demographic^[7,8].

Based on the aforementioned analysis, this study proposes the following recommendations to address the need for enhancing awareness of general practitioners among grassroots personnel.

- (1) During the promotion of general practitioner programs, hospitals and communities should actively establish collaborative models. Relevant community hospital staff should regularly conduct group-based educational sessions within communities to strengthen outreach efforts targeting populations with high demand for general practitioner services. Additionally, multimedia channels should be leveraged to actively promote online education among university students and young adults, enabling them to disseminate relevant knowledge to elderly family members through household communication, thereby improving overall public awareness^[9].
- (2) Additionally, for the elderly population, after community hospitals have completed training on general practitioner-related knowledge for community workers, community workers should conduct individualized education through home visits, which can be carried out multiple times, in order to enhance the elderly's grasp of general practitioner knowledge^[10].

5. Conclusion

In summary, regarding the cognitive level of general practitioner knowledge among community medical staff and patients, it is necessary to actively increase the channels for proactively acquiring and disseminating relevant knowledge, and strengthen the dissemination of such knowledge to individuals with low educational attainment

and the elderly population, thereby providing a public awareness foundation for the effective promotion of general practitioner medical programs at the grassroots level.

Disclosure statement

The authors declare no conflict of interest.

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Research on Risk Prediction Model for Multiple Bronchoalveolar Lavage in Children with Mycoplasma Pneumoniae Pneumonia

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Abstract: *Objective:* To study the risk prediction model for multiple bronchoalveolar lavage in children with mycoplasma pneumoniae pneumonia (MPP). *Methods:* 151 pediatric patients with MPP admitted in our hospital from July to December 2023 were selected, the incidence rate of multiple bronchoalveolar lavage was recorded. A logistic multivariate regression model was employed to analyze relevant factors and construct a risk prediction model for multiple bronchoalveolar lavage in children with MPP. *Results:* Among 151 children with MPP, 64 cases underwent multiple bronchoalveolar lavage, accounting for 42.38%. The Logistic multivariate model analysis revealed that the pleural effusion, sepsis, and abnormally elevated serum levels of LDH and D-D were independent influence factors for multiple bronchoalveolar lavage in children with MPP ($p < 0.05$), based on this, a Nomogram prediction model can be established. The ROC analysis results showed that the AUC of the model to judge the multiple bronchoalveolar lavage in MPP patients was 0.828 ($SE = 0.035$, $95\% CI = 0.760-0.896$, $p < 0.001$), the sensitivity was 0.813 and the specificity was 0.759. *Conclusion:* The multiple bronchoscopic bronchoalveolar lavage in MPP patients are associated with the levels of LDH and D-D, as well as the presence of pleural effusion and sepsis complications, the risk prediction model established, which based on this has high accuracy.

Keywords: Mycoplasma pneumoniae pneumonia; Bronchoalveolar lavage; Risk prediction model

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1. Introduction

Mycoplasma pneumoniae pneumonia (MPP) is a common respiratory disease in children, which can cause fever and chest pain. In severe cases, it can lead to respiratory failure and even endanger the life of affected children. Antibiotics are the primary treatment method for MPP. However, with the widespread clinical application of antibiotics, the issue of drug resistance caused by antibiotic abuse has gradually become prominent, reducing their therapeutic effectiveness^[1]. Bronchoscopic alveolar lavage refers to the procedure of injecting sterile saline into the bronchial alveoli under the guidance of a bronchoscope and then aspirating the lavage fluid to remove foreign bodies from the airways, thereby achieving therapeutic purposes. Recent studies have shown that bronchoscopic

alveolar lavage has minimally invasive characteristics and can directly obtain specimens from respiratory tract lesions, enabling precise diagnosis and treatment of MPP [2]. However, with the widespread clinical application, studies have revealed that multiple bronchoscopic alveolar lavages in children can damage the airways and may also cause glottic edema and bronchial spasm, affecting the prognosis of affected children [3]. Therefore, clinical practice should avoid multiple bronchoscopic alveolar lavages as much as possible. This study constructed a risk prediction model for multiple bronchoscopic alveolar lavages through retrospective analysis to guide early clinical intervention. The report is as follows.

2. Materials and methods

2.1. General information

A total of 151 children with *Mycoplasma pneumoniae pneumonia* (MPP) admitted to our hospital from July to December 2023 were selected as the study subjects. This study was approved by the hospital's ethics committee.

2.1.1. Inclusion criteria

- (1) All children were confirmed to have MPP through respiratory pathogen detection, aged between 1 and 12 years, with complete clinical data [4]
- (2) All received standardized diagnosis and treatment in our hospital
- (3) Guardians of the children were informed and consented to the study content

2.1.2. Exclusion criteria

- (1) Children with mixed infections
- (2) Children with comorbid conditions such as complement deficiency diseases, nephrotic syndrome, leukemia, or severe malnutrition
- (3) Children currently taking immunosuppressants
- (4) Children with comorbid psychiatric conditions such as depression or autism. Based on whether they received multiple bronchoscopic alveolar lavages, the children were divided into an observation group (receiving multiple bronchoscopic alveolar lavage treatments, $n = 64$) and a control group (not receiving multiple bronchoscopic alveolar lavages, $n = 87$)

2.2. Treatment methods

A 2% lidocaine aerosol inhalation was used for local anesthesia of the throat. After the anesthesia took effect, a fiberoptic bronchoscope (Shanghai Outai Medical Equipment Co., Ltd., Shanghai Medical Device Registration Number 20192060363, Model: OIF-BC66P) was used to perform alveolar lavage. The bronchoscope was inserted through the nasal cavity into the trachea, and the child's vital signs were monitored. Sterile tubes were used to aspirate bronchial secretions, and a portion of the secretions was subjected to drug sensitivity testing. Alveolar lavage was performed using 0.9% saline at 37°C, with repeated lavage of the lesion 2–3 times, 10–20 mL per time. After the lavage fluid became clear, 2 mg of budesonide suspension was injected through the bronchoscope, and the bronchoscope was then removed. The treatment was administered once daily for a continuous week.

2.3. Observation indicators

Clinical characteristics and laboratory parameters of children with MPP were collected. Clinical characteristics included gender, age, disease duration, lesion location, duration of fever, blood oxygen saturation (SpO₂), and pleural effusion status. Laboratory parameters included C-reactive protein (CRP), hemoglobin (Hb), serum albumin (Alb), D-dimer (D-D), lactate dehydrogenase (LDH), and erythrocyte sedimentation rate (ESR) levels. Within 3 days of admission, 3.0 mL of blood was drawn from the median cubital vein of the children. After routine centrifugation, the serum was retained. A fully automated biochemical analyzer (Shanghai Kehua Experimental Systems Co., Ltd., Shanghai Medical Device Registration Number 20172220195, Model: Excellence 300) was used to detect serum CRP and Alb levels. Serum D-D and LDH levels were detected using immune turbidimetric assay and rate assay, respectively. Plasma fibrinogen (Fib) was measured by immune turbidimetry. A fully automated blood cell analyzer (Shenzhen DiMai Biotechnology Co., Ltd., Guangdong Medical Device Registration Number 20172220016, Model: DH73CRP) was used to detect whole blood Hb levels, and the Westergren method was used to detect whole blood ESR levels.

2.4. Statistical methods

The SPSS 24.0 software package was selected for statistical analysis of data related to the clinical characteristics of the patients. Measurement data were described using (mean \pm standard deviation), and count data were described using [n (%)]. *t*-tests or chi-square tests were conducted accordingly. Logistic multivariate regression models were used to analyze relevant factors. Predictive models were drawn using R language, and the predictive value was analyzed using the Receiver Operating Characteristic (ROC) curve, with the results expressed as the area under the curve (AUC). A *p*-value less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of clinical features and laboratory indicators among different patients

Among the 151 children with MPP, 64 underwent multiple bronchoscopic alveolar lavage procedures, accounting for 42.38%, and were designated as the observation group, while the remaining 87 cases were the control group. Statistically significant differences were observed between the two groups in the incidence of pleural effusion, sepsis, and heart failure (*p* < 0.05). Similarly, significant differences were found in age, albumin (Alb), lactate dehydrogenase (LDH), erythrocyte sedimentation rate (ESR), D-dimer (D-D), and neutrophil-to-lymphocyte ratio (NLR) levels between the two groups (*p* < 0.05), as shown in **Table 1**.

Table 1. Comparison of clinical features and laboratory parameters among different patients

Indicator		Observation group (n = 64)	Control group (n = 87)	Statistical value (<i>t</i> / χ^2)	<i>p</i> -value
Gender	Male	36 (56.25)	39 (44.83)	1.924	0.165
	Female	28 (43.75)	48 (55.17)		
Age (years)		6.96 \pm 2.34	6.45 \pm 2.52	2.959	0.003
BMI (kg/m ²)		16.57 \pm 2.28	16.20 \pm 2.34	0.971	0.333
Lesion location	Right side	25 (39.06)	37 (42.53)	3.344	0.188
	Left side	21 (32.81)	36 (41.38)		
	Bilateral	18 (28.13)	14 (16.09)		

Table 1 (Continued)

Indicator		Observation group (n = 64)	Control group (n = 87)	Statistical value (t/ χ^2)	p-value
Pleural effusion	Present	38 (59.38)	20 (22.99)	20.637	< 0.001
	Absent	26 (40.63)	67 (77.01)		
Extrapulmonary complications	Sepsis	34 (53.13)	18 (20.69)	17.182	< 0.001
	Heart failure	30 (46.88)	12 (13.79)	20.099	< 0.001
CRP (mg/L)		12.22 \pm 12.53	15.71 \pm 22.22	-1.131	0.260
Hb (g/L)		110.53 \pm 6.82	111.89 \pm 8.57	-1.044	0.298
Alb (g/L)		38.75 \pm 3.90	40.67 \pm 3.77	-3.042	0.003
LDH (U/L)		349.30 \pm 110.52	306.98 \pm 83.70	2.678	0.008
ESR (mm/h)		30.09 \pm 3.96	25.87 \pm 3.86	6.567	< 0.001
D-D (mg/L)		0.39 \pm 0.93	0.18 \pm 0.10	2.034	0.044
Fib (g/L)		3.59 \pm 0.57	3.40 \pm 0.46	2.193	0.030
NLR		2.25 \pm 0.55	1.49 \pm 0.43	9.497	< 0.001

3.2. Factors associated with multiple bronchoscopic alveolar lavage procedures in children with MPP

Factors potentially influencing multiple bronchoscopic alveolar lavage treatments in children with MPP were assigned values, as shown in **Table 2**. These assigned factors were treated as independent variables, and whether the children underwent multiple bronchoscopic alveolar lavage treatments was considered the dependent variable. Logistic multivariate regression model analysis revealed that pleural effusion, sepsis, LDH, and D-D levels were independent influencing factors for multiple bronchoscopic alveolar lavage procedures in children with MPP ($p < 0.05$), as shown in **Table 3**.

Table 2. Assignment of factors associated with multiple bronchoscopic alveolar lavage procedures in children with MPP

Indicator		Assignment status
Pleural effusion	X1	Yes = 1, No = 0
Sepsis	X2	Yes = 1, No = 0
Heart failure	X3	Yes = 1, No = 0
Age (X4), Alb (X5), LDH (X6), ESR (X7), D-D (X8), and NLR (X9) are included with their original values.		

Table 3. Analysis results of factors associated with multiple bronchoscopic alveolar lavage procedures in children with MPP

Indicator	β	SE	Wald χ^2	p-value	OR	95% CI
Pleural effusion	1.031	0.343	9.041	0.003	2.805	1.432–5.494
Sepsis	1.340	0.278	23.169	< 0.001	3.819	2.213–6.590
Heart failure	1.721	0.984	3.061	0.080	5.591	0.813–38.449

Table 3 (Continued)

Indicator	β	SE	Wald χ^2	<i>p</i> -value	OR	95% CI
Age	1.337	1.004	1.773	0.183	3.806	0.532–27.229
Albumin (Alb)	-0.218	0.496	0.193	0.660	0.804	0.304–2.126
LDH	0.910	0.413	4.858	0.028	2.484	1.106–5.579
ESR	1.166	0.874	1.781	0.182	3.209	0.579–17.785
D-dimer (D-D)	1.253	0.436	8.252	0.005	3.501	1.489–8.232
NLR	1.584	0.869	3.320	0.068	4.875	0.887–26.793

3.3. Predictive model for multiple bronchoscopic alveolar lavage procedures in children with MPP

Based on the results of multivariate analysis, pleural effusion, sepsis, LDH, and D-D were included in the R software analysis to construct a Nomogram predictive model, and calibration curves were plotted, as shown in **Figure 1** and **2**. The mean absolute error between the predicted probability and the actual probability was 0.001. DCA was also plotted, as shown in **Figure 3**, indicating that the threshold probability for multiple bronchoscopic alveolar lavage procedures in children with MPP ranged from 10% to 92%, and the model could achieve a high clinical net benefit. The patient scores were calculated based on the predictive model and used as the test variable, while whether the patient underwent multiple bronchoscopic alveolar lavage procedures was used as the state variable to plot the ROC curve. The results showed an AUC of 0.828 (SE = 0.035, 95% CI = 0.760–0.896, $p < 0.001$), with a sensitivity of 0.813 and a specificity of 0.759, as shown in **Figure 4**.

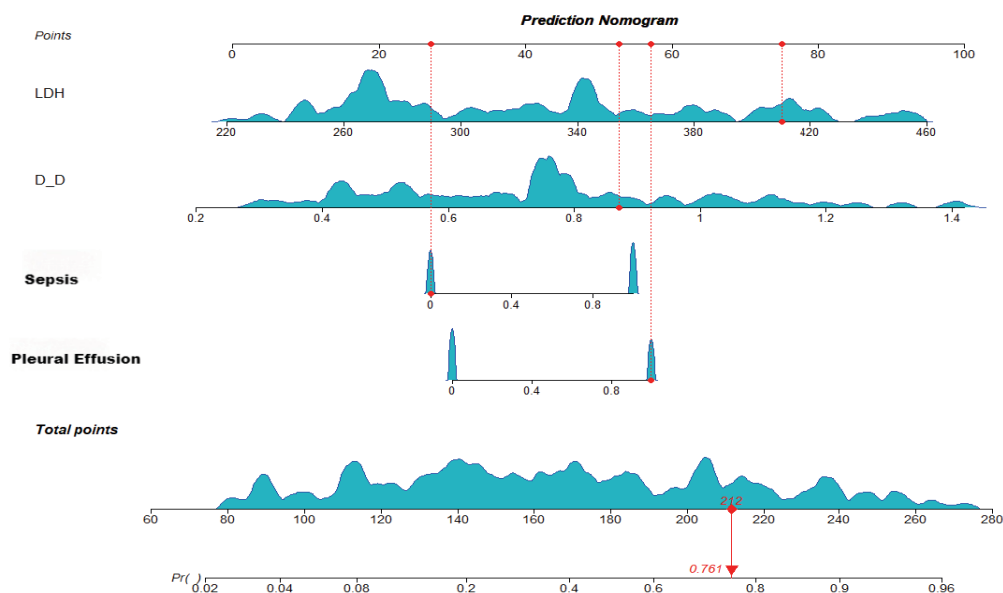


Figure 1. Nomogram predictive model for multiple bronchoscopic alveolar lavage procedures in children with MPP.

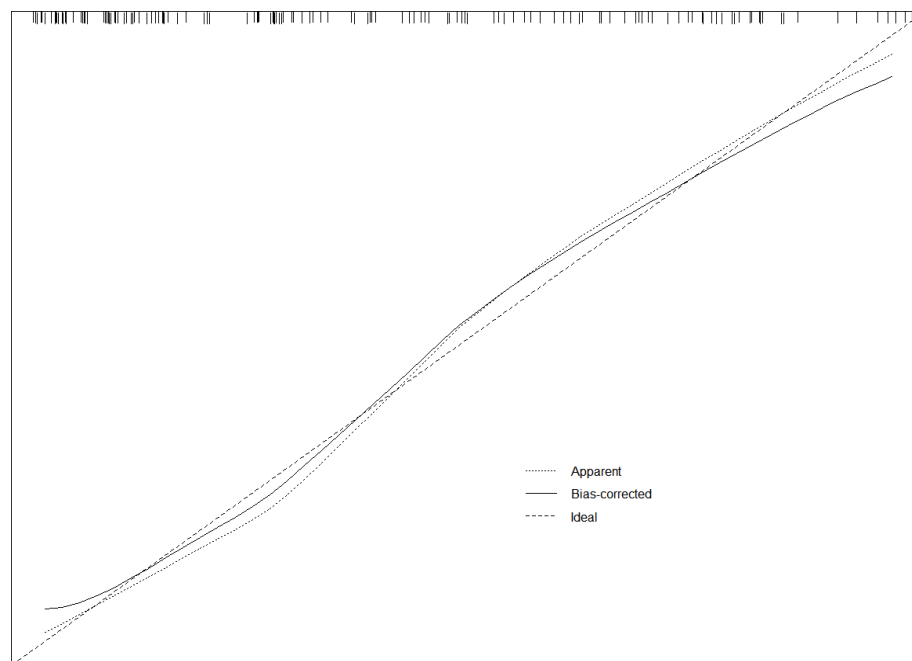


Figure 2. Calibration curve of the predictive model for judging multiple bronchoscopic alveolar lavage procedures in children with MPP.

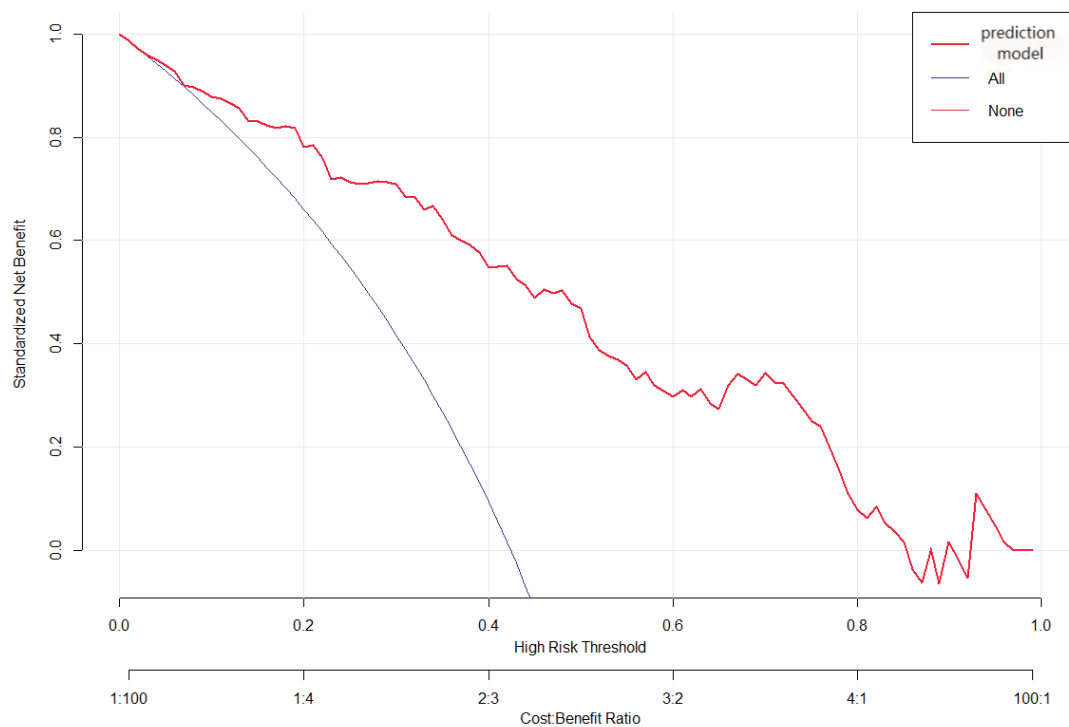


Figure 3. DCA analysis of the predictive model.

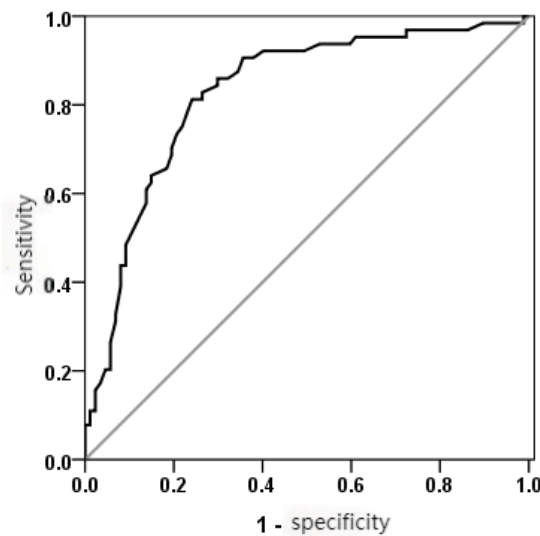


Figure 4. ROC analysis of the predictive model for determining the need for multiple bronchoscopic alveolar lavage procedures in children with MPP.

4. Discussion

Mycoplasma pneumoniae pneumonia (MPP) predominantly affects children. For those with severe or refractory MPP, bronchoscopic alveolar lavage can directly remove airway mucus plugs, reduce inflammatory mediators, relieve airway obstruction, alleviate clinical symptoms, and suppress inflammatory responses ^[5]. However, repeated bronchoscopic procedures can increase the risk of airway injury, leading to mucosal congestion and edema. In some children, it may even induce airway stenosis and fibrosis, resulting in permanent damage and affecting long-term prognosis ^[6]. Early identification of children requiring multiple bronchoscopic alveolar lavage procedures can guide clinical intervention, minimize injury, and improve prognosis.

This study revealed that pleural effusion is an independent risk factor for children with MPP requiring multiple bronchoscopic alveolar lavage procedures. This may be because the presence of pleural effusion indicates disease progression in children with MPP, with persistent inflammation leading to increased vascular permeability and fluid leakage into the pleural space ^[7]. Multiple bronchoscopic alveolar lavage procedures are thus necessary to accurately locate the lesion site and effectively flush out inflammatory exudates for precise treatment. Previous studies have also suggested that pleural effusion can compress lung tissue, obstructing the drainage of airway secretions ^[8]. Multiple bronchoalveolar lavages via bronchoscopy are beneficial in unblocking the bronchial lumen and facilitating the expulsion of secretions. Therefore, early identification of children with MPP complicated by pleural effusion plays a positive role in avoiding the need for multiple bronchoalveolar lavages.

This study also found that sepsis is a risk factor for multiple bronchoalveolar lavages in children with MPP. This may be because sepsis is a systemic inflammatory response syndrome, and the presence of sepsis in children with MPP often indicates a critical condition, with a large number of inflammatory secretions in the lungs and the accumulation of necrotic tissue in the bronchi and alveoli, thereby obstructing the airways ^[9,10]. In such cases, repeated bronchoalveolar lavages are often required to improve the airways and enhance oxygenation function. Additionally, the development of sepsis can affect the microcirculation in children with MPP, impair the alveolar-capillary barrier function, and lead to the accumulation of inflammatory secretions in the lungs, forming an

inflammatory storm^[11]. Multiple bronchoalveolar lavages can suppress the secretion of inflammatory factors, promote gas exchange, and improve respiratory function in these children.

Furthermore, this study also revealed that lactate dehydrogenase (LDH) and D-dimer (D-D) are independent risk factors for multiple bronchoalveolar lavages in children with MPP. LDH is closely related to the severity of MPP, and elevated LDH levels can further exacerbate the inflammatory response, increasing the amount of necrotic material and fibrin exudate in the airways, making it difficult to completely clear with a single bronchoalveolar lavage^[12]. Xie Youjun et al. also posited that an abnormal increase in LDH levels indicates that children with MPP are more prone to airway secretion obstruction, necessitating multiple bronchoscopic alveolar lavages to clear secretions and promote lung re-expansion^[13]. D-D, as a fibrin degradation product, an elevated D-D level suggests that children with MPP are in a hypercoagulable state, which may be accompanied by vascular endothelial damage and widespread inflammatory responses. This can impair the barrier function between alveoli and blood vessels, allowing inflammatory exudate to infiltrate the alveolar space and even increasing the risk of pulmonary edema. Clinically, multiple bronchoscopic alveolar lavages are required to facilitate the drainage of inflammatory secretions, correct vascular and alveolar obstruction, improve blood oxygen function, and enhance prognosis.

This study constructed a predictive model based on the results of multivariate analysis, which also demonstrated that the model's AUC for predicting the risk of multiple bronchoscopic alveolar lavages in children with MPP reached 0.828, indicating high accuracy. Therefore, clinical monitoring of D-D and LDH levels, along with early prevention and treatment of sepsis and pleural effusion, can help avoid multiple bronchoscopic alveolar lavages. However, this study was a retrospective analysis with a limited sample size. Future research should expand the sample size and conduct multicenter studies to externally validate the model and provide more evidence for clinical promotion.

5. Conclusion

In summary, multiple bronchoscopic alveolar lavages in children with MPP are associated with their D-D and LDH levels, as well as the presence of sepsis and pleural effusion. The predictive model constructed based on these factors aids in determining the likelihood of multiple bronchoscopic alveolar lavages in children with MPP and is worthy of clinical promotion and validation.

Disclosure statement

The authors declare no conflict of interest.

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Research Progress and Prospect of Biofeedback Technology Combined with Occupational Therapy in Hand Function Rehabilitation after Stroke

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Abstract: Hand function impairment after stroke has become a key and difficult issue in clinical rehabilitation due to complex neural innervation and a long recovery cycle. Biofeedback technology combined with occupational therapy can make up for the limitations of single therapy and provide a new solution for hand function rehabilitation after stroke. This paper systematically sorts out the theoretical basis and clinical research progress of biofeedback technology combined with occupational therapy in hand function rehabilitation after stroke, and looks forward to the future development direction, aiming to provide reference for clinical rehabilitation practice and scientific research.

Keywords: Stroke; Hand function rehabilitation; Biofeedback technology; Occupational therapy; Neuroplasticity

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1. Introduction

As one of the leading causes of disability in adults worldwide, stroke is characterized by high morbidity and high disability rate. Among them, hand function impairment is one of the most common sequelae after stroke. It not only affects patients' activities of daily living but also causes psychological problems such as anxiety and depression. In recent years, more and more studies have confirmed that biofeedback technology combined with occupational therapy has a synergistic effect in hand function rehabilitation after stroke, and has gradually become a research hotspot in this field.

2. Relevant theoretical basis

2.1. Pathophysiological mechanism of hand function impairment after stroke

The pathological basis of hand function impairment after stroke is the interruption of neural conduction pathways

caused by damage to the cerebral cortical motor area and the reduction of functional connections between bilateral primary motor cortices. Normal hand movement relies on motor instructions sent by the cerebral cortex, which regulate muscle contraction through spinal conduction pathways. Stroke can selectively damage large-scale neural circuits, leading to loss of normal neural innervation of patients' muscles, resulting in symptoms such as decreased muscle strength and motor coordination disorders^[1].

The theory of neuroplasticity refers to the brain's ability to undergo structural and functional adaptive changes during development, learning, and after trauma. Studies have confirmed that appropriate external stimulation and repetitive training can activate the brain's plasticity mechanism, promote the repair of damaged neural circuits and the establishment of new neural pathways.

2.2. Working principle and classification of biofeedback technology

Biofeedback technology is a rehabilitation technology based on motor learning theory. It collects patients' physiological parameters through sensors, converts them into perceptible feedback signals such as visual and auditory signals after processing. According to this information, patients can consciously adjust their muscle activity status to achieve neuro-muscular relearning. According to the type of feedback signals, biofeedback technologies used in hand function rehabilitation after stroke mainly include the following categories: electromyographic biofeedback technology, biomechanical biofeedback technology, and immersive virtual reality (VR) biofeedback technology.

2.3. Core connotation of occupational therapy

Occupational therapy is patient-centered and uses purposeful activities as the medium. Its goal is to help stroke patients restore or improve their activities of daily living, work ability, and social participation ability. In hand function rehabilitation, occupational therapy emphasizes designing training content according to patients' actual needs, such as sanding board pushing, roller training, screw tightening, finger-to-finger training, and daily training such as dressing and eating.

2.4. Synergistic mechanism of the combination of the two

2.4.1. Provide accurate assessment and realize personalized training

Biofeedback technology can provide objective and quantitative physiological parameters, helping therapists accurately assess the status of patients' hand muscle function and providing a scientific basis for the formulation of occupational therapy training plans; at the same time, according to the feedback data during patients' training, the content and intensity of occupational training can be adjusted in real time to achieve personalized rehabilitation.

2.4.2. Improve the initiative and effectiveness of training

The real-time feedback provided by biofeedback technology enables patients to clearly perceive the gap between their own movement status and goals, enhancing training enthusiasm; while the functional training content of occupational therapy provides practical application scenarios for biofeedback training, promoting the transformation of training effects into activities of daily living abilities.

2.4.3. Promote the synergistic activation of neuroplasticity

Biofeedback technology activates the neuroplasticity of the cerebral motor cortex through peripheral muscle

electrical signals; occupational therapy strengthens the neural connection between the brain and hand muscles through purposeful functional activities. The synergistic effect of the two can accelerate neural function reconstruction and promote the recovery of hand function.

3. Research progress of biofeedback technology combined with occupational therapy in hand function rehabilitation after stroke

3.1. Empirical research on clinical efficacy

In recent years, a number of clinical randomized controlled trials have confirmed the significant efficacy of biofeedback technology combined with occupational therapy in improving hand function in stroke patients, mainly reflected in the improvement of the following evaluation indicators.

3.1.1. Hand motor function scores

The Fugl-Meyer Assessment (FMA) and Action Research Arm Test (ARAT) are commonly used tools to evaluate upper limb and hand motor function in stroke patients. Zhang Zhijun conducted a study on 100 patients with upper limb hemiplegia after stroke, dividing them into an observation group (electromyographic biofeedback training combined with occupational therapy) and a control group (occupational therapy alone). After 4 weeks of treatment, the FMA upper limb score of the observation group was significantly higher than that of the control group^[2]. This indicates that the addition of biofeedback technology can more effectively improve the effect of occupational therapy on patients' hand motor function.

3.1.2. Activities of daily living ability

In a study involving 70 stroke patients by Wang Hongxiu et al., the observation group adopted electronic biofeedback technology combined with rehabilitation function training, and the control group adopted conventional rehabilitation training. After 5 weeks of treatment, the Modified Barthel Index (MBI) score of the observation group reached (68.5 ± 7.8) points, which was significantly higher than (52.1 ± 6.5) points of the control group ($p < 0.05$), indicating that the combination of the two can more effectively improve patients' daily living self-care ability^[3].

3.1.3. Hand function grading and muscle tension

Studies by Li Jinxian et al. showed that after 3 weeks of treatment, the Brunnstrom hand grading of the experimental group was higher than that of the observation group and the control group. In terms of muscle tension improvement, the Modified Ashworth Scale (MAS) score of the observation group decreased to (1.06 ± 0.11) points after treatment, which was significantly lower than (2.03 ± 0.28) points of the control group ($p < 0.05$), indicating that the combined therapy has advantages in relieving hand muscle spasticity and promoting the improvement of motor function grading.

3.1.4. Quality of life

The evaluation results of the Stroke-Specific Quality of Life Scale (SS-QOL) showed that biofeedback technology combined with occupational therapy can significantly improve patients' quality of life. In Zhang Zhijun's study, the SS-QOL score of the observation group after treatment reached (195.12 ± 14.87) points, which was higher

than (169.05 ± 14.12) points of the control group ($p < 0.05$). This is closely related to the improvement of patients' hand function and daily living self-care ability, and also benefits from the positive transformation of patients' psychological status during training.

3.2. Application research of different combined schemes

3.2.1. Electromyographic biofeedback combined with occupational therapy

Electromyographic biofeedback training detects the electrical activity signals of muscles through surface electrodes, amplifies and converts the collected signals into visual or auditory feedback, and presents them to patients, helping patients re-establish the communication channel between the brain and muscles^[4].

3.2.2. Virtual reality biofeedback combined with occupational therapy

With the development of virtual reality technology, combining it with biofeedback and occupational therapy has become a new research direction. This scheme aims to allow patients to complete occupational training in a virtual environment by creating virtual daily life scenarios, and at the same time, real-time feedback their electromyographic signals or movement parameters, quantify patients' training investment, and further improve their independent rehabilitation ability^[5].

3.2.3. Multimodal biofeedback combined with occupational therapy

Some studies have attempted to combine multiple biofeedback modalities, such as simultaneous use of electromyographic feedback and biomechanical feedback, to provide patients with more comprehensive training guidance^[6]. This multimodal combined scheme shows potential advantages in improving patients' fine hand motor function, but relevant research is still limited.

3.3. Application exploration in special populations

3.3.1. Chronic stroke patients

Due to the long course of disease, chronic stroke patients have greater difficulty in neural function recovery, and the effect of traditional rehabilitation therapy is often unsatisfactory^[7]. Murakami et al. used an artificial intelligence-integrated electromyography-driven upper limb rehabilitation robot for training (this scheme combines occupational therapy) in 20 chronic stroke patients. After 4 weeks, the patients' hand motor function was significantly improved, indicating that biofeedback technology combined with occupational therapy has a positive rehabilitation effect on chronic stroke patients.

3.3.2. Patients with severe hand function impairment

For patients with severe functional impairment with hand muscle strength below grade 3, simple occupational therapy is difficult to effectively activate target muscles. Biofeedback technology helps patients perceive subtle muscle activities by amplifying weak electromyographic signals, gradually establishing muscle control ability^[8]. Studies have shown that for such patients, the use of low-threshold electromyographic biofeedback combined with occupational therapy can effectively promote muscle strength recovery and lay the foundation for subsequent rehabilitation training.

4. Future prospect

4.1. Strengthen mechanism research and technological innovation

Basic research on the mechanism of action of the combined therapy should be strengthened. Combined with neuroimaging, neuroelectrophysiology and other technologies, the influence path on brain function reorganization and neuroplasticity should be explored to provide a theoretical basis for optimizing treatment plans^[9]. At the same time, promote the innovation of biofeedback technology, develop more portable, low-cost, and high-sensitivity equipment, and improve the accessibility of technology^[10].

4.2. Improve clinical research design

Carry out large-sample, multi-center, long-term follow-up randomized controlled trials to further verify the effectiveness and safety of the combined therapy, and clarify its scope of application in stroke patients with different courses and severity^[11]. At the same time, establish a standardized treatment plan and evaluation system, standardize biofeedback parameter settings and occupational training content, and ensure the comparability and reproducibility of research results.

4.3. Expand multi-technology combined application modes

Future rehabilitation treatment will integrate more technologies. Biofeedback technology and occupational therapy can be combined with central intervention methods to further enhance the activation effect of neuroplasticity^[12]. The integration of tele-rehabilitation technology will break the time and space limitations. Through the combination of wearable devices and remote platforms, patients can receive professional biofeedback training and occupational therapy guidance at home, which is very suitable for patients with limited mobility or living in remote areas^[13].

4.4. Promote clinical popularization and talent training

Strengthen policy support and technical assistance to grass-roots medical institutions, reduce the threshold for the use of biofeedback equipment, and promote the popularization of technology^[14]. At the same time, improve the training system for rehabilitation therapy talents, strengthen professional training on the combined application of biofeedback technology and occupational therapy, and improve therapists' clinical operation ability and comprehensive rehabilitation evaluation level^[15].

5. Conclusion

Biofeedback technology combined with occupational therapy has significant clinical efficacy in improving hand function, activities of daily living, and quality of life of stroke patients, and is one of the effective methods for treating hand function in stroke hemiplegic patients. In the future, it is necessary to further strengthen the combination of basic and clinical research, improve standardized treatment plans, promote the popularization of rehabilitation technology, and provide more high-quality and efficient rehabilitation services for stroke patients.

Disclosure statement

The author declares no conflict of interest.

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Research on the Application of “Internet + Continuous Nursing” in the Pregnancy Management of Pregnant Women with High-Risk Pregnancy

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Abstract: Pregnant women with high-risk pregnancy face a higher risk of complications due to factors such as chronic diseases, multiple pregnancies, and a history of adverse pregnancy and childbirth, requiring more systematic and dynamic health management support. In view of this, “Internet + continuous nursing” can break the limitations of time and space by integrating mobile communication, remote monitoring, data sharing, and intelligent analysis technologies, realizing closed-loop care with collaboration among hospitals, communities, and families. Research shows that continuous nursing based on the “Internet +” significantly improves the professional response ability of caregivers. Medical staff can grasp the patient’s status in real time, optimize diagnosis and treatment decisions, providing a feasible path for building an efficient, precise, and humanized high-risk pregnancy management system, which has broad clinical promotion value and public health significance.

Keywords: Internet + continuous nursing; Pregnant women with high-risk pregnancy; Pregnancy management

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1. Introduction

High-risk pregnancies, characterized by factors such as pre-existing chronic conditions, multiple gestations, or a history of adverse outcomes, present a significantly elevated risk of maternal and fetal complications. This necessitates more systematic and dynamic health management. The “Internet + continuous nursing” model, which leverages mobile communication, remote monitoring, and data analytics, offers a promising solution. By facilitating real-time collaboration among hospitals, communities, and families, this model breaks spatiotemporal barriers in care delivery. Evidence indicates that such an approach enhances the responsiveness of healthcare providers, optimizes clinical decision-making, and contributes to a more efficient, precise, and patient-centered

management system for high-risk pregnancy, holding substantial value for clinical practice and public health.

2. Intervention modes of “internet + continuous nursing”

2.1. Internet + hospital-community-family linked continuous management mode

By integrating medical resources and information technology, the “Internet + Hospital-Community-Family” linked continuous management mode provides a systematic and continuous health management path for pregnant women with high-risk pregnancy^[1]. With tertiary medical institutions as the core, this mode relies on the regional medical alliance structure to realize data sharing and collaborative services between professional medical teams in hospitals and grassroots community health service centers. Specifically, after pregnant women complete prenatal examinations or treatment in the hospital, their health records, risk assessment results, and personalized nursing plans are synchronously uploaded to the regional health information platform, allowing community medical staff to retrieve them in real time and carry out follow-up work.

At the hospital level, a multidisciplinary collaboration team composed of obstetricians, midwives, dietitians, and psychological consultants is established to conduct regular remote consultations on cases submitted by the community and dynamically adjust nursing plans. Community health institutions assume the intermediate connection function, assigning special personnel to connect with high-risk pregnant and lying-in women in their jurisdiction, collecting physiological parameters through mobile terminal devices, conducting health education lectures, and supervising the implementation of home care^[2]. As the basic unit for care implementation, families complete daily health data collection with the help of smart wearable devices and mobile applications, forming an information closed loop from hospital to community to family. In the entire process, all participants achieve role division and information interaction on a unified technical platform, breaking the time and space limitations of traditional medical services. This mode strengthens the collaboration efficiency between medical institutions at different levels, transforming high-risk pregnancy management from passive response to active prevention^[3].

2.2. “One-stop” platform service mode

The “one-stop” platform service mode builds an integrated medical service system relying on information technology, integrating electronic medical record systems, remote monitoring equipment, intelligent early warning modules, and multidisciplinary collaboration mechanisms. It can effectively break down data barriers between hospitals, communities, and families, allowing pregnant women to receive continuous and precise services in different care scenarios^[4].

The platform sets up personalized health management paths, automatically generating customized monitoring plans and educational content based on the specific risk factors of pregnant women, such as gestational hypertension, diabetes, or placenta previa. Health education resources are presented in the form of pictures, texts, audio, and short videos, covering nutrition guidance, exercise suggestions, complication prevention, and childbirth preparation, improving pregnant women’s disease awareness and self-management abilities^[5]. The online consultation function supports text, voice, and image interaction, shortening the distance between doctors and patients and reducing the number of unnecessary outpatient visits. For high-risk pregnant women with significant emotional fluctuations, the platform also embeds mental health assessment tools and psychological counseling channels, collaborating with psychologists to provide timely intervention.

The platform is connected to the regional medical and health system to realize mutual recognition of

inspection results and seamless connection of two-way referral. Community health service centers can obtain nursing plans issued by higher-level hospitals through the platform and feedback the implementation status, forming an upper-lower linked collaborative care network. After authorization, family members can view the pregnant woman's health status, participate in daily supervision and emotional support, and enhance care synergy. The platform also has data analysis and visualization functions, allowing managers to grasp core indicators such as service coverage, early warning response time, and patient compliance in real time, providing a basis for optimizing resource allocation and quality improvement. Currently, with the continuous iteration and upgrading of technology, the "one-stop" platform continuously integrates artificial intelligence-assisted decision-making and wearable device data access, promoting the development of high-risk pregnancy management towards intelligence and refinement^[6].

2.3. "Neo Raksha" mobile health application and "video consultation"

The "Neo Raksha" mobile health application realizes real-time data collection and transmission through intelligent terminal devices. Pregnant and lying-in women can complete daily recording of key indicators such as blood pressure, blood glucose, weight, and fetal movement at home. The system automatically identifies abnormal values and triggers an early warning mechanism to promptly notify medical staff for intervention. The application has built-in personalized health management plans, customizing follow-up plans and health education content according to the specific risk factors of each pregnant woman, such as gestational hypertension, diabetes, or placenta previa, improving management accuracy^[7].

The "video consultation" function is embedded in the "Neo Raksha" platform, enabling visual communication between doctors and patients. After discharge, pregnant women with high-risk pregnancy can still receive regular one-on-one online follow-up from specialist nurses or obstetricians. Consultations can be scheduled in advance, saving time and physical costs of traveling to the hospital. During video conversations, medical staff can observe the pregnant woman's mental state, home environment, and self-care behaviors, providing targeted technical guidance and psychological counseling^[8]. For individuals with limited mobility or living in remote areas, this service effectively makes up for the geographical limitations of traditional continuous nursing, ensuring the continuity of medical services.

All communication content adopts encrypted transmission technology to ensure the privacy and security of patients. The platform also has a reminder function, automatically prompting medication time, prenatal examination dates, and the completion of health tasks to improve compliance. Clinical practice shows that with the help of the "Neo Raksha" application and video consultation services, the self-management ability of pregnant women with high-risk pregnancy is significantly enhanced, the incidence of adverse pregnancy outcomes is reduced, and the efficiency of medical resource utilization is optimized.

3. Application effects of "internet + continuous nursing" in the pregnancy management of pregnant women with high-risk pregnancy

3.1. "Internet + continuous nursing" can improve caregivers' capabilities

Caregivers play a key role in the health management of pregnant women with high-risk pregnancy, and their professional level and response capabilities directly affect the safety and rehabilitation process of pregnant and lying-in women. The "Internet + continuous nursing" mode empowers caregivers through information means,

enabling them to achieve significant improvements in knowledge acquisition, risk identification, and emergency handling ^[9]. With the help of the Internet platform, caregivers can real-time access standardized training resources provided by medical institutions, such as key points for identifying common complications of high-risk pregnancy, methods for interpreting pregnancy monitoring indicators, and disposal procedures in emergency situations. In the actual care process, the platform supports caregivers to establish instant communication channels with the medical team. This remote collaboration mode shortens the decision-making response time and improves the scientificity and accuracy of care behaviors. Some systems integrate intelligent early warning functions, which can automatically analyze the vital sign data uploaded by pregnant women, issue reminders to caregivers once deviations from the normal range are found, and push corresponding intervention suggestions. This not only enhances caregivers' risk sensitivity but also improves their ability of independent judgment and initial handling ^[10].

"Internet + continuous nursing" also promotes the collaboration of multi-level care forces. On the one hand, hospital nurses can monitor the overall status of pregnant women in the background and conduct regular online follow-up and guidance for family caregivers; on the other hand, community medical staff can carry out offline home visits and health education according to platform task assignments. In this linkage mechanism, caregivers continuously accumulate practical experience and form standardized operating habits. Mobile applications record each care behavior and generate electronic logs for review and improvement. In addition, the platform has an experience sharing area, encouraging caregivers to exchange typical cases and nursing experiences, and improving overall care literacy through interaction. Long-term operation data shows that the pass rate of caregivers participating in this mode in knowledge assessment, skill operation, and stress response has increased significantly, and their ability to identify complex conditions and intervention efficiency have been substantially enhanced.

3.2. "Internet + continuous nursing" can improve pregnant women's self-care capabilities

Pregnant women with high-risk pregnancy face many physical and psychological challenges during pregnancy. The traditional nursing mode is limited by time, space, and resource allocation, making it difficult to achieve continuous and personalized health guidance ^[11]. After the introduction of "Internet + continuous nursing", pregnant women can obtain systematic and precise self-management support at different gestational weeks, significantly improving their self-care capabilities. With the help of mobile health platforms, pregnant women can real-time obtain personalized health education content through intelligent devices, such as dietary guidance, exercise suggestions, weight control, blood pressure monitoring, and methods for managing key indicators such as fetal movement recording. It helps pregnant women complete prenatal examination appointments, medication taking, and daily monitoring tasks on time, forming regular health management behaviors.

Through remote data upload, the nursing team can dynamically grasp the changes in the pregnant woman's vital signs and symptoms and promptly feedback adjustment suggestions, enabling pregnant women to receive professional guidance in a home environment. For example, pregnant women with gestational hypertension can measure their blood pressure at home and upload the data. The system automatically identifies abnormal values and triggers an early warning, and medical staff then intervene to avoid disease progression ^[12]. Psychological state is an important factor affecting self-care behaviors. "Internet + continuous nursing" can integrate psychological assessment tools and emotional counseling services, regularly pushing psychological adjustment resources such as relaxation training and mindfulness meditation to help pregnant women relieve anxiety and depression. Some applications also have mood check-in and sleep tracking functions to assist in identifying psychological risks and improving overall mental health. In the process of continuously receiving emotional support and technical

guidance, pregnant women can gradually establish self-efficacy and are willing to take active health behaviors.

4. Application prospects of “internet + continuous nursing” in the pregnancy management of pregnant women with high-risk pregnancy

4.1. Standardization of pregnancy management services in “internet + continuous nursing”

Under the “Internet + continuous nursing” mode, standardization is reflected in multiple dimensions. The establishment of information collection standards enables the standardized entry of pregnant women’s basic information, medical history records, examination results, and other data, facilitating cross-institutional sharing and dynamic tracking. The application of nursing assessment tools tends to be consistent, such as the adoption of a unified risk grading scale for the early identification of pregnancy complications, which helps to promptly formulate personalized intervention plans^[13]. The design of service paths reflects phased and continuous characteristics. From early pregnancy filing to postnatal follow-up, each stage has clear nursing goals and operational guidelines. The online platform automatically pushes health education content, follow-up reminders, and self-monitoring tasks according to the preset path, reducing human omissions. The remote consultation link sets response time limits and service language standards to ensure the professionalism and timeliness of communication. The division of responsibilities among medical team members is clear, with doctors, nurses, midwives, and health managers working collaboratively to form a closed-loop management mechanism. Data transmission and privacy protection comply with relevant national technical standards to ensure the security of patient information. System interfaces are compatible with electronic medical records, maternal and child health information systems, and other regional health platforms to support multi-source data integration and analysis^[14].

Continuously optimize service content based on big data feedback to achieve evidence-based decision-making. The quality control system runs through the entire process, regularly conducting service evaluations, including indicator compliance rates, abnormal situation handling efficiency, and patient compliance, as the basis for improvement. Standardization also promotes the replicable and scalable development of services. Different regions can adjust according to mature templates based on local conditions, shortening the exploration cycle. Policy support further accelerates the implementation of standards, providing a foundation for building a national high-risk pregnancy management system.

4.2. Professionalization of pregnancy care personnel in “internet + continuous nursing”

The advancement of the “Internet + continuous nursing” mode has transformed the role of pregnancy care personnel from traditional passive execution to active management, full-cycle tracking, and personalized guidance. Care personnel need to have solid professional knowledge in obstetrics and gynecology, be familiar with the pathological mechanisms and clinical manifestations of various high-risk factors such as gestational hypertension, diabetes, placenta previa, and multiple pregnancies, and be able to accurately identify changes in the condition and intervene in a timely manner. In the information context, care personnel also need to proficiently use “one-stop” service platforms and mobile health applications, such as “Neo Raksha”, to carry out online consultations, health education, psychological support, and follow-up management. This requires them to have certain information technology operation capabilities and network communication skills, enabling them to establish trust relationships in non-face-to-face situations and improve service accessibility and continuity. The application of video consultation services further improves the quality of interaction. Care personnel need to maintain a professional

image in front of the camera, with clear and standardized language expression, ensuring the accuracy and safety of medical information transmission ^[15]. In addition, the construction of a professional nursing team relies on systematic training and continuing education mechanisms. Medical institutions should formulate special training courses for high-risk pregnancy management, covering remote nursing processes, emergency response plans, legal and ethical norms, to strengthen care personnel's risk assessment and crisis response capabilities. By establishing a multidisciplinary collaboration mechanism, care personnel can form efficient linkage with obstetricians, dietitians, psychotherapists, etc., play a coordinating role in complex cases, and promote the transformation of nursing practice from experience-based to evidence-based.

5. Conclusion

In summary, the pregnancy management of pregnant women with high-risk pregnancy involves the collaborative cooperation of multiple links and multiple subjects. "Internet + continuous nursing" effectively connects hospitals, communities, and families through information technology, building a full-cycle nursing service system covering pre-pregnancy, pregnancy, and post-pregnancy. Relying on "one-stop" service platforms and mobile health applications such as "Neo Raksha", this mode realizes real-time monitoring of health data, remote consultation, personalized guidance, and risk early warning functions, making nursing services break through time and space limitations. Research shows that with the help of video consultation and online follow-up mechanisms, medical staff can timely grasp the physical condition and psychological changes of pregnant women, conduct dynamic assessment and intervention on common high-risk factors such as hypertension, diabetes, and abnormal fetal position, significantly reducing the incidence of complications. The trend of deep integration of technology and nursing is irreversible. In the future, further exploration should be made on unified data standards and cross-institutional collaboration mechanisms to improve the compatibility and security of the system.

Disclosure statement

The author declares no conflict of interest.

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Design and Application of Preoperative Checklist for Coronary Interventional Surgery Based on Multidisciplinary Collaboration

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Abstract: *Objective:* To design a preoperative checklist for coronary interventional surgery based on multidisciplinary collaboration, and verify its effect on improving the completeness rate of preoperative preparation, surgical punctuality, and medical staff satisfaction. *Methods:* A multidisciplinary team was established involving the Department of Cardiology, Anesthesiology, Clinical Laboratory, and Interventional Surgery. Referring to the latest clinical guidelines and nursing standards, a preoperative checklist covering 8 core modules and 61 sub-items was formulated, including “1 day before surgery + day of surgery” and “doctor + nurse + patient + family member”. A total of 213 patients undergoing coronary interventional surgery in our hospital from August 2023 to February 2024 (observation group) were selected to apply the checklist. The completeness rate of preoperative preparation and the on-time operation start rate were compared with 197 patients (control group) before the checklist application. The satisfaction of 34 medical staff was evaluated using a Likert 5-point scale. *Results:* The overall completeness rate of preoperative preparation in the observation group reached 95.72% (78.17% in the control group), among which the completeness rates of 6 sub-items such as medication, health education, and laboratory examinations reached 100%, and the completeness rate of consumables and equipment preparation was 97.1%; the on-time operation start rate was 97.3%; the satisfaction of the medical team with the checklist was 94.12%, which was significantly higher than that of the control group (82.61%), with statistically significant differences ($p < 0.05$). *Conclusion:* The preoperative checklist for coronary interventional surgery designed through multidisciplinary collaboration can significantly improve the quality of preoperative preparation and surgical efficiency, and is highly recognized by the medical team, providing practical reference for perioperative safety management of interventional diagnosis and treatment.

Keywords: Coronary interventional surgery; Preoperative checklist; Multidisciplinary collaboration; Perioperative management

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1. Introduction

Coronary interventional surgery is a minimally invasive technology that delivers catheters to the root of the aorta through peripheral arterial routes such as the radial artery and femoral artery, performing diagnostic and therapeutic operations including coronary angiography, balloon angioplasty, stent implantation, optical coherence tomography, intravascular ultrasound, and Fractional Flow Reserve measurement ^[1,2]. Preoperative preparation, as a key link in perioperative management, its implementation and the efficiency of medical-nursing collaboration directly affect intraoperative safety and surgical progress ^[3-6]. As an efficient quality inspection tool, the checklist can achieve rapid verification of important links through standardized item design, ensuring medical quality and safety ^[7-9]. To optimize perioperative nursing quality and medical work efficiency, this study designed a preoperative checklist for coronary interventional surgery based on multidisciplinary collaboration, applied it to the nursing management of 213 patients, and verified its effect, aiming to provide reference for clinical practice.

2. Materials and methods

2.1. General information

(1) Observation group

A total of 213 patients undergoing coronary interventional surgery in our hospital from August 2023 to February 2024, including 109 males and 104 females, aged 28–93 years (average 65.23 years). All patients received local anesthesia, and the surgery was successfully completed with stable postoperative conditions.

(2) Control group

A total of 197 patients undergoing coronary interventional surgery before the checklist application (January–July 2023). The baseline data were balanced and comparable with the observation group ($p > 0.05$), indicating comparability.

2.2. Methods

2.2.1. Checklist design

A special team composed of medical staff was established, with the Department of Cardiology responsible for formulating surgical plans, the Department of Anesthesiology conducting anesthesia risk assessment, the Clinical Laboratory reviewing preoperative indicators, and the Interventional Surgery Department preparing consumables/equipment. Based on the Interventional Nursing Guidelines and the latest clinical guidelines for coronary interventional diagnosis and treatment, combined with clinical pain points such as missing preoperative examinations and lack of consumables, the core framework of the checklist was designed as follows ^[1,3].

(1) Time dimension

Covering 1 day before surgery (basic preparation) and the day of surgery (real-time verification);

(2) Subject dimension

Including 4 types of subjects: doctor preparation (surgical plan, anesthesia assessment), nurse preparation (skin care, preoperative health education), patient preparation (dressing, medication cooperation), and family member preparation (informed consent, cost confirmation);

(3) Specific content

Detailed into 8 core items (medication, skin, jewelry and dressing, consumables and equipment,

preoperative health education, intraoperative medication, laboratory/imaging examinations, family members and costs), with a total of 61 sub-items. Each sub-item defines a “completion standard” (e.g., “skin preparation” requires recording the skin preparation range and presence of damage).

2.2.2. Checklist application process

(1) Distribution

On the day of admission, the responsible nurse places the checklist in the medical record folder, marking key time nodes (e.g., completing skin preparation before 16:00 on the day before surgery);

(2) Filling and verification

The responsible nurse checks “√” after completing each item, and explains special situations (e.g., patient refuses to remove jewelry) in the remark column; the operating room nurse conducts a second verification during the follow-up visit on the day before surgery, and confirms with the responsible nurse without omissions;

(3) Handover and filing

Before patient transfer, personnel from the ward and interventional operating room conduct a two-person handover based on the checklist; after the operation, the nursing supervisor sorts out the checklist in chronological order and files it for 6 months for quality traceability.

2.2.3. Quality control

Problems in the use of the checklist are fed back at the monthly department meeting, such as “missing preoperative examinations”, which are optimized through multidisciplinary team discussions: for example, adding prompt items such as “blood routine, liver and kidney function, cardiac ultrasound, and infectious disease screening” to the “laboratory and imaging examinations” item; the nursing supervisor randomly checks the standardization of checklist filling and counts the execution rate and completeness rate of each item.

2.2.4. Evaluation indicators and statistical methods

(1) Completeness rate of preoperative preparation

The completeness rate of a single item = (number of patients who completed the sub-item / total number of patients) × 100%, and the overall completeness rate is the average of the completeness rates of 8 single items;

(2) On-time operation start rate

Record the difference between the actual operation start time and the planned time, with ≤ 15 minutes considered on-time;

(3) Medical staff satisfaction

Evaluated using a Likert 5-point scale (very satisfied = 5 points, very dissatisfied = 1 point) from 3 dimensions: “information comprehensiveness, ease of use, and content accuracy”. “Very satisfied + satisfied” were included in the satisfaction rate.

(4) Statistical methods

SPSS 26.0 software was used for analysis. Count data were expressed as rates (%), and inter-group comparisons were performed using χ^2 test. A p -value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of completeness rate of preoperative preparation

The completeness rates of the 8 core items in the observation group were higher than or equal to those in the control group, with an overall completeness rate of 95.72% (78.17% in the control group), showing a significant difference ($p < 0.05$). Among them, the completeness rates of 4 items (medication, preoperative health education, intraoperative medication, laboratory and imaging examinations) reached 100%, the completeness rate of consumables and equipment preparation was 97.1%, and only the completeness rate of family member and cost preparation (84.6%) was basically the same as that of the control group (84.77%), as shown in **Table 1**.

Table 1. Comparison of completeness rate of preoperative preparation between the two groups (%)

Items	Medication preparation	Skin preparation	Jewelry and dressing preparation	Consumables and equipment preparation	Pre operative health education	Laboratory and imaging examinations	Family member and cost preparation	Overall completeness rate
Control group (n = 197)	83.77	88.83	89.85	90.86	76.29	91.88	84.77	78.17
Observation group (n = 213)	100.00	92.30	91.50	97.10	100.00	100.00	84.60	95.72
χ^2 value	42.15	3.98	0.52	12.37	68.51	23.64	0.01	102.43
p value	< 0.001	0.046	0.471	< 0.001	< 0.001	< 0.001	0.925	< 0.001

3.2. On-time operation start rate and medical staff satisfaction

The on-time operation start rate in the observation group was 97.3% (207/213), and that in the control group was 81.2% (160/197), with a statistically significant difference ($\chi^2 = 28.76$, $p < 0.001$). A total of 34 medical staff satisfaction questionnaires were distributed, with a recovery rate of 100%. The overall satisfaction rate in the observation group was 94.12% (32/34), including 95.65% (22/23) for nurses and 90.91% (10/11) for doctors; the overall satisfaction rate in the control group was 82.61% (28/34), including 82.61% (19/23) for nurses and 81.82% (9/11) for doctors, with significant inter-group differences ($p < 0.05$), as shown in **Table 2**.

Table 2. Comparison of satisfaction of medical teams between the two groups (n, %)

Group	Subgroup	Very satisfied	Satisfied	Generally satisfied	Dissatisfied	Satisfaction rate
Nurses (n = 23)	Control group	5	14	3	1	82.61
	Observation group	13	9	1	0	95.65
Doctors (n = 11)	Control group	3	6	2	0	81.82
	Observation group	6	4	1	0	90.91
Overall (n = 34)	Control group	8	20	5	1	82.61
	Observation group	19	13	2	0	94.12

4. Discussion

As a minimally invasive interventional diagnosis and treatment technology, the perioperative safety of coronary interventional surgery is highly dependent on multidisciplinary collaboration^[1,6]. Targeting clinical problems such as “fragmented preoperative preparation and easy omissions in handover links”, this study designed a checklist

through multidisciplinary team collaboration, achieving three core values.

4.1. Standardizing the preoperative preparation process

The checklist integrates scattered links such as “doctor’s plan formulation, nurse’s skin preparation, and family member’s informed consent” into 8 core modules ^[10]. The 61 sub-items define clear “completion standards”, avoiding preparation omissions caused by differences in personal experience. For example, the completeness rates of medication and health education in the observation group reached 100%. This is consistent with the concept of the preoperative checklist for small intestinal transplantation designed by Cen Luoxu et al., both reducing the risk of human error through checklist-based approach ^[4].

4.2. Improving surgical efficiency and safety

The on-time operation start rate in the observation group reached 97.3%, significantly higher than that in the control group. The core reason is that the checklist clarifies the completion time limits for key links such as “consumables and equipment preparation” and “intraoperative medication”, reducing surgical delays caused by lack of equipment and missing drugs; at the same time, the 100% completeness rate of laboratory and imaging examinations provides accurate basis for adjusting surgical plans, reducing perioperative risks ^[8].

4.3. Optimizing the medical-nursing collaboration experience

The 94.12% medical staff satisfaction indicates that the checklist simplifies the handover process (e.g., two-person verification mechanism), reducing redundant communication costs; nurses reported improved “information comprehensiveness”, and doctors believed that “content accuracy” helps with preoperative risk assessment, which is consistent with the conclusion reported by Hall et al. that “neurosurgical postoperative checklists improve medical-nursing collaboration” ^[7].

5. Conclusion

This study has limitations: the completeness rate of family member and cost preparation did not improve significantly, which may be related to family members’ insufficient understanding of the cost process. In the future, it is necessary to cooperate with the Finance Department to optimize the guidance content of “cost confirmation” in the checklist; in addition, the checklist needs to be dynamically updated with new technologies in coronary interventional diagnosis and treatment, such as the application of drug-eluting balloons.

In summary, the preoperative checklist for coronary interventional surgery based on multidisciplinary collaboration can effectively improve the quality of preoperative preparation and surgical efficiency, providing a promotable practical plan for perioperative safety management of interventional diagnosis and treatment.

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Disclosure statement

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Development of a Liquid Bandage Containing Rhubarb and Borneol

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Abstract: To address the limitations of traditional adhesive bandages such as poor air permeability, insufficient adaptability, and single function, this study developed a novel liquid bandage using rhubarb and borneol as core raw materials, polyvinyl butyral as the film-forming matrix, combined with glycerol and diethyl phthalate. The preparation process was optimized via $L_9(3^4)$ orthogonal experiment, with film-forming time, film adhesion, and 24-hour emodin dissolution rate as evaluation indicators to determine the optimal process parameters. The product's film-forming performance, antibacterial activity, skin safety, and wound healing-promoting effect were systematically investigated. Results showed that the optimal process parameters were: rhubarb extract concentration of 12%, borneol concentration of 1.5%, and film-forming temperature of 45 °C. Under these conditions, the product had a film-forming time of 3.2 ± 0.3 min, film adhesion of 3.8 ± 0.2 N, and 24-hour emodin dissolution rate of $86.7 \pm 1.6\%$. Performance evaluation indicated that the product exhibited excellent water resistance, antibacterial activity, hemostatic effect, and high stability. This liquid bandage achieves efficient integration of traditional Chinese medicine efficacy and modern film-forming technology, holding promising application prospects in the field of wound care.

Keywords: Liquid bandage; Rhubarb; Borneol; Orthogonal experiment; Wound healing

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1. Introduction

As a core material for daily trauma care, bandages have long dominated the household care market due to their portability, simplicity of operation, and low cost^[1,2]. However, traditional adhesive bandages have three core limitations: first, poor air permeability easily leads to wound moisture and bacterial growth, triggering secondary infections; second, insufficient adaptability causes easy detachment during limb movement, failing to form a continuous protective barrier; third, single function only achieves physical isolation, lacking active antibacterial, anti-inflammatory, and healing-promoting therapeutic effects, which is difficult to meet the care needs of complex wounds^[3,4]. As a new type of wound care material, liquid bandage rapidly forms a transparent film after spraying or smearing on the wound, integrating both physical protection and drug therapy, effectively making up for the defects of traditional products. Moreover, it can adaptively extend with skin deformation, perfectly fitting movable

parts such as joints ^[4].

Traditional Chinese medicine (TCM) has inherent advantages of “multi-component and multi-target” in wound care: rhubarb is rich in anthraquinone compounds such as emodin and rhein, and modern pharmacological studies have confirmed that its inhibition rate against common wound pathogens such as *Staphylococcus aureus* and *Escherichia coli* can reach more than 85%, reducing wound redness and swelling; borneol can expand transdermal absorption channels and alleviate wound pain and discomfort ^[5,6]. Some previously reported TCM liquid bandages have obvious wound stinging sensation due to high ethanol content, affecting user experience ^[7]. Based on this, this study used polyvinyl butyral as the film-forming matrix and glycerol as the plasticizer, optimizing the compound ratio of rhubarb and borneol and the preparation process via orthogonal experiment, aiming to develop a novel liquid bandage with rapid film formation, safety, painlessness, efficient antibacterial activity, and healing-promoting function.

2. Materials and methods

2.1. Experimental materials

2.1.1. Medicinal materials and reagents

(a) Rhubarb

Purchased from Beijing Tongrentang (Group) Co., Ltd., Batch No. 2023100;

(b) Borneol

Purchased from Shanghai Pharmaceutical Group Co., Ltd., Batch No. 20231002;

(c) Polyvinyl butyral

Purchased from Sinopharm Chemical Reagent Co., Ltd.;

(d) Glycerol, diethyl phthalate

Purchased from Jiangsu Yurun Biomedical Co., Ltd.

2.1.2. Instruments and equipment

(a) Electronic balance (ME204E)

Mettler Toledo Instruments (Shanghai) Co., Ltd.;

(b) Constant temperature water bath (HH-S4)

Shanghai Yiheng Scientific Instruments Co., Ltd.;

(c) Rotary evaporator (RE-52AA)

Shanghai Yarong Biochemical Instrument Factory.

2.2. Experimental methods

2.2.1. Preparation of rhubarb extract

The ethanol reflux extraction method was used to optimize the extraction process of active components from rhubarb: rhubarb medicinal materials were crushed and passed through a 40-mesh sieve; 10.0 g was accurately weighed, and 70% ethanol was added at a solid-liquid ratio of 1:10. The mixture was placed in a round-bottom flask and reflux extracted in a constant temperature water bath at 60 °C for 2 h, then filtered while hot with double-layer qualitative filter paper to remove residues ^[8]. The filtrate was concentrated to a relative density of 1.20 using a rotary evaporator to obtain the rhubarb extract.

The emodin content in the extract was determined by HPLC: chromatographic column was Agilent ZORBAX SB-C18; mobile phase was methanol 0.1% phosphoric acid solution (85:15, v/v); detection wavelength was 254 nm; column temperature was 30 °C; flow rate was 1.0 mL/min; injection volume was 10 µL. Results showed that the emodin content in the rhubarb extract was 1.12 mg/mL.

2.2.2. Preparation of borneol solution

10.0 g of borneol was accurately weighed, dissolved in anhydrous ethanol to a constant volume of 100 mL, and stirred at room temperature on a magnetic stirrer for 15 min until completely dissolved, preparing a 10% (w/v) borneol ethanol solution ^[9].

2.2.3. Preparation of film-forming matrix

Raw materials were weighed according to the basic formula: polyvinyl butyral 15%, glycerol 2%, diethyl phthalate 0.5%, and purified water 82.5%. Polyvinyl butyral was slowly added to purified water, stirred in a constant temperature magnetic stirrer at 50 °C for 2 h until completely dissolved to form a transparent viscous solution; glycerol and diethyl phthalate were then added, and stirring was continued for 30 min to mix uniformly; the mixture was left to stand at room temperature for 30 min to remove bubbles, obtaining the film-forming matrix.

2.2.4. Compound process of rhubarb-borneol liquid bandage

Rhubarb extract and borneol solution were added to the film-forming matrix at a ratio of 3:1, stirred on a magnetic stirrer at room temperature; the mixture was filtered through a 0.22 µm microporous membrane and dispensed into brown light-proof spray bottles to obtain liquid bandage samples.

2.2.5. Optimization design of preparation process

Based on single-factor preliminary experiments, three key influencing factors were selected, and the process was optimized using $L_9(3^4)$ orthogonal experimental design, with 3 levels set for each factor. The experimental design and levels were shown in **Table 1**. Film-forming time (Y_1 , min), film adhesion (Y_2 , N), and 24-hour emodin dissolution rate (Y_3 , %) were used as evaluation indicators. Each experimental point was repeated 3 times, and the average value was used for data analysis.

Table 1. Factors and levels of $L_9(3^4)$ orthogonal experiment

Level	Factor A: Rhubarb extract concentration (%)	Factor B: Borneol concentration (%)	Factor C: Film-forming temperature (°C)
1	8	1.0	35
2	10	1.5	45
3	12	2.0	55

2.2.6. Determination methods of evaluation indicators

(1) Film-forming time determination

A clean glass slide was taken, and 50 µL of sample was accurately pipetted and uniformly spread on the slide surface. The slide was placed in a constant temperature and humidity chamber with set temperature and 50% relative humidity, and a stopwatch was used to record the time from completion of smearing to

complete drying of the film ^[10].

(2) Film adhesion determination

Fresh pigskin was taken, and the sample was uniformly spread on the pigskin surface, then dried to form a film at the corresponding film-forming temperature; a digital display tensile testing machine was used to determine the 180° peel strength between the film and pigskin, with a tensile speed of 10 mm/min and a sensor range of 10 N. The maximum force during peeling was taken as the film adhesion ^[11].

(3) 24-hour emodin dissolution rate determination

The dialysis bag method was used to simulate the in vivo drug release process. 2 mL of sample was accurately pipetted into a dialysis bag, sealed and immersed in 50 mL of PBS, and oscillated in a constant temperature water bath at 37 °C; 5 mL of sample was taken at 1, 2, 4, 6, 8, 12, and 24 h respectively. After filtering through a 0.22 μm membrane, the emodin concentration was determined by HPLC, and the 24-hour dissolution rate was calculated.

(4) Dissolution rate calculation formula

24-hour emodin dissolution rate (%) = (Total cumulative emodin dissolved within 24 h / Initial total emodin in sample) × 100%

2.2.7. Product performance evaluation

(1) Physical performance evaluation

Appearance: The color, clarity, and film transparency of the sample were observed with the naked eye; pH value: The pH value of the sample was determined with a pH meter, repeated 3 times in parallel; Stability: Samples were stored at 4 °C, 25 °C, and 40 °C for 30 d, observed every 5 d to record whether stratification, precipitation, or discoloration occurred.

(2) Wound healing-promoting experiment

Two healthy SD rats were selected, and wounds were created on their tails. Three groups were set: blank control group (normal saline) and sample group (this study's product). Wounds were cleaned with sterile normal saline and hemostasis was performed. Treatment methods for each group including blank control group: 0.1 mL of normal saline was applied with a sterile cotton swab daily; sample group: 0.1 mL of the product was applied with a sterile cotton swab daily. Then, wounds were photographed with a camera after medication to record the repair effect.

3. Results and analysis

3.1. Optimization results of preparation process

3.1.1. Orthogonal experiment results and range analysis

The results and range analysis of the $L_9(3^4)$ orthogonal experiment was shown in **Table 2**. Range analysis indicated that the order of influence of each factor on film-forming time (Y_1) was: C (film-forming temperature) > A (rhubarb extract concentration) > B (borneol concentration). Comprehensive consideration of the three evaluation indicators determined the optimal process parameters as $A_3B_2C_2$, i.e., rhubarb extract concentration of 12%, borneol concentration of 1.5%, and film-forming temperature of 45 °C.

Table 2. Results and range analysis of L9(34) orthogonal experiment

Experiment No.	A	B	C	D	Film-forming time Y_1 (min)	Film adhesion Y_2 (N)	Emodin dissolution rate Y_3 (%)
1	1	1	1	1	4.8 ± 0.4	3.2 ± 0.2	75.3 ± 1.8
2	1	2	2	2	3.9 ± 0.3	3.4 ± 0.2	81.5 ± 1.6
3	1	3	3	3	3.1 ± 0.2	3.5 ± 0.2	83.2 ± 1.5
4	2	1	2	3	3.7 ± 0.3	3.5 ± 0.2	78.6 ± 1.7
5	2	2	3	1	2.9 ± 0.2	3.7 ± 0.2	85.4 ± 1.4
6	2	3	1	2	4.5 ± 0.3	3.6 ± 0.2	82.1 ± 1.6
7	3	1	3	2	3.0 ± 0.2	3.7 ± 0.2	80.2 ± 1.5
8	3	2	1	3	4.2 ± 0.3	3.9 ± 0.2	84.5 ± 1.3
9	3	3	2	1	2.8 ± 0.2	3.8 ± 0.2	87.1 ± 1.4
K_1	3.93	3.83	4.50	5.45	-	-	-
K_2	3.17	3.67	3.47	4.64	-	-	-
K_3	3.33	3.13	2.93	3.11	-	-	-
R	0.76	0.70	1.57	2.34	-	-	-

Note: K is the average value of indicators at the same level of each factor; R is the difference between the maximum and minimum K values under the same indicator.

3.1.2. Verification experiment

To verify the reliability of the optimal process, 3 batches of samples were prepared according to the $A_3B_2C_2$ parameters, and film-forming time, film adhesion, and 24-hour emodin dissolution rate were determined. Results showed that the film-forming time of the 3 batches of samples was (3.2 ± 0.3) min, film adhesion was (3.8 ± 0.2) N, and 24-hour emodin dissolution rate was $(86.7 \pm 1.6\%)$, with relative standard deviation (RSD) $< 5\%$, indicating stable and reliable process with good repeatability.

3.2. Product performance evaluation results

3.2.1. Physical performance

(a) Appearance and film thickness

The sample was a pale-yellow transparent liquid without turbidity or precipitation; after drying, it formed a uniform and transparent film with a smooth surface free of pores or spots (**Figure 1**).



Figure 1. Rhubarb-borneol liquid bandage sample.

(b) pH value

The pH value of the sample was (6.8 ± 0.2), which was within the skin tolerance range (6.0–7.5), reducing irritation to the wound.

(c) Stability

Samples stored at 4 °C and 25 °C for 30 d showed no stratification, precipitation, or discoloration; the film-forming time change rate was 8.5%, and the film adhesion change rate was 7.2%, both $\leq 10\%$; slight stratification occurred after storage at 40 °C for 15 d, indicating that the sample should be stored at room temperature or refrigerated to avoid high temperatures.

3.2.2. Wound healing-promoting effect

Figures 2a1 and **2a2** were hemostasis photos of mice treated with normal saline; it was seen from **Figure 2a2** that blood still flowed out after applying normal saline to mice with tail injuries. **Figures 2b1** and **2b2** were hemostasis photos of mice treated with the rhubarb-borneol liquid bandage; it can be seen that bleeding stopped after applying the product to mice with tail injuries. This indicates that the rhubarb-borneol liquid bandage has a good hemostatic effect and can promote wound healing.

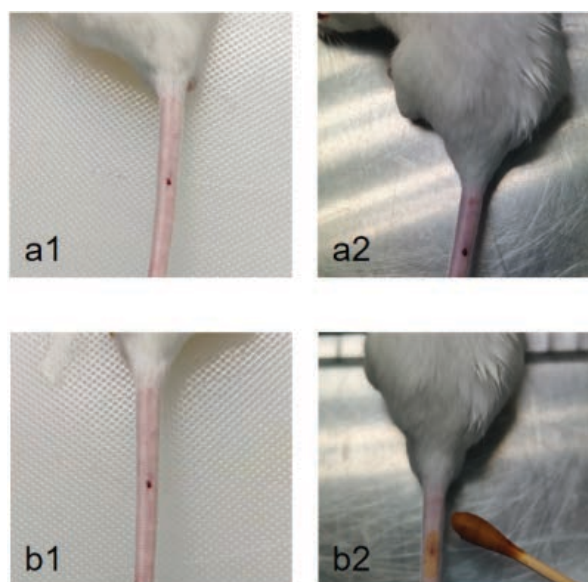


Figure 2. Hemostasis photos of the rhubarb-borneol liquid bandage.

4. Discussion

4.1. Film-forming mechanism

As the film-forming matrix, polyvinyl butyral can form a three-dimensional network structure through hydrogen bonds between hydroxyl groups on its molecular chain, forming a continuous and transparent film^[11]. Glycerol, as a plasticizer, can insert between polyvinyl butyral molecular chains, weakening intermolecular forces, reducing the glass transition temperature of the film, and improving flexibility; diethyl phthalate further enhances film ductility by forming ester bonds with polyvinyl butyral, avoiding film breakage during joint movement^[12].

4.2. Synergistic mechanism of rhubarb and borneol

The synergistic effect of rhubarb and borneol is the core of the product's function.

(1) Antibacterial synergy

Emodin destroys bacterial cell membrane integrity, causing leakage of intracellular substances; borneol enhances bacterial cell membrane permeability, promoting emodin entry into bacteria, together improving bactericidal efficiency. Experiments showed that the compound antibacterial rate was 15–20% higher than that of rhubarb alone.

(2) Penetration-promoting synergy

D-borneol in borneol changes the lipid arrangement of the skin stratum corneum, forming “temporary channels” to promote transdermal absorption of emodin

(3) Anti-inflammatory and analgesic synergy

Emodin reduces wound redness and swelling by inhibiting the release of inflammatory factors; borneol activates skin cold receptors, producing a cool sensation to mask wound pain and improve user comfort [13,14].

4.3. Advantage comparison with traditional bandages

Compared with traditional adhesive bandages, the rhubarb-borneol liquid bandage developed in this study has significant advantages.

(1) Better adaptability

The film can adaptively extend with skin deformation, achieving higher coverage on irregular parts such as finger joints and finger gaps

(2) More comprehensive functions

Integrating physical protection and drug therapy, while traditional bandages only achieve physical protection

(3) Higher safety

No adhesive, avoiding allergic reactions, suitable for people with sensitive skin

(4) Better user experience

The transparent film does not affect appearance, has good air permeability, and avoids wound moisture [15]

4.4. Research limitations and improvement directions

This study has the following limitations

(1) The stability study only lasted 30 d, and the impact of long-term storage (> 3 months) on components and performance needs further investigation

(2) The wound healing-promoting experiment only used rat models, and the applicability to human wounds (such as diabetic foot ulcers and pressure ulcers) requires clinical research verification

(3) The inhibitory effect of the product on fungi was not investigated, failing to cover the care needs of fungal wounds

Future research can be improved from three aspects

(1) Adding antioxidants and stabilizers to extend the product shelf life

(2) Conducting multi-center clinical trials to verify the product's efficacy in different types of human wounds

(3) Introducing antifungal components to expand the product's application range

5. Conclusion

In this study, a novel rhubarb-borneol liquid bandage was successfully developed using polyvinyl butyral as the film-forming matrix, and rhubarb and borneol as core active components. The preparation process was optimized via $L_9(3^4)$ orthogonal experiment. The optimal process parameters were rhubarb extract concentration of 12%, borneol concentration of 1.5%, and film-forming temperature of 45 °C. Under these conditions, the product had rapid film formation (3.2 ± 0.3 min), good film adhesion (3.8 ± 0.2 N), and high emodin dissolution rate ($86.7 \pm 1.6\%$).

This study achieves effective integration of traditional Chinese medicine and modern film-forming technology, providing a practical scheme for the innovation of wound care materials. The product has wide raw material sources, simple preparation process, and controllable cost, with industrialization potential. It is expected to become an upgraded alternative to traditional bandages, offering a new choice for clinical trauma care and family health management.

Disclosure statement

The authors declare no conflict of interest.

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Application and Prospect of Artificial Intelligence in Acute and Critical Care Nursing Teaching

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Abstract: Driven by social needs, national policies, and digital innovation, the traditional teaching model of acute and critical care nursing can no longer meet the demand for high-quality acute and critical care nursing talents in modern medical care. Artificial intelligence (AI) technology provides effective innovative solutions for acute and critical care nursing teaching through capabilities such as virtual simulation, big data technology, and natural language processing. This paper systematically sorts out the application scenarios of AI in acute and critical care nursing teaching, analyzes the current challenges such as technical costs, teachers' literacy, and ethical risks in application, and looks forward to the future development direction from the dimensions of technological integration, policy support, and talent training, aiming to provide useful references for the reform of acute and critical care nursing teaching.

Keywords: Artificial intelligence; Acute and critical care nursing; Nursing teaching; Virtual simulation; Large language model; Personalized learning

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1. Introduction

The "Action Plan for Further Improving Nursing Services (2023–2025)" jointly issued by the National Health Commission and the National Administration of Traditional Chinese Medicine clearly proposes to use new-generation information technologies such as AI and 5G to optimize nursing service processes and strengthen the informatization development of nursing, which provides a clear direction for the intelligent transformation of acute and critical care nursing teaching. Acute and critical care nursing requires nurses to have comprehensive abilities in rapid condition assessment, accurate operation execution, and multi-disciplinary collaborative response. Introducing AI-assisted teaching can construct virtual simulation training environments, supplement teaching resources, improve the practicality of nursing teaching, and exercise students' clinical adaptability.

2. Core application scenarios of AI in acute and critical care nursing teaching

2.1. Constructing clinical training scenarios with virtual simulation technology

Virtual simulation technology can reproduce acute and critical care clinical scenarios through the integration of 3D modeling and real-time interaction algorithms, allowing students to conduct operational drills^[1]. Currently, mainstream application forms include VR intensive care unit (ICU) simulation, AR first-aid process guidance, and digital twin patient systems, with specific applications as follows.

2.1.1. VR intensive care scenario training

With VR devices such as HTC Vive and Oculus Rift, a virtual ICU can be constructed, including equipment such as multi-functional monitors, ventilators, and CRRT used in real scenarios. Students can operate virtual equipment through handles to simulate scenarios such as “adjusting ventilator parameters for patients with respiratory failure” and “infusing vasoactive drugs for patients with hypotension”. The system advances the training process according to students’ operation steps and corrects errors through voice prompts^[2].

2.1.2. AR first-aid process visualization

In operation training such as cardiopulmonary resuscitation (CPR) and tracheal intubation, students can wear AR glasses. For example, during CPR training, the AR interface can real-time display prompts such as “compression depth 5–6 cm” and “compression frequency 100–120 times per minute”, and correct compression angle deviations through motion capture technology to improve the standardization rate of students’ CPR operations.

Digital Twin Patient System AI-driven virtual patients constructed based on real clinical cases are used in students’ practical training. For example, an AI-driven acute myocardial infarction patient can be constructed, and the virtual patient will show symptoms such as arrhythmia and hypotension according to operational feedback. Students need to make accurate judgments on the patient’s condition and take first-aid measures^[3]. The system can determine whether their operations are correct based on the measures taken by students.

2.2. Creating intelligent teaching interaction and resource generation tools with large language models

Large language models represented by ChatGPT 4.0 and Wenxin Yiyan 4.0 can act as intelligent teaching assistants in acute and critical care nursing teaching by virtue of their natural language processing capabilities, with specific applications including the following three aspects.

Firstly, providing personalized Q&A for students to strengthen their learned knowledge. Students can ask difficult questions about acute and critical care nursing through the dialogue interface, such as “principles of fluid resuscitation in patients with septic shock”. The model can not only output standardized answers but also expand with cases to guide students to deepen their understanding^[4].

Secondly, generating clinical cases to provide efficient resource development support for teachers. Acute and critical care nursing teaching requires a large number of clinical cases. With large language models, teachers can obtain cases meeting teaching requirements by simply inputting keywords matching teaching focuses^[5].

Thirdly, simulating inter-professional communication to train students’ thinking logic. In acute and critical care nursing practice, nurses need to cooperate closely with doctors, and efficient inter-professional communication directly affects patient treatment efficiency and prognosis^[6]. In training, teachers can set specific disease backgrounds according to teaching objectives, allowing students to report the condition to a “virtual

doctor” simulated by the model in the role of nurses. The doctor simulated by the model will ask follow-up questions based on the concerns of clinical doctors in assessing the condition.

2.3. Improving the precision of teaching evaluation with intelligent assessment and feedback systems

AI can make teaching evaluation more objective and comprehensive by collecting and analyzing students’ learning data, providing a basis for teaching improvement.

Quantitative scoring of operational details is one of the important functions of intelligent assessment systems. In first-aid training simulations, the system deploys infrared sensors and motion capture cameras (such as Kinect) to real-time capture data of each operation step of students. For example, in defibrillation operation assessment, the system automatically records indicators such as electrode placement position, charging time, and interval between compression and defibrillation for scoring, and finally forms a quantitative assessment report^[7].

Visual assessment of clinical thinking refers to converting students’ thinking into analyzable and evaluable specific paths through virtual case decision-making tools. In the assessment, the system presents typical acute and critical care cases, such as nursing scenarios for patients with acute respiratory distress syndrome. Students need to sequentially complete the selection of inspection items and the formulation of treatment plans according to the condition^[8]. The system records the order of students’ decisions, the rationality of inspection items, and the matching degree between treatment plans and the condition, generating a visual thinking path map to help teachers locate the weak links of students’ clinical thinking.

Dynamic monitoring of team collaboration can evaluate the critical team cooperation ability in acute and critical care nursing. For example, in training scenarios requiring team collaboration such as multi-person CPR and mass trauma treatment, the system captures the interaction details and operational coordination of team members throughout the process. After the training, the system can real-time generate a team collaboration heat map, marking the task participation of each member with different colors^[9].

2.4. Implementing differentiated teaching support based on AI algorithms with personalized learning platforms

Building personalized learning platforms relying on AI algorithms can provide adaptive learning support for each student. This analysis method does not rely on a single data but comprehensively judges based on performance in multiple scenarios. The final learning needs analysis results generate personalized learning paths for students.

In addition, AI can continuously track students’ learning and provide real-time learning feedback for teachers and students. Teachers can adjust the focus of classroom teaching accordingly, strengthen the explanation of weak knowledge points or add targeted training^[10]. Through the platform, students can intuitively see their performance in different ability dimensions, clearly know the content they need to prioritize improving, and then independently formulate learning plans to improve targeted learning efficiency.

3. Challenges in the application of AI in acute and critical care nursing teaching

3.1. Technical costs and adaptability issues

The introduction of AI teaching equipment requires high investment. A complete VR ICU simulation system needs an investment of hundreds of thousands of yuan, and the separate purchase cost of the CRRT virtual training

module is about 150,000 yuan, which may exceed the budget capacity of some institutions. At the same time, existing AI tools, such as some virtual simulation software (e.g., Laerdal SimChart), are not interoperable with the existing teaching platforms of institutions (e.g., Chaoxing Learning Pass), resulting in students' operation records unable to be synchronized to the total score^[11].

3.2. Insufficient teachers' AI literacy and teaching integration capabilities

Teachers of acute and critical care nursing need to have the ability to operate AI tools and design teaching, but the current teaching team has certain shortcomings. Firstly, the proportion of teachers who have received systematic AI technology training is low; secondly, some teachers regard AI as a substitute tool, simply replacing practical training with VR videos, lacking the ability to integrate AI technologies and tools into teaching design^[12].

3.3. Ethical and data security risks

AI teaching involves students' operation data and virtual patient privacy information. If students' operation records and biometrics are not stored encrypted, they may be obtained by third parties. In addition, some students may use AI such as ChatGPT to write nursing case reports and experimental summaries, leading to an increase in academic misconduct.

3.4. Technology lacks clinical authenticity and humanistic care

Although AI technology can simulate clinical operations, it still lacks clinical authenticity. Virtual patients cannot fully restore the individual differences of real patients, resulting in students needing to re-adapt in real clinical practice^[13]. At the same time, AI lacks the simulation of humanistic care in nurse-patient communication. For example, virtual patients cannot show emotions such as "anxiety and fear", making it difficult for students to improve their humanistic care literacy.

4. Future prospect of artificial intelligence in acute and critical care nursing teaching

4.1. Technological integration: 5G + AI building a "virtual-real integration" training system

In the future, the low-latency characteristics of 5G networks will realize real-time linkage between virtual training and real scenarios. Firstly, in real scenarios such as ambulances and emergency rooms, virtual resources can be called through AR glasses. For example, a "trauma assessment flow chart" can be superimposed at the first-aid scene to help students make quick decisions; secondly, multiple institutions share VR ICU and AI virtual patient resources to reduce the cost investment of individual institutions. At the same time, digital twin technology will further improve scene authenticity, constructing "personalized virtual patients" by collecting physiological data of real patients to exercise students' response capabilities^[14].

4.2. Innovative teaching model: AI + evidence-based medicine building a dynamic knowledge base

The problem of knowledge lag in current AI teaching resources will be solved through "AI + evidence-based medicine": firstly, establishing an automatic update mechanism of "guidelines-cases". For example, when a new version of the International Cardiopulmonary Resuscitation Guidelines is released, the AI system automatically

revises parameters such as compression depth and ventilation ratio in CPR training and generates new cases; secondly, introducing an “AI evidence-based assistant”, allowing students to call the latest research evidence at any time in case analysis to cultivate students’ evidence-based thinking.

4.3. Strengthening teacher training and ethical construction: Improving the AI teaching support system

To address the insufficient AI literacy of teachers, a training system can be improved: primary training focuses on basic operation of AI tools, such as VR equipment use and ChatGPT case generation; intermediate training focuses on AI teaching design, such as curriculum arrangement of “virtual training + real practice”; advanced training focuses on AI technology research and development, such as participating in the development of virtual simulation cases^[15]. At the same time, the national level is expected to introduce the “Ethical Norms for the Application of AI in Nursing Education” in the future, clarifying data security requirements and academic integrity requirements.

4.4. Deepening industry cooperation: School-enterprise co-construction of AI teaching and training bases

In accordance with the requirement of “deepening the integration of production and education” in the “Healthy China 2030” Planning Outline, future cooperation will be promoted between nursing institutions, AI enterprises, and medical institutions: firstly, co-constructing “acute and critical care AI training centers”, with enterprises providing technical support (such as Huawei providing 5G networks and Yihuixun providing virtual simulation software) and medical institutions providing clinical cases; secondly, developing a “clinical-teaching” data interoperability system, allowing students’ internship operation data in hospitals to be synchronized to the school’s AI platform, so that teachers can adjust teaching focuses accordingly.

5. Conclusion

Artificial intelligence has brought innovative approaches to acute and critical care nursing teaching, and its application can effectively improve students’ operational skills and clinical thinking. Currently, although AI technology faces challenges such as high costs and insufficient humanistic care, these problems will be gradually resolved with the development of 5G and digital twin technologies and the improvement of the policy system. In the future, acute and critical care nursing teaching must adhere to the principle of “technology as the form and talent training as the essence”. It is necessary to give play to the advantages of AI in scenario simulation and data processing, while focusing on cultivating students’ empathy and ethical awareness, so as to transport more high-quality acute and critical care nursing talents for the medical industry.

Disclosure statement

The authors declare no conflict of interest.

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Efficacy of Biofeedback Combined with Occupational Therapy on Upper Limb Function in Stroke Patients

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Abstract: *Objective:* To study the efficacy of biofeedback combined with occupational therapy in stroke patients, including upper arm function, hand function, and self-care ability. *Methods:* A total of 60 stroke patients who met the inclusion and exclusion criteria of this study were divided into a treatment group and a control group, with 30 cases in each group, using a random number table method. The total course of treatment was 4 weeks, with 5 treatments per week. Both groups received routine rehabilitation treatment, while the treatment group was supplemented with biofeedback therapy on the basis of routine rehabilitation. Before treatment and after 4 weeks of treatment, the Hemiplegic Hand Function Assessment Scale, Carroll Upper Extremity Function Assessment Scale, Wolf Motor Function Test (WMFT), and Brunnstrom Scale were used to evaluate patients' hand function, Activities of Daily Living (ADL) ability, and motor function, respectively. Adverse events during treatment were observed. *Results:* After treatment, the Brunnstrom stages, Carroll upper extremity function scores, and Wolf upper extremity function scores of patients in both groups were significantly improved ($p < 0.001$), and the improvement effect in the treatment group was more significant ($p < 0.001$). *Conclusion:* Stroke patients receiving basic rehabilitation treatment combined with occupational therapy and biofeedback therapy can better improve their upper arm and hand functions. Meanwhile, the combination of biofeedback therapy and occupational therapy is superior to occupational therapy alone, enhancing the self-care ability of stroke patients.

Keywords: Biofeedback combined with occupational therapy; Stroke; Upper limb function

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1. Introduction

Stroke is the leading cause of death and disability. Among them, the rehabilitation of hemiplegic upper limb function after stroke is a key and hot issue in clinical rehabilitation. Approximately 55–75% of patients are prone to residual upper limb dysfunction of varying degrees, which affects their quality of life and increases the burden on families and society. Occupational therapy can specifically formulate rehabilitation measures for Activities of Daily Living (ADL), accelerating the recovery of upper limb and hand functions. Biofeedback therapy can record

the electrical activity information of patients' muscles, helping them understand their own muscle status, thereby gradually adjusting muscle activity and better completing related movements. This study aims to analyze the therapeutic effect of biofeedback therapy on the hemiplegic hand function, upper limb motor function, and self-care ability of stroke patients.

2. Materials and methods

2.1. General information

A total of 60 hemiplegic patients after stroke who were hospitalized in the Department of Rehabilitation Medicine of our hospital from October 2023 to May 2025 were selected and divided into a treatment group (30 cases) and a control group (30 cases) using a random number table method ^[1]. There were no significant differences in general data such as age, gender, and time from onset to admission between the two groups ($p > 0.05$), indicating comparability. Specific data are shown in **Table 1**.

Table 1. Comparison of general conditions of patients

Group	Number of cases	Male/Female (cases)	Average age (Years, $\bar{x} \pm s$)	Time from onset to admission (Days, $\bar{x} \pm s$)
Treatment group	30	12/18	54.66 \pm 13.58	71.90 \pm 105.40
Control group	30	14/16	54.60 \pm 11.14	59.00 \pm 77.42

2.1.1. Inclusion criteria

Conforming to the national diagnostic criteria for the disease; confirmed as cerebrovascular disease by CT, MRI, etc.; presenting with unilateral hemiplegia; active wrist dorsiflexion range of motion $> 10^\circ$ on the affected side; patients and their families providing informed consent and signing the informed consent form.

2.1.2. Exclusion criteria

Suffering from severe hypertension or underlying heart disease; having large-area cerebral infarction; complicated with shoulder dislocation on the hemiplegic side; having severe cognitive impairment ^[2].

2.2. Treatment methods

Both groups of patients need to receive conventional drug therapy, such as blood pressure-lowering and blood sugar-lowering treatment, and actively carry out basic rehabilitation training in combination with their specific functional disorders.

First, the control group conducts basic rehabilitation training. Its training content involves basic items such as joint mobility training and balance function training. Each training session lasts 30–40 minutes, once a day, with a total course of 4 weeks and 5 treatment sessions per week ^[3].

Second, the treatment group conducts basic rehabilitation training, supplemented by occupational therapy and biofeedback therapy. In the selection of treatment environment and body position, an independent treatment room should be chosen. Patients should be instructed to sit upright to achieve the goal of natural relaxation ^[4]. For electrode placement, alcohol cotton balls can be used to wipe the connection between the electrode pads and the skin. After air-drying, place them on the extensor muscles of the upper arm on the hemiplegic side of stroke and other positions. In the specific treatment process, medical staff should guide patients to perform movements such

as elbow extension and finger extension so that the electromyographic signals can reach the threshold ^[5]. Patients can refer to voice prompts and adjust their movements according to the guidance of rehabilitation therapists. When the instrument sends a relaxation signal, patients can be guided to perform muscle relaxation, and the instrument will automatically adjust according to the spontaneous electromyographic signals. Regarding the treatment duration, it should be separated from occupational therapy by 1–2 hours, with a total course of 4 weeks ^[6].

2.3. Evaluation methods

The assessment should be conducted at different time points, such as before treatment and after the 4-week course of treatment, by the same professional physician to evaluate the patient's function, thereby enhancing the objectivity of the assessment results ^[7]. First, for the assessment of hemiplegic hand function, the physician can mainly evaluate the patient's hand function from perspectives such as hand muscle strength and fine motor skills, with a total score of 100 points. The higher the score, the better the recovery effect of the hand function. Second, the Carroll upper limb function assessment can be carried out, which specifically involves tests such as picking up and placing objects. Different actions are scored (0–5 points), with a total of 10 test items and a total score of 50 points ^[8]. Third, the Wolf upper limb function test can be conducted, where the patient is required to participate in 10 daily activity tasks, such as writing and picking up a water cup. The completion time and movements of the tasks are recorded and scored accordingly. The lower the total score, the better the upper limb function ^[9]. Fourth, the Brunnstrom scale can be created, which divides the recovery of upper limb and hand motor function into stages I–VI. The higher the stage, the better the recovery of the patient's upper limb and hand motor function. From the perspective of the entire treatment stage, the physician needs to follow the conditions of patients in different groups, analyze whether there are adverse conditions such as dizziness and skin allergies, and record the time and status of their occurrence, so as to take corresponding measures ^[10].

2.4. Statistical analysis

SPSS 22.0 statistical software was used for data processing. Measurement data (such as hemiplegic hand function assessment and Carroll upper extremity function assessment) were expressed as mean \pm standard deviation ($\bar{x} \pm s$) ^[11]. Paired *t*-tests were used for intra-group comparisons before and after treatment, and independent sample *t*-tests were used for inter-group comparisons. Count data (such as the incidence of adverse events) were expressed as frequency (*n*) and percentage (%), and comparisons were performed using χ^2 tests. A *p*-value < 0.05 was considered statistically significant ^[12].

3. Results

3.1. Hemiplegic hand function assessment

Before treatment, there was no significant difference in the Hemiplegic Hand Function Assessment Scale scores between the two groups ($p > 0.05$). After 4 weeks of treatment, the scores of both groups were significantly higher than those before treatment ($p < 0.001$), and the score of the treatment group (82.5 ± 7.3) was significantly higher than that of the control group (65.2 ± 8.1), with a statistically significant difference ($p < 0.001$). Specific data are shown in **Table 2**.

Table 2. Comparison of hemiplegic hand function assessment before and after treatment

Group	Number of cases	Before treatment	After treatment	<i>t</i> -value	<i>p</i> -value
Treatment group	30	45.3 ± 9.2	82.5 ± 7.3	18.65	< 0.001
Control group	30	44.8 ± 8.9	65.2 ± 8.1	10.32	< 0.001

3.2. Carroll upper extremity function assessment

Before treatment, there was no significant difference in Carroll upper extremity function scores between the two groups ($p > 0.05$). After treatment, the scores of both groups were significantly improved ($p < 0.001$), and the score of the treatment group (42.3 ± 4.5) was higher than that of the control group (31.5 ± 5.2), with a statistically significant difference ($p < 0.001$)^[13]. Specific data are shown in **Table 3**.

Table 3. Comparison of Carroll upper extremity function assessment before and after treatment

Group	Number of cases	Before treatment	After treatment	<i>t</i> -value	<i>p</i> -value
Treatment group	30	18.6 ± 5.1	42.3 ± 4.5	22.47	< 0.001
Control group	30	19.1 ± 4.8	31.5 ± 5.2	9.86	< 0.001

3.3. Wolf motor function test (WMFT)

Before treatment, there was no significant difference in WMFT scores between the two groups ($p > 0.05$). After treatment, the scores of both groups were lower than those before treatment ($p < 0.001$), and the score of the treatment group (28.6 ± 6.4) was lower than that of the control group (45.3 ± 7.2), with a statistically significant difference ($p < 0.001$).

3.4. Brunnstrom scale

Before treatment, there was no significant difference in Brunnstrom stages of upper limb and hand function between the two groups ($p > 0.05$). After treatment, the stages of both groups were improved ($p < 0.001$), and the stages of upper limb and hand function in the treatment group were higher than those in the control group, with a statistically significant difference ($p < 0.001$).

4. Discussion

The core of upper limb dysfunction after stroke is decreased muscle control due to nerve damage, manifested as motor dysfunction. Although routine rehabilitation training can improve some functions through basic exercises, it lacks targeting and accuracy, making it difficult to meet patients' needs. The results of this study show that the treatment group had a more significant improvement in various functions after the combination of biofeedback and occupational therapy, indicating the effectiveness of this treatment plan. Occupational therapy can simulate daily life scenarios, promote the integration of rehabilitation goals with patients' needs, facilitate patients to acquire living skills, strengthen the coordination of upper limb movement and cognitive functions, and accelerate functional recovery^[14]. Biofeedback therapy can help patients break through muscle sensory barriers through visual signal feedback, understand their own muscle status, appropriately improve movement patterns, form good muscle control pathways, and accelerate neural remodeling. The organic combination of the two can not only

address the problems of patients in routine training but also convert motor functions into practical living abilities through occupational training, promoting the connection between rehabilitation training and daily life applications.

From a mechanistic perspective, biofeedback therapy can effectively stimulate the corresponding areas of the cerebral motor cortex through real-time myoelectric signal feedback, enhance the cortex's control ability over the hemiplegic limbs, effectively reduce abnormal muscle tone, and alleviate muscle spasticity, providing good conditions for subsequent precise movement training ^[15]. Occupational therapy can effectively consolidate the effects of biofeedback therapy through functional movement exercises, establish good neural pathways, strengthen muscle memory, and improve motor coordination and stability. The exertion of the above synergistic effects can achieve better therapeutic results.

At the same time, this study has certain limitations, specifically small sample size and single-center research, which may limit the generalizability of the results. Due to the relatively short follow-up time, long-term efficacy was not observed. In the future, attention should be paid to expanding the sample size, conducting multi-center studies, appropriately extending the follow-up time, and objectively verifying the long-term efficacy and safety of this treatment plan. In conclusion, the combination of biofeedback and occupational therapy can better optimize the upper limb and hand functions of stroke patients, continuously improve their self-care skills, and show good safety, providing a favorable plan for the subsequent clinical rehabilitation quality of stroke and having good promotion and application value.

5. Conclusion

In conclusion, the integration of occupational therapy with biofeedback therapy significantly enhances upper limb and hand function recovery in stroke patients, demonstrating superior efficacy compared to occupational therapy alone. This combined approach also leads to greater improvements in patients' self-care abilities.

Disclosure statement

The author declares no conflict of interest.

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An Interpretative Phenomenological Research of the Psychological Experience of Dietary Management in Older Adults with Diabetes

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Abstract: *Objective:* To explore in depth the psychological perceptions and meaning construction of older adult patients with diabetes during the dietary management process, and to provide a theoretical reference for developing individualized clinical nursing care. *Methods:* A purposive sampling method was used to select 13 older adult patients with diabetes for semi-structured in-depth interviews. The interview data were collated and analyzed using Van Manen's analysis method. *Results:* The psychological experience of dietary management in older adult patients with diabetes included four core themes: (1) Information fog and cognitive shock at initial diagnosis; (2) Self-struggle during the habit reshaping stage; (3) Alternating cycle of hope and frustration in long-term management; (4) Reconstructing normality and searching for meaning in life. *Conclusion:* Dietary management is an important process for older adult patients with diabetes to reconstruct the meaning of life. Clinical nursing should focus on patients' psychological experiences and value needs, providing more humanistic and individualized support.

Keywords: Dietary management; Psychological experience; Diabetes; Geriatric nursing; Qualitative research

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1. Introduction

The global aging process is accelerating, making the elderly the main bearers of the disease burden of diabetes. Epidemiological surveys show that the prevalence of diabetes in this group has reached 25% to 33%^[1]. As a key link in blood glucose control, dietary management faces many special challenges in the practice of older adult patients with diabetes: cognitive decline makes complex nutritional calculations difficult to execute, and psychosocial factors such as depressive tendencies and insufficient social support mean that approximately 29.1% of patients exhibit self-neglect behaviors, leading to decreased management adherence^[2]. Although some interventions can improve physiological indicators such as HbA1c and BMI in the short term, long-term

effects are often difficult to maintain due to the neglect of psychological experiences^[3]. Current research mostly focuses on improving the disease management ability of older adult patients with diabetes through behavioral intervention methods such as self-efficacy theory, while analysis of the patients' subjective meaning and deep psychological experience is relatively lacking^[4]. Older patients often experience cognitive conflict between the "desire to eat autonomously" and "disease management needs", and traditional quantitative methods struggle to capture such meaning structures. Hermeneutic phenomenology is dedicated to understanding individuals' subjective interpretation and meaning generation of life experiences, making it suitable for deeply exploring the essence of the psychological experience of older adult patients with diabetes in dietary management^[5]. Based on Heideggerian Hermeneutic Phenomenology, this study aims to reveal the psychological process and meaning construction mechanism behind the dietary management behaviors of older adult patients with diabetes, providing a basis for constructing individualized nursing intervention plans.

2. Methods

2.1. Research objects

Using a purposive sampling method, 13 older adult patients with diabetes hospitalized in the endocrinology department of a tertiary hospital in Huizhou City or registered at surrounding community service centers were selected as research participants.

2.1.1. Inclusion criteria

- (1) Age ≥ 60 years^[6]
- (2) Meeting the World Health Organization diagnostic criteria for diabetes^[7]
- (3) Diabetes duration greater than 5 years
- (4) Voluntary participation in this study

2.1.2. Exclusion criteria

- (1) Presence of language communication barriers
- (2) Hearing impairment
- (3) Refusal of audio recording.

2.1.3. Sample size

Sample size was determined by data saturation, meaning no new concepts or themes emerged during the qualitative data analysis^[8]. This study was approved by the hospital ethics committee. All participants signed informed consent forms, and the acquired interview data and demographic information were anonymized. A total of 13 older adult patients with diabetes were interviewed, 9 males and 4 females; average age (71.2 ± 9.6) years, average disease duration (18.2 ± 6.9) years, mostly married and living with their spouse. General data are shown in **Table 1**.

Table 1. General data of older adult patients with diabetes (n = 13)

No	Sex	Age	Education level	Occupation	Marital status	Living situation	Origin	Duration (Years)	No. of comorbidities
P1	F	69	Secondary School	Retired	Married	Spouse	Sichuan	> 20	6
P2	M	60	Primary School	Gardener	Married	Spouse	Guangdong	7	2
P3	M	64	University	Retired	Married	Spouse	Guangdong	> 20	3
P4	M	79	Junior High	Retired	Married	Spouse & children	Guangdong	> 20	3
P5	F	61	Secondary School	Freelance	Married	Spouse	Jilin	> 10	1
P6	M	80	Primary School	Retired	Married	Spouse	Hebei	> 20	2
P7	M	62	University	Retired	Married	Children	Henan	> 20	2
P8	M	73	University	Retired	Married	Spouse	Guangdong	> 20	3
P9	F	80	Secondary School	Retired	Married	Spouse	Heilongjiang	> 30	3
P10	M	82	Secondary School	Retired	Married	Spouse	Jiangsu	15	1
P11	F	65	University	Lawyer	Divorced	Alone	Inner Mongolia	14	2
P12	M	62	High School	Property Management	Married	Spouse	Jilin	> 10	1
P13	M	88	University	Retired	Widow	Alone	Guangdong	> 30	3

2.2. Research methods

2.2.1. Developing the interview guide

Based on the research purpose and literature review, a preliminary interview guide was developed. Three older adult patients with diabetes were selected for pre-interviews. Based on the pre-interview results and clinical expert opinions, the interview guide was revised and finalized. The final version included:

- (1) What were your initial thoughts when the doctor first mentioned dietary management after diagnosis?
- (2) What were your psychological feelings during the early stages of dietary management?
- (3) Have you tried any new methods in dietary management? What were your thoughts at the time?
- (4) What do you consider the biggest gain after long-term adherence to dietary management?
- (5) What are the main psychological difficulties you encounter in dietary management?
- (6) What factors play a key role in helping you persist with dietary management?
- (7) What are your expectations or plans for future dietary management?

2.2.2. Data collection methods

Data were collected through face-to-face semi-structured interviews. The research team included two nursing master's students with a background in qualitative research and one clinical nursing expert. One graduate student was responsible for leading the interviews, while the other recorded participants' non-verbal behaviors and assisted with audio recording and documenting the environment. Before the interview, the researcher established a trusting relationship with the participant, explained the purpose and significance of the study, and obtained informed consent. Interviews were conducted in private rooms on the ward or in the participants' homes to ensure face-to-face communication was free from external interference. The interviews were audio-recorded, and simultaneous field notes were taken, focusing on recording patients' non-verbal information, observing changes in expression,

tone, and actions. Interview duration was controlled between 25 and 40 minutes.

2.2.3. Data analysis methods

The researcher, as the research instrument, transcribed the audio recordings verbatim within 24 hours after each interview, integrating records of non-verbal behaviors. Reflective journals and interview notes detailing the interview process were also written. The transcribed data were analyzed using Van Manen's method ^[9] with the assistance of Nvivo 12.0 software, following these steps:

- (1) Repeated reading of the text to immerse in the participants' narratives
- (2) Line-by-line coding to identify meaning units
- (3) Categorizing similar expressions to extract preliminary themes
- (4) Integrating and interpreting themes within the four existential dimensions of body, time, space, and relations
- (5) Forming the analysis report through narrative writing.

After the interviews, three researchers transcribed the recordings into text within 24 hours, numbered sequentially. Discrepancies were resolved through discussion to reach consensus.

2.2.4. Quality control

(1) Credibility

Representativeness of research objects (the selected participants represented older adult patients with diabetes of different ages, education levels, genders, occupations, and disease durations). Second, for patients with language communication difficulties (e.g., Hakka speakers), the interview time was appropriately extended. Besides, triangulation was used, including data source triangulation (medical records, audio recordings, interview notes, literature), method triangulation (interviews, observation), and researcher triangulation (three researchers independently observing and analyzing) to ensure data reliability. Moreover, it reflect on the researcher's role and bias, where interview notes and reflective journals were written promptly after each interview, and elements were considered in the thematic analysis to help readers understand the study's limitations.

(2) Dependability

Refers to stability across time and location. Firstly, the research sites included hospital wards and communities (wards in endocrinology and neurology departments, communities in participants' homes); interviews were scheduled between 3 to 4 PM, ensuring sufficient time and participant concentration, thus ensuring data reliability. Moreover, two team members independently performed audio transcription and analysis, then jointly discussed the data analysis coding and final theme extraction.

3. Results

3.1. Information ambiguity and cognitive shock in the initial stage of diagnosis

3.1.1. Lack and ambiguity of authoritative guidance

Patients generally faced the problem of unclear dietary information in the initial stage of diagnosis. The advice provided by doctors was usually general and lacked specific and feasible guidance, leaving patients confused at the starting stage and having to rely on themselves for difficult exploration. For example, Uncle Tian (P2) mentioned:

“No, the doctor didn’t say anything. (In a low tone)” Another interviewee (P4) also expressed a similar feeling: “At first, they didn’t say anything, and I didn’t know... They just said to leave it to me, and didn’t say anything else”. In Grandpa Zhao’s (P6) memory, the doctor’s advice only remained: “Don’t eat sweet food. I don’t remember anything else, only that I shouldn’t eat sweet food”. This lack of guidance laid the foundation for subsequent long-term self-exploration and confusion. Only a few such as (P11) experienced systematic nutrition management in later hospitalization: “The University of Hong Kong-Shenzhen Hospital didn’t let me avoid certain foods; they just fixed the amount for me”, but such experiences were not common in the early stage.

3.1.2. Initial construction of disease cognition and emotional coping

Faced with the “diabetes” diagnosis, different older adult patients formed varying understandings of the disease and emotional response patterns based on their life experiences and cognitive backgrounds. Some participants showed high medical compliance, such as P11 who clearly stated: “I believed it, believed it very much (the doctor’s words)”. Some showed greater vigilance due to factors like family history, such as P12 who was “particularly concerned about myself”. However, other participants, due to their era background and life pressures, chose to neglect the disease. P13 and P7 considered it a secondary issue, lacking sufficient attention: “At that time, it was work, work piled up, nobody to rely on but yourself, no time to think about these things”. These early-formed cognitive patterns and emotional tones profoundly influenced their subsequent decades of disease management attitudes and behavioral choices.

3.2. Self-struggle during the habit reshaping stage

3.2.1. Tug-of-War between physiological desires and self-control

Changing long-formed eating habits was described by most interviewees as a long-term process accompanied by physical and mental discomfort. There was a strong conflict between the desire for sweet and high-fat foods and health cognition. “Being unable to control one’s mouth” was a common real experience, and the sense of deprivation and restraint were the core dilemmas. P1 mentioned: “When I see those fruits, I really want to eat them, but I just stand there for a while and then leave... I don’t dare to eat them even if I buy them back”. When talking about occasional dietary compromises, P2 revealed helplessness in his tone: “When I’m in a good mood, I still can’t help it.. Hehe”. He constantly struggled between the physical need for satiety and the new understanding of health. “Hunger” became a common real experience. P11 recalled: “Once I was so hungry that I felt dizzy and bloated”. P12 also believed that “eating less staple food... makes it easy to get hungry... it’s a bit difficult”. P13’s experience was more historically characteristic, reflecting the helplessness in the era of material scarcity: “I felt a little hungry, but there was no way... I just mixed soy sauce with water to drink”. The confrontation between physical needs and willpower became a major challenge in dietary management.

3.2.2. Alienation and adaptation in the social world

Dietary management is not a solo act; it deeply affects patients’ social interactions. Occasions like family gatherings, friend meetups, and travel often caused pressure, forcing them to make difficult trade-offs between maintaining social connections and adhering to dietary principles, often experiencing feelings of being out of place or needing deliberate avoidance. P11 shared a travel experience: “Went traveling with friends, ate just one-eighth of a local pancake, that small corner, and my blood sugar was high that evening”. This reflects the psychological burden of not being able to fully let go even in relaxed settings. P7 had his own set of social coping strategies: “They

eat theirs, I just have a dish I can eat... Of course they shouldn't insist (on persuading)". P12 also had methods for handling drinking occasions: "Friends ask you out for drinks... Be careful, drink less". P9, however, almost no longer participated in group meals due to the disease, reflecting the risk of social isolation that dietary management may trigger.

3.3. Alternating cycle of hope and frustration in long-term management

3.3.1. "Uncontrollable" blood sugar and persistent frustration

Even if patients try their best to follow the prescribed dietary plans, their blood glucose may still have unpredictable changes, cause confusion and self-doubt, and seriously shaking their confidence in dietary management. P1's words were full of powerlessness: "My blood sugar just can't be controlled, it still can't be controlled now, I don't know why I can't control it". P4 said: "If you eat too much or are full, your blood sugar will definitely be on the high side... If it's high, you just don't eat that much next time". P12 described the frustrating reality of increasing medication dosage year by year: "The blood sugar injection (insulin)... is increasing year by year, not decreasing at all". Even P13, whose blood sugar was relatively stable, said that his "postprandial blood glucose two hours after meals is generally around 10", which is far from the target. The gap between long-term efforts and poor results constitutes a source of continuous psychological frustration.

3.3.2. Embodiment of "trouble" and treatment resistance

The treatment behavior itself, especially the complex medication regimen and insulin injection, was regarded by the interviewees as a heavy "trouble" due to the cumbersome process, accompanying pain, and interference with daily life. This negative physical experience led some interviewees to have a strong sense of treatment resistance or burnout. The root cause was not the lack of understanding of the benefits of treatment, but the psychological resistance to "daily life being constantly interfered with and occupied by the disease". Interviewee P1 expressed this: "My biggest regret is taking insulin... If I don't take insulin, it won't be so troublesome. I have to take the needle, the medicine, and prepare disinfectant and cotton swabs. It's too troublesome". Interviewee P10 also clearly explained the reason for refusing insulin: "The reason I don't take it is that I think it's too troublesome to inject before each meal. First, it hurts, and second, I'm worried about dependence". Interviewee P11 vividly described the large amount of medication: "I take more medicine than food; I'm full just from taking medicine". This resistance is essentially a rebellion against "life being 'colonized' by the disease".

3.4. Awakening to coexistence with the disease – reconstructing normality and searching for life meaning

3.4.1. Identity shift from "patient" to "expert"

After years of self-management practice, many older adult patients with diabetes, through the experience of "prolonged illness makes a doctor", regained a sense of control and initiative in their lives. They transformed from "patients" passively receiving medical orders into proactive "self-managers". This identity shift brought about psychological experiences of confidence and composure. P7 said proudly: "I know clearly in my heart, I am an 'old doctor' with 20 years of experience... I also explain diabetes-related knowledge to others". P10 also displayed confidence based on experience: "Our life experience is much richer than young people's, what to eat and what not to eat... We also have knowledge reserves in this area". P11 demonstrated strong autonomy: "I don't really listen to the doctor now... For example, the doctor says don't eat fruit, I eat it every day, just control the amount". They

were no longer panicked patients but had gradually become active agents with practical knowledge.

3.4.2. Philosophical acceptance of “dancing with sugar”

In the end, many patients developed an open-minded life philosophy, integrating diabetes into part of their lives rather than the whole. “Attaching importance to it without excessive anxiety” is their core coping wisdom. They learned to find a dynamic and personalized balance between strict control and moderate enjoyment, adherence to discipline and self-forgiveness, and achieved peaceful coexistence with the disease. P3 summarized it as: “Despise it strategically, attach importance to it tactically... It’s not that I want to ruin myself, but I don’t want to take it too seriously”. P5 showed an open-minded attitude: “I am very optimistic and think openly... When it’s time to give up... I will find a way to end it”. P10 experienced inner peace: “We have a good attitude... The greatest gain in my life is that I don’t have any discomfort, and my mentality is better”. P11 established a stable dietary pattern and felt satisfied: “I have gradually stabilized now... But I eat well”. P12 rationally realized: “Although it can’t be cured, it can be controlled”. P13 showed an indifferent attitude after many years: “Worrying is useless... I don’t worry”. By reconciling with the disease, they regained a sense of control over life and peace of mind.

4. Discussion

4.1. Information fog: Absence of health system support and initiation of self-exploration

This study found that patients generally faced a lack of professional dietary guidance in the early stages of diagnosis, a phenomenon corroborated by several existing studies ^[10,11]. Advice provided by healthcare professionals at the diagnosis stage was often too general, lacking specific operational guidance, leaving patients in a state of cognitive ambiguity from the start. This information vacuum forced patients to turn to informal channels for relevant knowledge, such as peer communication, online information, or TV programs, not only increasing their information anxiety but also potentially leading to subsequent unscientific self-management behaviors ^[12]. Therefore, enhancing the systematic, individualized, and operational aspects of initial dietary education and effectively integrating it into the diagnosis and treatment process is an important direction for improving the diabetes support system.

4.2. Self-regulation game: Balance between individual needs and social constraints

Dietary management essentially constitutes a long-term internal conflict, i.e., the continuous confrontation between individuals’ original dietary desires and health needs. This study reveals the inner struggle of patients in the process of self-control, especially the internal contradictions when facing high-temptation foods and social occasions. This finding is consistent with the self-depletion theory, indicating that willpower, as a limited psychological resource, tends to be exhausted in continuous dietary regulation, thereby increasing the possibility of behavioral relaxation ^[13]. More importantly, the study further reveals the social dimension contained in dietary management: when eating behavior is embedded in social interactions, patients often fall into a dilemma between following medical advice and conforming to group norms, accompanied by emotional experiences such as guilt, embarrassment, or marginalization ^[14]. This suggests that effective interventions need to go beyond the individual level, incorporate family and social support, and alleviate patients’ psychological pressure in social situations by creating an inclusive dietary environment.

4.3. Cyclical dilemma: Finding a sense of control amid “loss of control” and “trouble”

This study found that even if elderly diabetic patients invest a lot of energy, the unpredictability of blood glucose levels and the cumbersomeness of the treatment process are still the main challenges they face in long-term management. Unexpected fluctuations in blood glucose readings directly impact patients’ self-efficacy and are likely to induce negative psychological reactions such as learned helplessness ^[15]. In addition, the embodied analysis of the “trouble” of treatment provides a new perspective: patients’ resistance to treatments such as insulin is not due to insufficient understanding of medical knowledge, but to psychological rejection of daily experiences that constantly reinforce their “patient” identity. Each injection, each special meal, constantly reminds them of their disease state, thereby triggering psychological resistance ^[16]. Therefore, when advocating treatment compliance, clinical workers should fully understand the psychological motivations behind the behavior — namely, patients’ inherent yearning for a normal life, autonomy, and convenience. Promoting more convenient and minimally invasive treatment methods and incorporating appropriate flexibility into management strategies is expected to alleviate patients’ psychological burden.

4.4. Meaning construction process: Identity reshaping from passive compliance to active management

The study showed that some patients, through long-term self-management practice, gradually achieved an identity transformation from “passively receiving medical orders” to “actively implementing disease management”, even becoming “health knowledge disseminators” within their families, and ultimately forming a life philosophy of “peaceful coexistence with the disease”. This aligns with illness narrative theory, where patients regain control and meaning by integrating the illness experience into their life story ^[17]. “Prolonged illness makes a doctor” is not just knowledge accumulation but also subjectivity reconstruction. The wisdom of “despising it strategically, valuing it tactically” that they practiced reflects a high level of psychological adaptation, achieving a balance between vigilance and relaxation, control and enjoyment. Nursing staff should consciously promote the establishment of such positive identities, for example, through peer support groups to facilitate experience sharing, providing role models for newly diagnosed individuals.

4.5. Adaptive balance in the older adult population: Between disease management and quality of life

Compared to younger patients, older adult patients with diabetes exhibit characteristics of “adaptive balance” in dietary management: neither strictly following all norms nor abandoning control, but rather seeking an individualized balance between health maintenance and quality of life ^[18]. This characteristic is rooted in their life experiences, older adults who experienced periods of material scarcity have profound memories of “fullness” and are more sensitive to the “sense of deprivation” brought by dietary restrictions (P13); the emphasis on “meaning in life” in later years makes them unwilling to sacrifice life’s pleasures excessively for blood sugar control. This suggests that clinical practice should avoid “over-medicalized” strategies, allow for appropriate flexibility in special circumstances, and focus on guiding patients to reflect and adjust their behaviors after unplanned eating, rather than pursuing absolute adherence to norms ^[19].

4.6. Study limitations

The samples of this study were all from Huizhou area, which may have regional limitations; the interview duration

was limited, and some in-depth experiences failed to be fully explored; cross-sectional interviews were used, making it difficult to track the dynamic changes of patients' meaning-making; some elderly patients may not have fully expressed their early experiences due to blurred memories, resulting in limited interview depth. Future longitudinal studies can be carried out to track the psychological change trajectory in different disease course stages.

5. Conclusion

Using an interpretive phenomenological approach, this study deeply revealed that dietary management for older adult patients with diabetes is a dynamic, complex psychosocial adaptation process. The study showed that insufficient professional guidance early on poses challenges for long-term management, highlighting the importance of individualized, continuous nutritional support. Dietary management involves not only the reshaping of physiological habits but also profound physical and psychological experiences and social adaptation, with patients often facing social alienation and psychological pressure. In long-term management, the unpredictability of blood sugar and the burden of treatment easily lead to a cycle of hope and disappointment, weakening self-efficacy. However, some older patients demonstrated psychological resilience, achieving a balance between disease management and quality of life through identity transformation and wise acceptance. Clinical nursing should intervene multi-dimensionally, strengthening knowledge education, paying attention to emotional needs, guiding positive coping, and integrating support resources to provide comprehensive, personalized dietary psychological support for older adult patients with diabetes, enhancing their disease management ability and quality of life.

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Application and Effectiveness Evaluation of PBL Combined with Virtual Reality Technology in Teaching Geriatric Sarcopenia

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Abstract: *Objective:* To investigate the impact of applying PBL combined with virtual reality (VR) technology in clinical teaching of geriatric sarcopenia on students' knowledge acquisition, attitudes, and behaviors, providing practical evidence for geriatric medicine teaching reform. *Methods:* Eighty clinical medicine undergraduate interns admitted to the geriatrics department of a hospital from January 2024 to June 2025 were randomly divided into an observation group ($n = 40$) and a control group ($n = 40$). The control group received traditional lecture-based instruction, while the observation group underwent PBL combined with VR technology. The two groups were compared on end-of-term theoretical knowledge assessment scores, clinical practice operation scores, teaching satisfaction, and clinical behavior observation scale scores. *Results:* Students in the observation group achieved significantly higher scores in basic theoretical knowledge (86.52 ± 5.31) and clinical practice skills (88.15 ± 4.26) compared to the control group (75.28 ± 6.15) and (72.33 ± 5.87), respectively ($p < 0.05$). The observation group and control group students' awareness of geriatric sarcopenia and satisfaction with teaching methods were 95.00% and 97.50%, and 77.50% and 72.50%, respectively, with statistically significant differences ($p < 0.05$); The observation group demonstrated significantly higher frequency of proactive sarcopenia screening, greater enthusiasm in participating in nutritional intervention plan development, and increased engagement in health education during clinical practice compared to the control group, with statistically significant differences ($p < 0.05$). *Conclusion:* The application of a PBL combined with virtual reality (VR) technology teaching model in clinical teaching on geriatric sarcopenia significantly enhances students' foundational theoretical knowledge, improves their attitudes toward geriatric sarcopenia, and enhances their clinical practice behaviors. This represents a scientifically effective teaching method in geriatric medicine.

Keywords: Problem-Based Learning (PBL) teaching model; Virtual Reality (VR) technology; Geriatric sarcopenia; Screening; Nutritional intervention

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1. Introduction

With the acceleration of global population aging, China's population aged 65 and above has surpassed 14%,

marking the nation's full entry into a deeply aged society. Sarcopenia, a common degenerative disease among the elderly, is characterized by reduced muscle mass, diminished muscle strength, and impaired physical function. Its prevalence significantly increases with age, reaching 30% to 50% among individuals aged 80 and above ^[1]. Sarcopenia not only increases the risk of falls, fractures, and disability among the elderly but also exacerbates the healthcare burden. Therefore, cultivating clinical medical professionals with high-level expertise in screening, assessing, and intervening in sarcopenia is crucial for enhancing geriatric healthcare services ^[2]. However, under traditional lecture-based teaching models, the inability to authentically replicate early screening and nutritional intervention processes for geriatric sarcopenia often leaves students with only foundational theoretical knowledge. When confronted with real clinical scenarios, they frequently feel overwhelmed and unable to apply their learning. Problem-Based Learning (PBL) is an emerging student-centered teaching approach that guides students to actively explore through real clinical problems, effectively enhancing their clinical reasoning skills ^[3]. Wen Maowan observed that applying PBL significantly improved clinical interns' performance and self-directed learning abilities, while greatly benefiting the development of their clinical reasoning skills ^[4]. Virtual reality technology, also known as artificial reality or cyberspace technology, utilizes computers to construct immersive, interactive virtual clinical scenarios. This allows students to engage in repeated practice within simulated environments, enabling them not only to rapidly master clinical operational techniques but also to internalize foundational knowledge through continuous practice ^[5]. This holds significant importance for developing clinical reasoning, enhancing procedural compliance, and improving teamwork capabilities. Ling Lin et al. conducted an experimental study on applying VR technology in standardized residency training, confirming that VR enhances trainees' learning interest and improves their clinical skills ^[6]. This study will integrate PBL with VR technology, using sarcopenia screening and nutritional intervention in the elderly as its entry point, to construct a novel teaching model. It aims to explore the impact of this approach on medical interns' knowledge acquisition, attitudes, and behaviors, thereby providing new insights and methodologies for teaching sarcopenia in geriatrics.

2. Materials and methods

2.1. General data

The study enrolled 80 clinical medicine undergraduate interns admitted to the geriatrics department of a certain hospital from January 2024 to June 2025.

2.1.1. Inclusion criteria

- (1) Completion of basic medical coursework and entry into the clinical internship phase
- (2) Voluntary participation in the study with signed informed consent
- (3) Absence of contraindications for VR device use

2.1.2. Exclusion criteria

- (1) Failure to complete all teaching content during internship due to leave or department transfer
- (2) Prior specialized training in geriatric medicine.

2.1.3. Participants

Participants were randomly assigned to an observation group (n = 40) and a control group (n = 40) using a

random number table. Observation group: 22 males, 18 females; age 22–25 years, mean (23.45 ± 0.82) years; academic performance grades (based on undergraduate GPA): 12 excellent, 20 good, 8 satisfactory. The control group comprised 20 males and 20 females, aged 22–26 years (mean 23.62 ± 0.91 years). Academic performance levels were: 10 excellent, 21 good, and 9 satisfactory. Comparisons of general characteristics (gender, age, academic performance) between groups showed no statistically significant differences ($p > 0.05$ for all), indicating comparability.

2.2. Methods

Both groups were taught by faculty members holding the title of Associate Chief Physician or above in geriatrics. The practical training focused on geriatric sarcopenia, emphasizing

- (1) Definition, epidemiological characteristics, and pathogenesis of sarcopenia in the elderly
- (2) Screening methods for sarcopenia in older adults (grip strength measurement, 6-meter walk test, bioelectrical impedance analysis, etc.)
- (3) Nutritional interventions for sarcopenia in the elderly (protein supplementation, vitamin D regulation, dietary pattern optimization, etc.)
- (4) Comprehensive management and health guidance for sarcopenia patients.

The total teaching duration was 12 months.

2.2.1. Control group

Employed a traditional lecture-based teaching model, systematically presenting content in the conventional sequence of “definition-mechanism-clinical manifestations-diagnosis-treatment” using PPT slides, images, and videos. Post-class assignments included relevant literature readings. Following foundational theory instruction, students participated in bedside teaching sessions.

2.2.2. Observation group

Employed a PBL combined with VR technology teaching model, implemented as follows:

(1) PBL problem design

Using the core case “An 82-year-old male admitted for ‘two recurrent falls,’ with a 10-year history of hypertension and no history of diabetes. Physical examination: Height 165 cm, weight 52 kg, grip strength 21 kg, 6-meter walk speed 0.5 m/s. Laboratory tests: Serum albumin 32 g/L, vitamin D 15 ng/mL”. A series of questions were designed around this core case: ① Does this patient have sarcopenia? What is the evidence? ② What additional tests are needed to confirm the diagnosis? ③ How should a nutritional intervention plan be developed for this patient? ④ How should fall prevention and health guidance be provided to the patient?

(2) VR scenario construction

Utilize a VR teaching system to construct virtual scenarios for sarcopenia screening and nutritional intervention in the elderly: ① Virtual clinic scenario: Includes standardized elderly patient models, grip strength meters, bioelectrical impedance analyzers, and other examination equipment; ② Nutritional assessment scenario: Provides virtual dietary survey tools, nutritional calculation software, and common food models; ③ Health guidance scenario: Simulates a home environment for one-on-one health education practice.

(3) Teaching implementation process

- ① Pre-class Preparation: Instructors distribute case materials. Students form groups (5 members per group) to review relevant literature and outline preliminary problem-solving approaches. □ Classroom Discussion: Each group presents case analysis findings. Instructors guide students in discussing core issues to clarify sarcopenia screening protocols and key nutritional intervention points. □ VR Practical Application: Students wear VR equipment to enter virtual scenarios and sequentially complete: a. Grip strength measurement, gait speed testing, and bioelectrical impedance analysis on virtual patients to assess sarcopenia presence; b. Nutritional assessment based on virtual patients' dietary status, developing personalized protein and vitamin D supplementation plans; c. Fall prevention and nutritional education for virtual patients in home settings. Instructors provide real-time guidance to correct improper procedures.
- ④ Post-Session Summary: Group members share practical insights, and the instructor summarizes key teaching points to reinforce knowledge retention.

2.3. Observation indicators

2.3.1. Learning outcomes for the “geriatric sarcopenia prevention and management training program”

(1) Basic theoretical knowledge assessment

Following instruction, a closed-book exam evaluates both groups' mastery of geriatric sarcopenia knowledge, covering foundational theory (40 points), screening criteria (30 points), and nutritional intervention principles (30 points), with a total score of 100 points.

(2) Clinical practice assessment

Two senior geriatric physicians conducted blinded evaluations of students' proficiency in using dynamometers, conducting gait speed tests, developing nutritional plans, and providing health guidance. The maximum score was 100 points, with the final grade being the average of the two evaluators' scores.

2.3.2. Attitude change (pre- and post-training comparison)

Post-training questionnaires surveyed students' attitude shifts. Questionnaire items included:

- (1) Attention to geriatric sarcopenia (rated as “Highly Concerned”, “Concerned”, “Neutral”, or “Unconcerned”)
- (2) Satisfaction with teaching methods, rated on a 4-point scale: “Very satisfied”, “Satisfied”, “Neutral”, “Dissatisfied”.

A total of 80 questionnaires were distributed, with 80 valid responses collected, achieving a 100% valid response rate.

2.3.3. Behavioral change assessment

Within one month after the teaching session, supervising instructors assessed interns' performance in geriatric clinical practice using a clinical behavior observation scale. Key indicators included: frequency of proactive sarcopenia screening, initiative in participating in patient nutrition intervention plan development, and involvement in sarcopenia-related health education for elderly patients (rated as “frequently involved”, “occasionally involved”, or “not involved”, with “frequently involved” counted as positive).

2.4. Statistical analysis

Data analysis was performed using SPSS 26.0 statistical software. Quantitative data are expressed as mean \pm standard deviation ($\bar{x} \pm s$). Intergroup comparisons were conducted using independent samples *t*-tests. Qualitative data are presented as rates (%). Intergroup comparisons were performed using chi-square (χ^2) tests. A *p* value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of academic performance between groups

Students in the observation group demonstrated significantly higher scores in both theoretical knowledge assessments and practical skill evaluations compared to the control group, with statistically significant differences ($p < 0.05$). See **Table 1**.

Table 1. Comparison of basic theoretical knowledge and clinical practice scores between two student groups ($\bar{x} \pm s$, points)

Group	Basic theoretical knowledge assessment score	Practical skills assessment score (Points, $\bar{x} \pm s$)
Control group (n = 40)	75.28 \pm 6.15	72.33 \pm 5.87
Observation group (n = 40)	86.52 \pm 5.31	88.15 \pm 4.26
<i>t</i>	8.749	13.795
<i>p</i>	< 0.001	< 0.001

3.2. Comparison of attitude changes between the two groups

Students in the observation group demonstrated significantly higher levels of awareness regarding geriatric sarcopenia and greater satisfaction with teaching methods compared to the control group, with statistically significant differences ($p < 0.05$). See **Table 2**.

Table 2. Comparison of attention to geriatric sarcopenia and satisfaction with teaching methods between groups [(n), %]

Group	Attention to geriatric sarcopenia	Satisfaction with teaching methods
Control group (n = 40)	29 (72.50)	31 (77.50)
Observation group (n = 40)	38 (95.00)	39 (97.50)
χ^2	7.440	7.314
<i>p</i>	0.006	0.007

3.3. Comparison of behavioral changes between intern groups

The observation group demonstrated significantly higher frequency of proactive sarcopenia screening during clinical practice, greater enthusiasm in participating in nutrition intervention plan formulation, and higher engagement in health education compared to the control group, with statistically significant differences ($p < 0.05$). See **Table 3**.

Table 3. Comparison of proactive screening frequency, initiative in plan development, and health education participation between groups [(n), %]

Group	Frequency of proactive screening (≥ 3 times/week)	Plan development participation (active)	Health education participation (frequent participation)
Control group (n = 40)	18 (45.00)	22 (55.00)	25 (62.50)
Observation group (n = 40)	32 (80.00)	35 (87.50)	35(87.50)
χ^2	10.453	10.313	6.667
<i>p</i>	0.001	0.001	0.009

4. Discussion

Sarcopenia in the elderly is a syndrome characterized by reduced total body muscle mass, decreased muscle strength, and diminished physical function, representing an increasingly prominent public health issue in geriatric medicine. Currently, clinical awareness, screening rates, and diagnostic rates for sarcopenia remain generally low, posing significant challenges to its prevention and treatment. This necessitates higher competency standards for clinicians in geriatrics and general practice. However, traditional clinical teaching methods suffer from disconnects between theoretical instruction and clinical practice, as well as monotonous teaching formats, making it difficult to stimulate trainees' interest and ability to actively explore and solve complex clinical problems. Therefore, actively exploring and applying innovative educational models, such as Problem-Based Learning (PBL) combined with Virtual Reality (VR) technology, is of great significance for breaking through traditional teaching bottlenecks, deepening educational reform, and cultivating outstanding medical professionals capable of meeting the health needs of an aging society. The study findings indicate that students in the observation group achieved significantly higher scores in both theoretical knowledge assessments and practical skill evaluations compared to the control group. This demonstrates that PBL combined with VR technology effectively enhances interns' mastery of geriatric sarcopenia knowledge ^[7].

- (1) PBL, guided by real clinical cases, motivates students to proactively review literature and organize knowledge frameworks. This approach integrates the fundamental theory of sarcopenia with screening and intervention practices, fostering a systematic knowledge system.
- (2) VR technology creates immersive scenarios enabling students to directly observe physiological characteristics of elderly patients and repeatedly practice procedures like grip strength measurement and gait speed testing. This addresses the traditional teaching challenge of "much observation but little practice", enhancing proficiency and accuracy in clinical operations ^[8].

This study further revealed that students in the observation group demonstrated superior attention to geriatric sarcopenia, teaching satisfaction, and clinical behavior compared to the control group. This indicates that this teaching model effectively improves interns' learning attitudes and clinical practice behaviors. On one hand, the engaging and interactive nature of VR technology heightened students' learning interest, shifting their mindset from "I have to learn" to "I want to learn", thereby increasing their focus on sarcopenia, a critical geriatric medicine topic ^[9]. On the other hand, PBL group discussions cultivated students' teamwork and communication skills, while health guidance simulations in VR scenarios strengthened their confidence in communicating with elderly patients. This enabled them to participate more proactively in sarcopenia screening and health education

during clinical practice^[10].

5. Conclusion

In summary, the PBL-VR integrated teaching model combines problem-oriented learning with immersive practice, significantly improving medical interns' mastery of geriatric sarcopenia knowledge, enhancing their attitudes toward the condition, and modifying clinical behaviors. This approach warrants further promotion and refinement in medical education.

Disclosure statement

The author declares no conflict of interest.

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Nurse-Led Case Management for Wernicke's Encephalopathy in Acute Myelomonocytic Leukemia Post Allogeneic Stem Cell Transplantation

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Abstract: Wernicke's encephalopathy (WE), a neurological emergency caused by thiamine deficiency, represents a rare but life-threatening complication following allogeneic hematopoietic stem cell transplantation (allo-HSCT). This study details the nurse-led management of a 50-year-old man with acute myelomonocytic leukemia with eosinophilia (AML-M4Eo) who developed WE post-transplant. A structured nursing protocol was implemented, comprising comprehensive neurological monitoring (including consciousness and cranial nerve assessments), high-dose intravenous thiamine supplementation, individualized combined enteral and parenteral nutrition with gradual transition to oral intake, infection and bleeding prophylaxis, and psychological support using validated screening tools. After 27 days of integrated care, the patient achieved complete neurological recovery (Glasgow Coma Scale improved from 10 to 15), normalized thiamine levels (22.9 ng/mL), significant nutritional improvement, and fusion gene clearance. At the three-month follow-up, he maintained relapse-free status with substantially enhanced quality of life. This case emphasizes the vital role of systematic, nurse-driven interventions, incorporating early detection, targeted nutrient repletion, stepped nutritional rehabilitation, and psychosocial support, in optimizing WE outcomes post-allo-HSCT, supporting the integration of such multidimensional care into standard transplant protocols.

Keywords: Nurse-led case management; Wernicke's encephalopathy; Allogeneic stem cell transplantation; Thiamine supplementation; Nutritional support; Quality of life

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1. Introduction

Allogeneic hematopoietic stem cell transplantation (allo-HSCT) remains the definitive curative treatment for acute myelomonocytic leukemia with eosinophilia (AML-M4Eo), yet it is frequently complicated by metabolic and

neurological sequelae, including Wernicke's encephalopathy (WE)^[1,2]. WE, a life-threatening neuropsychiatric disorder caused by severe thiamine deficiency, manifests classically as a triad of ophthalmoplegia, ataxia, and confusion, with an incidence of 0.4–2.8% in high-risk populations^[3]. In the allo-HSCT setting, the risk of WE is amplified by conditioning-related catabolism, prolonged anorexia, gastrointestinal graft-versus-host disease (GVHD)-induced malabsorption, and delayed nutritional support. Despite its clinical urgency, WE is often underrecognized in transplant recipients due to atypical presentations that mimic infections, drug neurotoxicity, or GVHD-related complications, leading to delayed diagnosis and irreversible neurological damage. Current management lacks standardized nursing protocols for early detection and intervention, underscoring a critical gap in post-transplant care. Here, this study presents a case of AML-M4Eo in which a patient developed severe protein-energy malnutrition and WE following allo-HSCT. Through a structured, nurse-led approach, incorporating rigorous neurological monitoring, prompt thiamine repletion, phased nutritional rehabilitation, and psychological support, the patient achieved full neurological recovery and metabolic stabilization within 27 days. This report highlights the pivotal role of systematic nursing strategies in mitigating WE-related morbidity in high-risk transplant populations and proposes a framework for proactive surveillance and intervention.

2. Case presentation

A 50-year-old male with acute myelomonocytic leukemia (AML-M4Eo, intermediate-risk; CBFβ-MYH11 positive, with KIT and NF1 mutations) was admitted on March 25, 2025, due to progressive anorexia and nutritional deterioration over two months, worsening in the past week, having been diagnosed 10 months prior with remission after induction chemotherapy but persistent fusion gene positivity, followed by matched sibling allogeneic hematopoietic stem cell transplantation (HLA 12/12 matched, donor O positive to recipient A positive) with successful engraftment, and two months before admission, he experienced abdominal pain, vomiting, and diarrhea after self-administering herbal medicine, which resolved with symptomatic treatment; on admission, he was conscious with severe anemia (hemoglobin 53 g/L), but on March 27, he developed apathy, reduced verbal output, limb weakness, and delirium with a Glasgow Coma Scale (GCS) score of 10, leading to laboratory confirmation of profound thiamine deficiency (0.012 ng/mL) and brain MRI with DWI showing restricted diffusion in bilateral thalamus and brainstem, resulting in a diagnosis of Wernicke's encephalopathy after excluding intracranial infection and transplant-associated thrombotic microangiopathy (TA-TMA); treatment involved high-dose thiamine, methylcobalamin, other B vitamins, intensive nutritional support, electrolyte correction, blood transfusions, and immunosuppressant adjustment, with nursing interventions including hourly GCS monitoring, fall prevention for ataxia and weakness, phased enteral nutrition with refeeding syndrome monitoring, bleeding risk control during hematochezia episodes (noted on April 8 with intermittent blood-stained stools), psychological support using PHQ-9 (score: 14), and medication safety protocols, leading to consciousness clearance by April 2, significant thiamine level improvement by April 3, transition to nasogastric enteral nutrition on April 12 after bleeding control, and by April 15, CBFβ-MYH11 fusion gene was negative with complete donor chimerism (100%), culminating in discharge on April 21 and no recurrence during 3-month follow-up.

3. Nursing interventions

3.1. Systematic multidimensional monitoring

Neurological function was monitored hourly using the Glasgow Coma Scale (GCS) to dynamically track

symptoms of Wernicke's encephalopathy, including ophthalmoplegia, ataxia, confusion, and atypical manifestations such as speech impairment. Pupillary size, light reflex, and signs of increased intracranial pressure (e.g., headache, vomiting) were documented regularly. Changes in muscle strength and language function were recorded to objectively evaluate therapeutic progress. A structured "bleeding-infection" dual-risk checklist was implemented, with handover items focusing on stool color, texture, and volume for early detection of gastrointestinal bleeding. Standardized oral care (three times daily), perineal care (twice daily), and back patting were performed to promote sputum excretion and assess infection signs in critical areas. Strict aseptic techniques were maintained during central venous catheter procedures to minimize iatrogenic infection risks. Vital signs were measured every four hours with continuous blood oxygen saturation tracking. Daily monitoring of electrolytes, blood glucose, and liver and kidney functions was conducted, and parenteral nutrition formulas and infusion rates were dynamically adjusted to prevent refeeding syndrome and metabolic disorders.

3.2. Precision medication management centered on thiamine supplementation

A two-stage thiamine supplementation protocol was implemented based on EFNS guidelines ^[3]. During the rescue phase (March 27–29), 200 mg of thiamine dissolved in 100 mL normal saline was intravenously infused every 8 hours via pump control over 30 minutes. In the consolidation phase (March 30–April 21), 100 mg of thiamine was administered intramuscularly twice daily. Serum thiamine levels were monitored weekly, and doses were adjusted dynamically based on improvements in neuropsychiatric symptoms (e.g., apathy, delirium, speech function), transitioning from a standardized to an individualized regimen. A strict "thiamine before glucose" sequence was enforced, requiring double verification by two nurses to prevent exacerbation of thiamine deficiency due to glucose metabolism. Safety measures included readily available epinephrine for allergic reactions during intravenous thiamine administration ^[4]. Blood glucose, serum triglycerides, and liver and kidney functions were monitored during parenteral nutrition. For immunosuppressants (cyclosporine, mycophenolate mofetil), double verification ensured accuracy in administration time and dosage, with therapeutic drug monitoring to guide regimen adjustments.

3.3. Phased nutritional support

A stepwise nutritional support plan was developed collaboratively by nurses and dietitians ^[5]. In the initial phase (March 27–April 7), parenteral nutrition was combined with controlled oral intake (50 mL rice broth) to prevent refeeding syndrome. During the bleeding phase (April 8–11), oral intake was halted, and pure parenteral nutrition was prioritized alongside acid-suppression therapy. In the transition phase (April 12–17), enteral nutrition was initiated via nasogastric tube at 50 mL/h and gradually increased to 100 mL/h after the patient achieved Grade II on the Kubota Water Swallowing Test. In the recovery phase (April 18–discharge), oral nutritional supplements were introduced alongside enteral nutrition, with a final transition to full oral intake of thiamine-rich foods (e.g., animal liver, whole grains) ^[6]. Serum albumin, prealbumin, and 24-hour fluid balance were monitored to assess tolerance and adjust nutritional formulas.

3.4. Multidisciplinary collaborative comprehensive intervention

Psychological interventions were guided by Patient Health Questionnaire-9 (PHQ-9) scores, including structured relaxation training (e.g., progressive muscle relaxation, mindfulness meditation) conducted twice daily for 15 minutes to reduce eating anxiety and improve sleep quality ^[7,8]. Family members were engaged in caregiving

through health education manuals to enhance support. Safety measures included 24-hour accompaniment, elevated bed rails, and increased ward rounds to prevent falls and bed egress. Repositioning was assisted every two hours using a pressure-relieving air mattress to avoid pressure injuries. Daily assessments of muscle strength and activity tolerance were conducted, with guidance for progressive active and passive exercises to aid functional recovery and prevent deep vein thrombosis. A nurse-led multidisciplinary team (MDT) with a 30-minute rapid response protocol facilitated consultations (e.g., for gastrointestinal bleeding) to adjust treatment plans promptly. For blood transfusions in this ABO-incompatible transplant recipient, donor-compatible blood products (e.g., O⁺ leukocyte-depleted red blood cells, single-donor platelets) were used ^[9]. A comprehensive transfusion safety process was implemented, including pre-transfusion double verification, intra-transfusion leukocyte filtration with vital sign monitoring, and post-transfusion lactate dehydrogenase (LDH) tracking to detect occult hemolysis. The 36-Item Short Form Health Survey (SF-36) was incorporated to evaluate intervention effectiveness and quality of life.

3.5. Standardized continuity of care

Before discharge, a personalized nutrition and medication plan was developed, emphasizing thiamine-rich foods, dosage management, and adverse reaction monitoring. A multidisciplinary follow-up team dynamically adjusted rehabilitation based on patient feedback and physiological indicators. Remote monitoring via mobile apps tracked nutritional intake and psychological status. Illustrated health education manuals and family lectures were provided to improve compliance. Collaboration with community health centers ensured the delivery of home-community care services, maintaining post-discharge continuity and effectiveness ^[10].

4. Nursing outcomes

After 27 days of targeted, evidence-based nursing interventions, the patient showed comprehensive and sustained clinical improvements. Quantitative indicators, safety outcomes, and subjective feedback collectively validated the care plan's efficacy. Neurologically, the Glasgow Coma Scale (GCS) score improved from 10 points, marked by apathy, speech inability, and delirium, to 15 points, indicating full recovery of consciousness, clear verbal communication, and normal muscle strength and coordination. The core pathogenic indicator, serum thiamine, increased from 0.012 ng/mL (severe deficiency) to 22.894 ng/mL, returning to the normal range. Nutritionally, the severe malnutrition state was reversed: serum albumin rose from 21.82 g/L to 38 g/L, hemoglobin improved from 53 g/L (severe anemia) to 78 g/L, and prealbumin increased from 105 mg/L to 250 mg/L, with a stable 24-hour fluid intake and output balance. Psychologically, the Patient Health Questionnaire-9 (PHQ-9) score decreased from 14 points (moderate depression) to 5 points, and the 36-Item Short Form Health Survey (SF-36) score improved by 52 points, indicating a significant enhancement in overall quality of life. In terms of safety and complication control, gastrointestinal bleeding was effectively controlled within 72 hours without recurrence; no iatrogenic complications such as infection (body temperature maintained at 36.2–37.2 °C, white blood cell count stable at $4.0\text{--}6.5 \times 10^9/\text{L}$), pressure injury, falls, or deep vein thrombosis occurred during hospitalization. For the ABO-incompatible transplant blood transfusion, 6 units of O⁺ leukocyte-depleted suspended red blood cells and 2 units of single-donor platelets were administered safely, with no adverse reactions such as hemolysis, and lactate dehydrogenase (LDH) remained within the normal range (120–250 U/L). Subjectively, the patient reported, “Anxiety about neurological symptoms and bleeding has completely disappeared; I can eat and sleep normally and move freely without restrictions”. Family members noted, “Nurses’ detailed guidance on daily care and nutrition

helped us master home care skills, and remote follow-up via mobile APP gave us peace of mind”. A 3-month post-discharge follow-up confirmed stable neurological function, persistently normal nutritional indicators, negative CBF β -MYH11 fusion gene, and 100% donor chimerism, with no disease recurrence.

5. Discussion

This case underscores the critical role of systematic nursing interventions in managing complex metabolic encephalopathies following allogeneic hematopoietic stem cell transplantation. The rapid neurological deterioration observed in this patient, characterized by plummeting thiamine levels and declining consciousness, highlights the time-sensitive nature of Wernicke’s encephalopathy management in post-transplant settings. Our findings demonstrate that structured nursing surveillance protocols, particularly hourly neurological assessments coupled with nutritional monitoring, can serve as early warning systems for metabolic crises that might otherwise be overlooked in complex hematological patients. The success of this intervention challenges conventional paradigms that often prioritize hematological parameters over neurological and metabolic monitoring in post-transplant care ^[11]. By implementing a “thiamine before glucose” protocol alongside phased nutritional support, this study addressed the fundamental pathophysiology of Wernicke’s encephalopathy while preventing iatrogenic exacerbation through glucose administration. This approach represents a significant advancement in nursing management of transplant complications, emphasizing the need for metabolic awareness in patients with nutritional deficiencies. The integration of psychological assessment using validated tools like PHQ-9 further illustrates the holistic approach required for these complex cases. The moderate depression score identified upon admission underscores the interconnectedness of metabolic, neurological, and psychological dimensions in post-transplant recovery, an aspect often underemphasized in conventional hematological care. While our results are promising, they should be interpreted within the context of single-case limitations. The absence of controlled comparisons prevents definitive causal attributions, and the unique characteristics of this case (including the specific transplant type and absence of active GVHD) may limit generalizability. Nevertheless, the temporal association between nursing interventions and clinical improvement, along with the biological plausibility of our approach, suggests genuine therapeutic efficacy.

6. Conclusion

This case illustrates that nurse-led, protocol-driven care models can significantly impact outcomes for patients developing Wernicke’s encephalopathy following hematopoietic stem cell transplantation. The implementation of structured neurological surveillance, metabolic monitoring, and nutritional support protocols represents a replicable framework for managing this serious complication. Our experience suggests that early recognition of nonspecific neurological changes, coupled with immediate thiamine repletion and careful nutritional management, can alter the clinical course of this potentially devastating condition. These findings advocate for greater integration of neurological and metabolic monitoring standards in post-transplant care protocols, emphasizing nursing’s pivotal role in detecting and managing these complex interdisciplinary challenges. Future research should focus on validating risk assessment tools and standardized intervention protocols across multiple centers to establish evidence-based guidelines for preventing and managing metabolic encephalopathies in high-risk transplant populations.

Disclosure statement

The authors declare no conflict of interest.

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To Analyze the Influence of Psychological Counseling Combined with Operating Room Nursing Intervention Based on Maslow's Hierarchy of Needs Theory on the Sleep Quality of Burn Patients

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Abstract: *Objective:* To explore the combined effects of psychological counseling and operating room nursing intervention based on Maslow's hierarchy of needs on sleep quality, psychological state, and social adaptability in burn patients. *Methods:* Eighty burn patients were selected as the study subjects and randomly divided into the intervention group and the control group using the random number table method, with 40 cases in each group. The control group received routine care, including wound care, pain management and health guidance, etc. In addition to routine care, the intervention group received systematic psychological counseling and an operating room nursing intervention based on Maslow's hierarchy of needs for a period of 4 weeks. The Chinese version of the Burn-specific Health Scale (BSHS-C), Pittsburgh Sleep Quality Index (PSQI), Self-Rating Anxiety Scale (SAS), and Self-rating Depression Scale (SDS) were used to assess sleep quality and mental state before and after the intervention. *Results:* After the intervention, the total PSQI score of the intervention group (8.3 ± 1.4) was significantly lower than that of the control group (10.7 ± 1.6), and the difference was statistically significant ($t = 7.43, p < 0.01$). The SAS score (41.8 ± 4.1) and SDS score (40.2 ± 3.9) in the intervention group were significantly lower than those in the control group (SAS: 50.5 ± 4.6 ; SDS: 49.4 ± 4.2), and the differences were statistically significant ($p < 0.01$). In terms of social adaptability, the scores of psychological function (25.6 ± 2.5), social relationship (23.9 ± 2.2), health status (22.7 ± 2.4), and physical function (24.2 ± 2.6) in the BSHS-C scale of the intervention group were significantly better than those of the control group, and the differences were statistically significant ($p < 0.01$). *Conclusion:* Psychological counseling combined with operating room nursing intervention based on Maslow's hierarchy of needs can improve the sleep quality of burn patients, reduce anxiety and depression, and enhance their social adaptability. It is an effective comprehensive nursing model worthy of clinical promotion and application in the rehabilitation nursing of burn patients.

Keywords: Burns; Psychological counseling; Maslow's hierarchy of needs; Sleep quality; Nursing intervention

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1. Introduction

Burns are common traumatic diseases, often accompanied by severe pain, tissue damage, and metabolic disorders, which can have a significant impact on the physical and mental health of patients. Thanks to the advancement of modern medical technology, the success rate of treating burn patients has improved, but complications such as psychological disorders, anxiety, and insomnia have gradually emerged, having a significant impact on the recovery process and the quality of life of patients. In clinical practice, many burn patients experience severe anxiety and fear during surgery due to the risks of the operation, wound pain and the uncertainty of postoperative recovery. These negative emotions often result in poor sleep, weakened immunity and slow wound healing, thus creating a vicious cycle. The operating room is an important place for treating burn patients. The quality of nursing in the operating room is related not only to whether the surgery can proceed smoothly, but also affects the postoperative recovery and psychological state of the patients.

In the traditional care model, nursing staff focus more on the physical symptoms of patients and the prevention of postoperative complications, while ignoring the psychological feelings and personal needs of patients. In fact, burn patients encounter many psychological needs during treatment, including the need for physical safety as well as the need for emotional support and mental comfort. American psychologist Maslow proposed the hierarchy of needs, which provides systematic guidance for nursing work. The hierarchy of needs holds that human needs develop gradually from low to high, namely physiological needs, safety needs, needs for belonging and love, esteem needs, and self-actualization needs. If caregivers meet patients' needs in different ways according to this theory, it can effectively increase patients' sense of security and trust, and improve positive psychological responses and treatment compliance.

Psychological counseling is an important part of nursing intervention. Through means such as communication, support, suggestion, and cognitive adjustment, it prompts patients to have a correct understanding of the disease and treatment, reduces anxiety and depression, and shapes positive psychological defense mechanisms. When psychological counseling is combined with Maslow's hierarchy of needs, a multi-dimensional, personalized nursing model is formed, elevating nursing work from a single technical service to a humanized service that takes into account both the body and mind ^[1].

Based on this, this study takes burn patients as the research subjects to explore the impact of psychological counseling combined with operating room nursing intervention based on Maslow's hierarchy of needs on the sleep quality of patients, aiming to provide references and evidence for optimizing the perioperative nursing model of burn patients, improving their psychological state and enhancing the quality of nursing services.

2. Data and methods

2.1. General information

Eighty burn patients who were hospitalized in our hospital from January 2022 to December 2023 were selected.

2.1.1. Inclusion criteria

- (1) Aged between 18 and 65 years
- (2) Burn area of 10% to 50%
- (3) Conscious and able to cooperate with the investigation
- (4) Sign the informed consent form

2.1.2. Exclusion criteria

- (1) Comorbid with severe heart, liver or kidney disease
- (2) History of mental illness
- (3) Pregnant or lactating women.

2.1.3. Sample size

Patients were randomly divided into the intervention group and the control group using a random number table, with 40 cases in each group. There were 22 males and 18 females in the intervention group, with an age of (42.5 ± 10.3) years and a burn area of $(28.4 \pm 8.7) \%$; In the control group, there were 24 males and 16 females, with an age of (41.8 ± 9.6) years and a burn area of $(27.9 \pm 9.1) \%$. There was no statistically significant difference in the general data between the two groups ($p > 0.05$), and they were comparable ^[2].

2.2 Methods

2.2.1. Control group

Patients in the control group received a routine care plan, basic medical needs were met, standardized wound debridement and dressing changes were carried out, analgesia was administered according to pain assessment results, individualized nutritional support plans ensured adequate energy and protein intake, routine health education guidance, basic psychological comfort and support were provided. These are the routine care in the burn ward at present.

2.2.2. Intervention group

In addition to routine care, the intervention group also received psychological counseling combined with Maslow's hierarchy of needs operating room nursing intervention. Nursing staff received uniform training before the intervention to understand the main contents of Maslow's hierarchy of needs and the methods of psychological counseling to ensure consistency in the nursing process. The interventions are as follows:

(1) Physiological needs level

Provide the patient with a quiet, clean, temperature-appropriate ($22-25^{\circ}\text{C}$), and moderately humid surgical environment before the operation, and reduce external noise stimulation; Before the operation, assess the degree of pain and physical discomfort and assist the patient in adopting a comfortable position; After the operation, multimodal analgesia was performed based on the pain score, with attention paid to sleeping position and comfort of turning over; For those with poor appetite and sleep, provide targeted nursing guidance to ensure basic physiological needs.

(2) Postoperative monitoring and care

In terms of safety needs, nursing staff explain the surgical procedures, anesthesia methods, and postoperative precautions to patients in simple and understandable language, enabling patients to have a correct understanding of the surgical process and reducing their fear of unknown risks. Strengthen aseptic awareness and safety check systems during the operation to reduce errors and infections. Postoperative monitoring should be strengthened, and patients' discomfort should be dealt with promptly to ensure a sense of security both physically and psychologically.

(3) The need for belonging and love

Nursing staff should maintain a friendly tone and gentle attitude during communication, actively listen to

patients' emotional expressions, give sincere responses, and establish a good nurse-patient relationship; Encourage family members to participate in the nursing process, provide emotional support during preoperative visits or postoperative companionship, and make the patient feel cared for by the family and society; By participating in care decisions together, enhance patients' sense of belonging and trust.

(4) Respecting patient needs and dignity in surgical care

On the level of respecting needs, caregivers respect personality, respect emotional equality, respect patients' privacy, and protect patients' dignity in care. Encourage patients to express their true feelings in preoperative communication and respect their opinions and choices regarding treatment options; Use positive and affirmative language to boost the patient's confidence and make the patient feel respected and valued.

(5) At the level of self-actualization needs

Set rehabilitation goals based on individual differences and encourage patients to actively participate in self-care and functional exercises to improve their ability to take care of themselves. By presenting successful cases and creating role models, patients are encouraged to form positive self-expectations, promoting their psychological development and rehabilitation motivation, thus shifting from passive treatment to active rehabilitation.

(6) Comprehensive psychological and emotional support in surgical care

Add systematic psychological counseling techniques on top of the various levels of intervention mentioned above. Cognitive behavioral intervention is used to help patients re-recognize surgical risks and disease prognosis, correct irrational thinking, use progressive muscle relaxation training, deep breathing, meditation and other methods to relieve tension, play light music before surgery to create a relaxing atmosphere, and use positive suggestion and positive guidance to reduce anxiety, fear and depression. Nurses conduct regular psychological assessments before and after the operation, and adjust the counseling methods in a timely manner according to the changes in the patient's psychological state to keep the patient emotionally stable and mentally positive ^[3].

2.3. Observation indicators

- (1) The social adaptability of the two groups of patients before and after nursing intervention was analyzed using the Chinese version of the Burn Specific Health Scale-Chinese (BSHS-C) The analysis was conducted in three aspects: psychological function (score 0–120), social relationship (score 0–60), health status (score 0–60), and physical function (score 0–80).
- (2) Sleep Quality is assessed using the Pittsburgh Sleep Quality Index (PSQI). The scale has seven aspects including time to fall asleep, sleep duration, sleep difficulty, daytime functional difficulty, etc., with a total score of 0 to 21. The higher the score, the poorer the sleep quality. It was evaluated by uniformly trained nurses before the intervention and within one week after the intervention.
- (3) Psychological states were evaluated using the Self-Rating Anxiety Scale (SAS) and the Self-Rating Depression Scale (SDS). Both scales were filled out by the patients themselves. A standardized SAS score of ≥ 50 was considered anxiety, and a standardized SDS score of ≥ 53 was considered depression. The evaluation time was the same as that of PSQI, used to observe the impact of the intervention on psychological status. The combined evaluation of these indicators can reflect the effects of psychological counseling combined with Maslow's hierarchy of care intervention on sleep, psychology and other aspects

of burn patients, providing data support for the next result analysis ^[4].

2.4. Statistical processing

Data analysis was performed using SPSS 22.0 software. Measurement data were expressed as mean \pm standard deviation ($\bar{x} \pm s$), and the *t*-test was used for comparison between groups; Count data were expressed as rates (%), and the χ^2 test was used for comparison between groups. A difference was considered statistically significant when $p < 0.05$.

3. Results

3.1. Comparison of SAS and SDS scores before and after intervention between the two groups of patients

The comparison between the groups after the intervention showed that the SAS and SDS scores of the intervention group were significantly lower than those of the control group, and the difference was highly statistically significant ($p < 0.01$). Specific data are shown in **Table 1**.

Table 1. Comparison of SAS and SDS scores ($\bar{x} \pm s$, points) between the two groups of patients before and after intervention

Groups	Number of cases	Point in time	SAS score	SDS score
Intervention group	40	Before intervention	58.3 \pm 5.2	57.1 \pm 4.8
		After intervention	41.8 \pm 4.1*	40.2 \pm 3.9*
Control group	40	Before intervention	57.8 \pm 5.0	56.9 \pm 5.1
		After intervention	50.5 \pm 4.6*	49.4 \pm 4.2*

3.2. Comparison of social adaptability between the two groups of patients

The comparison between the groups after the intervention showed that the scores of the intervention group in the four dimensions of psychological function, social relationship, health status and physical function were significantly higher than those of the control group, and the differences were statistically significant ($p < 0.05$ or $p < 0.01$). Specific data are shown in **Table 2**.

Table 2. Comparison of social adaptability between the two groups ($\bar{x} \pm s$, points)

Groups	Time point	Psychological function	Social relationships	Health status	Physical function
Intervention group (n = 40)	Before intervention	18.2 \pm 3.1	16.5 \pm 2.8	15.8 \pm 2.9	17.1 \pm 3.3
	After intervention	25.6 \pm 2.5*	23.9 \pm 2.2*	22.7 \pm 2.4*	24.2 \pm 2.6*
Control group (n = 40)	Before intervention	18.0 \pm 3.0	16.7 \pm 2.6	15.9 \pm 3.0	16.9 \pm 3.1
	After intervention	21.8 \pm 2.7*	20.1 \pm 2.5*	19.5 \pm 2.8*	21.0 \pm 2.9*
<i>t</i> values (comparison between groups, after intervention)	-	6.52	7.18	5.29	5.15
<i>p</i> value (comparison between groups, after intervention)	-	< 0.01	< 0.01	< 0.01	< 0.01

3.3. Comparison of PSQI scores before and after intervention between the two groups of patients

The PSQI score of the intervention group was significantly lower than that of the control group ($p < 0.05$). Specific data are shown in **Table 3**.

Table 3. Comparison of PSQI scores of the two groups of patients before and after intervention ($\bar{x} \pm s$, points)

Groups	Number of cases	1 day after surgery	3 days after surgery	5 days after surgery	7 days after surgery
Intervention group	40	15.3 \pm 2.0	12.1 \pm 1.8*	9.8 \pm 1.5*	8.2 \pm 1.4*
Control group	40	15.1 \pm 2.2	13.5 \pm 1.9*	11.9 \pm 1.7*	10.7 \pm 1.6*
<i>t</i> values (comparison between groups)	-	0.42	3.45	6.02	7.43
<i>p</i> value (comparison between groups)	-	0.675	< 0.01	< 0.01	< 0.01

4. Discussion and conclusion

This article combines systematic psychological counseling with Maslow's hierarchy of needs theory and applies it to the perioperative care of burn patients. The results showed that the comprehensive intervention model could significantly improve patients' negative emotions, sleep quality and social adaptability, proving that it was an effective nursing model.

The results of this study show that the anxiety (SAS) and depression (SDS) scores of the intervention group were lower than those of the control group after the intervention. The results were achieved because stratified and structured psychological interventions were carried out. Cognitive behavioral therapy enabled patients to identify and correct disastrous thinking about trauma, appearance, and prognosis, fundamentally reducing psychological stressor, and relaxation training provided patients with practical skills to deal with acute anxiety and pain, effectively reducing physiological arousal levels. The key point is that the nursing intervention based on Maslow's theory meets patients' multi-level needs for physiology, safety, love and belonging, respect and self-actualization in a systematic way, creating an atmosphere of being understood, respected and supported. This comprehensive support system, together with simple psychological counseling, forms a powerful synergy to transform the physical and mental state of the patient ^[5].

The PSQI score of the intervention group was better than that of the control group on the third day after the operation, and the improvement degree remained better than that of the control group over time. The quality of sleep is closely related to the state of mind. The relief of anxiety and depression directly reduces the core factors of difficulty falling asleep and waking up at night. At the same time, a focus on satisfying "physiological needs" in nursing interventions, active pain management, and a comfortable environment directly eliminated the physiological discomfort that affected sleep. The satisfaction of the "safety need", namely the detailed process explanation before the operation, significantly reduced the preoperative stress caused by the fear of the unknown in patients, laying a psychological foundation for stable sleep. Dynamic PSQI scores demonstrated that the combined intervention model was both effective and fast-acting in improving sleep problems in burn patients.

In addition, patients in the intervention group scored better than those in the control group in terms of social adaptability in psychological function, social relationship, health status and physical function. The benefits of

this intervention model have extended beyond the hospital to the broader field of rehabilitation. It meets patients' higher-level needs for "love and belonging" and "self-actualization", giving them confidence and inner motivation to reintegrate into society. The improvement of psychological function enables patients to better cope with challenges, and the recovery of physical function lays the foundation for participation in social activities. The three form a virtuous cycle among the psychological, physiological and social aspects, thereby enhancing the quality of rehabilitation of patients.

In summary, the surgical nursing intervention that combines psychological counseling with Maslow's hierarchy of needs aims to comprehensively improve the physical and mental condition of burn patients by starting from multiple targets and levels. This study also has the shortcomings of a relatively short intervention period and the inability to conduct long-term follow-up. In the future, the intervention period could be extended to study the differences in the effects of this model among patients with different degrees of burns, thereby improving the level of clinical care.

Disclosure statement

The author declares no conflict of interest.

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Evaluation of the Effectiveness of Standardized Patient Scenario Simulation Teaching in Geriatric Medicine Education

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Abstract: *Objective:* To investigate the effectiveness of standardized patient scenario simulation teaching in geriatric medicine clinical education and provide references for improving teaching methods in geriatrics. *Methods:* Sixty-five clinical physicians from other departments who rotated into the Geriatric Medicine Department for training between August 2024 and July 2025 were randomly divided into a control group ($n = 32$) and an observation group ($n = 33$). The control group received traditional centralized theoretical lectures combined with instructor-led clinical mentoring, while the observation group underwent standardized patient scenario simulation training. The two groups were compared on post-rotation examination scores and teaching satisfaction metrics. *Results:* The observation group achieved significantly higher post-rotation examination scores (88.37 ± 3.04) than the control group (80.17 ± 3.29) ($p < 0.01$). Teaching satisfaction surveys revealed that trainees in the observation group demonstrated significantly higher satisfaction than the control group ($p < 0.05$) regarding the teaching method's effectiveness in enhancing learning interest, independent learning ability, comprehensive clinical problem-solving skills, patient communication skills, teamwork capabilities, and research conceptualization abilities. *Conclusion:* Standardized patient scenario simulation teaching effectively improves clinical teaching quality in geriatric medicine, enhances trainees' comprehensive clinical competencies, and holds value for broader application.

Keywords: Standardized patients; Scenario simulation teaching method; Geriatrics; Clinical teaching; Teaching evaluation

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1. Introduction

Geriatrics is a discipline focused on the health and disease prevention of the elderly. Geriatric patients often present with multiple chronic conditions, complex and variable clinical presentations, and unique physiological and psychological characteristics. This necessitates clinical medical education that emphasizes the development of trainees' comprehensive analytical skills, problem-solving abilities, communication techniques, and humanistic