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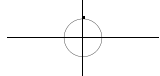
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Journal of Clinical and Nursing Research (JCNR) is an international, peer reviewed and open access journal that seeks to promote the development and exchange of knowledge which is directly relevant to all clinical and nursing research and practice. Articles which explore the meaning, prevention, treatment, outcome and impact of a high standard clinical and nursing practice and discipline are encouraged to be submitted as original article, review, case report, short communication and letters.

Topics covered by not limited to:

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- Patients and family experiences of health care
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Evaluation of the Efficacy of Flat Mesh Tension-Free Hernioplasty in the Treatment of Inguinal Hernia

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Abstract: *Objective:* To explore and analyze the clinical efficacy of flat mesh tension-free hernioplasty in the treatment of patients with inguinal hernia. *Methods:* A total of 60 patients with inguinal hernia were included and equally divided into an observation group (30 cases, flat mesh tension-free hernioplasty) and a control group (30 cases, mesh plug tension-free hernioplasty) based on differences in surgical plans. The visual analog scale (VAS) for postoperative pain, inflammatory markers (C-reactive protein, white blood cell count), and complication rates were compared between the two groups. *Results:* At 24 and 48 hours postoperatively, the VAS scores in the observation group were significantly lower than those in the control group ($P < 0.05$). At 24 hours postoperatively, the levels of CRP and WBC were also lower in the observation group ($P < 0.05$). The complication rate was slightly lower in the observation group ($P > 0.05$). *Conclusion:* Flat mesh tension-free hernioplasty for inguinal hernia can alleviate postoperative pain and suppress inflammatory responses, with fewer complications, making it suitable for promotion at primary healthcare facilities.

Keywords: Clinical efficacy; Flat mesh tension-free hernioplasty; Inguinal hernia; Mesh plug tension-free hernioplasty; Postoperative pain

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1. Introduction

Inguinal hernia is a common condition in general surgery, primarily caused by a decrease in the structural strength of the abdominal wall aponeurosis layer or prolonged elevation of intra-abdominal pressure, leading to the protrusion of intra-abdominal tissues through the defect^[1]. Currently, surgical treatment remains the only curative option. Traditional tension repairs, which require high levels of postoperative analgesia and carry a significant risk of recurrence, are gradually being replaced by tension-free techniques.

Tension-free repair involves the use of artificial meshes to close fascial defects, with flat mesh coverage and mesh plug placement being the two commonly used clinical techniques. Although laparoscopic and minimally invasive concepts are rapidly gaining popularity in hernia surgery, open surgery remains the primary treatment

modality in primary healthcare facilities due to limitations in equipment availability and operational experience^[2].

In view of this, this study included 60 patients with primary unilateral inguinal hernia to randomly compare the therapeutic effects of mesh-patch tension-free repair and plug-mesh tension-free repair in such patients, with the specific content reported as follows.

2. Materials and methods

2.1. General information

A total of 60 male patients admitted from May 2022 to May 2025 were included and evenly divided into two groups (30 cases each) based on differences in surgical methods. The observation group had an average age of (56.67 ± 8.23) years, with 24 cases of indirect inguinal hernia and 6 cases of direct inguinal hernia, and a disease duration of (2.78 ± 1.12) years. The control group had an average age of (57.57 ± 7.67) years, with 23 cases of indirect inguinal hernia and 7 cases of direct inguinal hernia, and a disease duration of (2.89 ± 1.11) years. There were no statistically significant differences in baseline data between the two groups ($P > 0.05$), indicating comparability. This study was approved by the hospital's ethics committee.

The inclusion criteria are as follows:

- (1) Diagnosis of inguinal hernia confirmed by both physical and ultrasound examinations^[3];
- (2) Age between 18 and 75 years old;
- (3) Scheduled to undergo elective open surgery;
- (4) Voluntarily signed an informed consent form.

Exclusion criteria:

- (1) Signs of incarceration or strangulation;
- (2) Coexisting coagulopathy or active infection;
- (3) Massive abdominal wall defects or recurrent hernia;
- (4) Coexisting severe cardiac, hepatic, or renal dysfunction.

2.2. Methods

Continuous epidural anesthesia was used for both groups, with the specific procedure involving puncturing the L2-3/L3-4 interspace and controlling the anesthetic plane within the range of $\leq T10$. The patient was placed in a supine position, and after disinfection and draping, an oblique incision approximately 4–6 cm in length was made from 2 cm above the midpoint of the inguinal ligament to the pubic tubercle. The layers were then incised until the external oblique aponeurosis was reached, and after separation, the internal and external rings of the inguinal canal were exposed while protecting the relevant nerves. Next, the spermatic cord was freed to a length of ≥ 2 cm, and the hernia sac was explored and freed to the extraperitoneal fat layer (large hernia sacs were transected 3 cm from the hernia ring, and the proximal end was returned to the abdomen).

For the observation group (Lichtenstein Tension-Free Hernioplasty), an American Bard 10×15 cm polypropylene mesh (376015) was used. After trimming, the mesh was placed to cover 1.5–2 cm medial to the pubic tubercle, extend 2 cm lateral to the internal ring, and overlay 1–1.5 cm of the transverse abdominal muscle arch. The mesh was positioned posterior to the spermatic cord and sutured to the pubic aponeurosis (2–3 stitches), transverse abdominal muscle arch (continuous suture), and inguinal ligament (interrupted sutures, spaced 0.5–1 cm apart) using 2-0 Ethicon non-absorbable sutures, ensuring no excessive tightening or shrinkage. The spermatic

cord was repositioned, and the external oblique aponeurosis was closed with 4-0 Ethicon absorbable sutures (VICRYL). The incision was closed layer by layer and dressed.

For the control group (Plug-and-Patch Hernioplasty), an American Bard mesh kit (375015, consisting of a conical plug and a flat mesh) was used. The transversalis fascia was incised, and the hernia sac was reduced. A conical plug was placed into the hernia ring (with the tip directed towards the abdomen), and the base of the plug was sutured to the edge of the hernia ring using 2-0 sutures (4–6 stitches, spaced 0.8–1 cm apart). A flat mesh was placed posterior to the spermatic cord (covering the edge of the plug by ≥ 1 cm) and sutured in the same manner as the observation group. The incision closure steps were identical to those in the observation group.

2.3. Observation indicators

2.3.1. Postoperative pain VAS score

Pain was recorded at 6 h, 24 h, and 48 h postoperatively using the Visual Analog Scale (VAS), where 0 indicates no pain and 10 indicates unbearable severe pain.

2.3.2. Inflammatory indicators

Peripheral venous blood samples were collected once 24 h before and once 24 h after surgery. C-reactive protein (CRP, reference range 0–10 mg/L) was measured using immunoturbidimetry, and white blood cell count (WBC, reference range $4\text{--}10 \times 10^9/\text{L}$) was determined using an automated hematology analyzer during the same period.

2.3.3. Incidence of complications

Patients were followed up for 3 months postoperatively to record complications such as incision redness and swelling, urinary retention, foreign body sensation from the mesh, and persistent pain.

2.4. Statistical methods

Comparisons were made using SPSS 23.0 software. For categorical data, percentages (%) and the χ^2 test were employed for analysis. For measurement data conforming to a normal distribution, the mean (mean \pm SD) and t-test were used. A statistically significant difference was considered when $P < 0.05$.

3. Results

3.1. Comparison of VAS scores

As shown in **Table 1**, the VAS scores of the observation group at 6 hours, 24 hours, and 48 hours postoperatively were all lower, with $P < 0.05$.

Table 1. Comparison of VAS scores at different time points postoperatively between groups (mean \pm SD)

Group	n	6h postop	24h postop	48h postop
Observation group	30	3.42 \pm 0.37	2.43 \pm 0.21	1.23 \pm 0.14
Control group	30	4.45 \pm 0.34	3.55 \pm 0.19	2.44 \pm 0.18
t-value		11.227	21.662	29.063
P-value		0.001	0.001	0.001

3.2. Comparison of inflammatory markers

As presented in **Table 2**, the CRP and WBC values of the observation group at 24 hours postoperatively were both lower, with $P < 0.05$, although there was an increasing trend compared to preoperative levels, with $P < 0.05$.

Table 2. Comparison of inflammatory markers between groups (mean \pm SD)

Group	n	CRP (mg/L)		WBC ($10 \times 10^9/L$)	
		Preoperative 24h	Postoperative 24h	Preoperative 24h	Postoperative 24h
Observation group	30	5.21 \pm 1.18	10.78 \pm 1.12	6.45 \pm 1.34	9.21 \pm 1.15
Control group	30	5.45 \pm 1.21	13.56 \pm 1.17	6.56 \pm 1.25	12.67 \pm 1.22
t-value		0.778	9.401	0.329	11.304
P-value		0.440	< 0.001	0.744	< 0.001

3.3. Comparison of complications

As indicated in **Table 3**, the incidence of complications in the observation group was lower, but there was no significant difference between the groups, with $P > 0.05$.

Table 3. Comparison of complications between groups [n (%)]

Group	n	Incisional redness/ swelling	Urinary retention	Mesh foreign body sensation	Chronic pain	Total incidence
Observation group	30	1 (3.33%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (3.33%)
Control group	30	0 (0.00%)	0 (0.00%)	1 (3.33%)	2 (6.67%)	3 (10.00%)
χ^2 value						1.071
P-value						0.301

4. Discussion

With the continuous development of surgical techniques, tension-free hernia repair has completely replaced traditional tension repair as the clinical preference due to its advantages such as lower postoperative recurrence rates and relatively faster recovery. However, there is still controversy regarding the choice between the two commonly used tension-free techniques, namely, the plug-and-patch and the flat-mesh techniques, in terms of efficacy and safety. According to recent clinical data statistics, the plug-and-patch tension-free hernia repair, which was initially believed to enhance hernia ring repair strength with the aid of a conical plug, has been widely applied in the treatment of complex hernias^[4]. However, issues such as postoperative pain and foreign body reactions have gradually emerged^[5].

The flat-mesh tension-free hernia repair, due to its simple operation and minimal disruption to anatomical structures, has seen an increasing application rate in primary hospitals and among patients seeking rapid recovery. However, data on its efficacy in high-risk populations remains relatively scarce. This study conducted a retrospective analysis of the clinical data of 60 patients with inguinal hernia to compare the therapeutic effects of two surgical procedures. The results demonstrated that the observation group had advantages in terms of postoperative pain relief and control of inflammatory responses, with a decreasing trend in the incidence of

complications.

The results of this study indicated that at 24 and 48 hours postoperatively, the VAS scores of the study group were significantly lower than those of the control group ($P < 0.05$). The core mechanism underlying this difference is directly related to the intervention methods of the two surgical procedures on the anatomical structure of the abdominal wall. From an anatomical perspective, the inguinal region is traversed by the iliohypogastric nerve, the ilioinguinal nerve, and the genital branch of the genitofemoral nerve. Damage or irritation to these nerves is a primary cause of postoperative pain^[6]. The flat mesh tension-free hernia repair procedure employs a “paving” method to fix the mesh, ensuring a high degree of adherence between the mesh and the abdominal wall tissue. During suturing, intermittent or continuous suturing is performed along tough tissues such as the transverse abdominal muscle aponeurosis and the inguinal ligament, which can prevent excessive traction or suture compression on the nerve pathways^[7].

In contrast, during the mesh plug hernia repair procedure, the conical plug must be fixed at the edge of the hernia ring, which happens to be a critical area where the ilioinguinal nerve traverses. The physical compression caused by the plug may temporarily disrupt nerve conduction function, resulting in persistent dull pain after surgery. During the process of fitting the plug into the hernia ring, if the hernia ring diameter is small, forced dilation of the hernia ring is required to insert the plug, which can easily cause damage to the fascial tissue surrounding the hernia ring and exacerbate the pain response^[8].

Meanwhile, postoperative inflammatory responses represent a stress reaction of the body to surgical trauma, and their intensity directly reflects the magnitude of surgical trauma and the state of the body's recovery. In this study, the CRP and WBC levels of the observation group at 24 hours postoperatively were lower than those of the control group ($P < 0.05$), indicating that the flat mesh tension-free hernia repair procedure causes less traumatic stress to the body and results in milder inflammatory responses.

From the perspective of pathophysiological mechanisms, surgical trauma activates the body's innate immune response, prompting inflammatory cells such as neutrophils and macrophages to gather at the site of the trauma. These cells release inflammatory factors, which induce the liver to synthesize CRP^[9]. Simultaneously, surgical trauma stimulates the bone marrow to release white blood cells into the bloodstream. The plug-and-patch tension-free hernioplasty, involving procedures such as hernia ring separation and filler placement, entails a broader range of tissue dissection and a larger traumatic area. This leads to more intense activation of inflammatory cells and release of inflammatory factors. On the other hand, the flat-mesh tension-free hernioplasty is a simpler procedure that only requires limited separation of the posterior wall of the inguinal canal, significantly reducing the traumatic area and the stimulation to the body's immune system. Consequently, the elevation of CRP and WBC levels is more gradual.

Additionally, our study results showed that the complication rate in the observation group was slightly lower than that in the control group ($P > 0.05$). Although this difference did not reach statistical significance, it still holds some clinical reference value. Regarding the types of complications, the control group primarily experienced complications such as persistent seroma, incision pain, and a sensation of foreign material from the mesh. Conversely, the observation group mainly experienced mild incision redness and swelling. Analyzing the reasons, although the filler used in the plug-and-patch tension-free hernioplasty has relatively good compatibility with surrounding tissues as a foreign body, it can still trigger a foreign body reaction in local tissues, leading to seroma formation.

The presence of the filler may also increase the incidence of a sensation of foreign material from the mesh after surgery^[10]. By contrast, the flat-mesh tension-free hernioplasty uses a smaller mesh that fits more closely with the tissue, resulting in a milder foreign body reaction and lower incidence rates of complications such as

seroma and a sensation of foreign material from the mesh.

5. Conclusion

In summary, employing the flat-mesh tension-free hernioplasty for inguinal hernia treatment can effectively alleviate postoperative pain, reduce the degree of inflammatory response, and present a lower risk of complications. Therefore, it is worthy of clinical promotion and application. Future research should focus on prospective, large-sample, and multi-center designs, incorporating stratified analysis based on individual patient differences to clarify the suitable population for the flat-mesh tension-free hernioplasty and its long-term treatment outcomes. This will provide more robust evidence to support the precise treatment of inguinal hernia.

Disclosure statement

The author declares no conflict of interest.

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Application Effect of PBL Teaching Method Based on Situational Simulation Videos in Undergraduate Teaching of Internal Medicine

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Abstract: *Objective:* To explore the application effect of Problem-Based Learning (PBL) teaching method based on situational simulation videos in undergraduate teaching of internal medicine, and to provide practical basis for optimizing the undergraduate teaching mode of internal medicine and improving teaching quality. *Methods:* A total of 32 undergraduate students majoring in clinical medicine (Grade 2021) from Shanghai University of Medicine & Health Sciences were selected as the research subjects. They were divided into an experimental group and a control group by random number table method, with 16 students in each group. The control group adopted the traditional PBL teaching method, while the experimental group used the PBL teaching method based on situational simulation videos. After the teaching, the mastery of theoretical knowledge of students in the two groups was evaluated by examinations; a questionnaire survey was conducted to assess students' self-perceived improvement in clinical thinking, learning interest, self-directed learning ability and teamwork ability; statistical methods were used to analyze the data. *Results:* The scores of theoretical knowledge examination of students in the experimental group were significantly higher than those in the control group, and the difference was statistically significant ($p < 0.05$). In terms of self-evaluation, the experimental group showed better performance than the control group in the cultivation of clinical thinking, learning interest and self-directed learning ability, with statistically significant differences ($p < 0.05$); however, there was no statistically significant difference in the self-evaluation of teamwork ability between the two groups ($p > 0.05$). *Conclusion:* The PBL teaching method based on situational simulation videos can effectively improve students' level of theoretical knowledge, enhance their clinical thinking, learning interest and self-directed learning ability in undergraduate teaching of internal medicine, and is worthy of further promotion and application in undergraduate teaching of internal medicine.

Keywords: PBL; Situational simulation video; Teaching effect; Undergraduate teaching of internal medicine; Clinical medicine major

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1. Introduction

For undergraduate students majoring in clinical medicine, learning internal medicine not only requires mastering solid theoretical knowledge, but also developing the ability to flexibly apply theoretical knowledge to clinical practice, as well as sound clinical thinking and teamwork skills. As a new teaching model, Problem-Based Learning (PBL) is student-centered. Through teachers putting forward questions, guiding students to take the initiative to search for materials, conduct group discussions and solve problems, it plays an important role in cultivating students' various abilities^[1]. Scenario simulation videos can transform abstract medical knowledge into intuitive and vivid clinical scenarios. By simulating real doctor-patient communication, disease diagnosis and treatment processes, these videos make students feel as if they are in an actual clinical environment, which helps students better understand and master medical knowledge and develop clinical thinking skills. Therefore, this study, which combines scenario simulation videos with the PBL teaching method and applies them to the undergraduate teaching of internal medicine, is of great value.

2. Materials and methods

2.1. General information

Thirty-two undergraduate students majoring in Clinical Medicine from the 2021 cohort of Shanghai University of Medicine & Health Sciences were selected as the research subjects. All students had completed the study of basic medical courses, possessed a certain level of basic medical knowledge, and voluntarily participated in this research. The 32 students were divided into an experimental group and a control group using the random number table method, with 16 students in each group. In the experimental group, there were 7 male students and 9 female students; the age range was 22–24 years old, with an average age of (23.88 ± 1.03) years old. In the control group, there were 6 male students and 10 female students; the age range was 22–24 years old, with an average age of (23.75 ± 1.28) years old. Statistical analysis was conducted on the general information such as gender and age of the students in the two groups. The results showed that there was no statistically significant difference ($p > 0.05$), indicating comparability between the two groups.

To ensure the homogeneity of the research subjects and the reliability of the research results, the following inclusion criteria were formulated for this study.

- (1) Full-time undergraduate students majoring in Clinical Medicine from the 2021 cohort of Shanghai University of Medicine & Health Sciences, who have completed the study of basic medical courses which includes Anatomy, Physiology, Pathology, Pharmacology, achieved qualified scores in the basic course assessments, possess the knowledge foundation for conducting internal medicine learning.
- (2) Voluntarily participate in this research, sign the informed consent form, and be able to complete the learning, examinations, and questionnaires throughout the entire teaching cycle in accordance with the research plan.
- (3) No serious physical diseases, mental illnesses, or learning disabilities, and be able to normally participate in teaching activities such as classroom discussions and literature review.
- (4) No long-term leave, with continuous leave of more than 3 class hours or absence from class during the teaching cycle to ensure the integrity of participation in teaching activities.
- (5) Have not participated in other concurrent research related to internal medicine teaching reform, so as to avoid the interference of other teaching intervention measures on the results of this research.

2.2. Methods

Both groups of students studied the integrated course, Hematology, which is organized by organ systems. The teaching was delivered by the same internal medicine lecturer with extensive teaching and clinical experience. The total teaching duration was 4 weeks, with 2 class hours per week and each class hour lasting 45 minutes.

2.2.1. Control group

The control group adopted the traditional Problem-Based Learning (PBL) method. Sixteen students were divided into 2 groups, with 8 students in each group. The role of each student in the group was clearly defined, and the group leader was responsible for organizing group discussions and coordinating the division of labor among group members. The teacher designed relevant medical scenarios and corresponding questions based on the course content and learning objectives, and presented each clinical scenario in the form of paper media. Students searched for relevant books, teaching materials and literature to answer the questions and acquire the necessary key knowledge points ^[2]. Each group conducted discussions under the organization of the group leader, and every member was required to present their findings and opinions, followed by in-depth analysis and communication on the questions. Subsequently, each group reported their discussion results to the teacher. The teacher evaluated and summarized each group's answers, sorted out key concepts, corrected inappropriate viewpoints, and emphasized the key points.

2.2.2. Experimental group

The experimental group adopted the PBL method based on situational simulation videos. The basic processes, including group division, role assignment, question raising, literature review, group discussion and result presentation, were consistent with those of the control group. The main difference lay in the way of scenario presentation, which was as follows.

(1) Production of situational simulation videos

Before the course, the teacher collaborated with medical doctors and filmmakers to produce situational simulation videos based on real clinical backgrounds. These videos covered scenarios such as outpatients with common internal medicine diseases, the process of doctors' physical examination, the diagnostic steps after reading test reports, and the formulation of diagnosis and treatment plans as well as corresponding measures. The roles in the videos were played by medical undergraduates or licensed physicians to ensure the authenticity and professionalism of the videos. The duration of the videos varied according to the content, generally ranging from 5 to 10 minutes ^[3].

(2) Presentation of situational simulation videos

During the course, the teacher played the situational simulation videos using multimedia equipment. After watching the videos, students needed to analyze the questions raised by the teacher and determine the direction and focus of their research to solve the problems. Taking "anemia" as an example, a video was played, which showed a patient visiting the doctor due to fatigue and discomfort. The doctor conducted an inquiry, performed a physical examination, arranged blood-related tests (which indicated "severe anemia"), further recommended and completed gastrointestinal endoscopy examinations, and finally diagnosed the patient with colon cancer and provided treatment suggestions based on the test results. After watching the video, the teacher would ask questions such as: "What are the etiologies of anemia? What are the important steps in the diagnosis and treatment of gastrointestinal tumors? How to formulate

a reasonable medication plan for iron-deficiency anemia?” Through the video content played and the questions raised by the teacher, students independently searched for relevant literature and summarized the key knowledge points^[4].

(3) Literature review and discussion

In the group discussion session, students analyzed and discussed the questions based on the specific content of the videos. For example, in the doctor-patient communication session, they considered how to inquire about the patient to collect health information; in the session where doctors formulated treatment plans, they discussed whether the plan was feasible and the reasons for its feasibility. During this session, the tutor would remind students to pay attention to the details in the videos during the inspection tour, including the details of the patient’s symptoms, dynamic changes in the patient’s physical condition, and the interpretation of test data. This not only enabled students to acquire more theoretical knowledge but also helped them better connect theory with practice^[5].

2.3. Observation indicators

After the completion of the teaching, both groups of students took a unified theoretical knowledge exam. The exam content covered all the knowledge points of this internal medicine teaching, with question types including multiple-choice questions, short-answer questions, and case analysis questions, and the full score was 100. A self-designed questionnaire survey was conducted on the two groups of students. The questionnaire content mainly focused on evaluating the improvement of students’ own clinical thinking, learning interest, self-directed learning ability, and teamwork ability. Each evaluation item was divided into 3 levels, “Significantly Improved”, “Slightly Improved”, and “No Significant Change”. After the teaching, the questionnaires were distributed to the two groups of students by the teachers. A total of 32 questionnaires were distributed and 32 were recovered, with a questionnaire recovery rate of 100%.

2.4. Statistical analysis

The data in this study were analyzed and processed using SPSS 26.0 statistical software. Measurement data such as exam scores and age were expressed as mean \pm standard deviation ($\bar{x} \pm s$) and *t*-test was used for inter-group comparison; count data such as the number and percentage of students at each level in the questionnaire survey results were expressed as [n (%)], and chi-square test (χ^2 test) was used for inter-group comparison. A *p*-value of less than 0.05 ($p < 0.05$) was considered statistically significant.

3. Results

3.1. Comparison of assessment scores between the two groups of students

After the completion of teaching, statistical analysis was conducted on the theoretical knowledge test scores of the two groups of students, and the specific data are shown in **Table 1**.

Table 1. Comparison of theoretical knowledge test scores between the two groups of students ($\bar{x} \pm s$, points)

Group	Number of Participants	Test Score	<i>t</i> -value	<i>p</i> -value
Experimental Group	16	86.56 \pm 3.97	2.586	0.014
Control Group	16	83.13 \pm 3.10		

3.2. Comparison of self-evaluation between the two groups of students

The questionnaire survey results of the two groups of students were statistically analyzed, and the specific data are shown in **Table 2** and **3**.

Table 2. Comparison of self-evaluation between the two groups of students [n (%)]

Group	Clinical Thinking			Learning Interest		
	Significantly Improved	Slightly Improved	No Significant Change	Significantly Improved	Slightly Improved	No Significant Change
Experimental group	11 (68.75)	3 (18.75)	2 (12.5)	13 (81.25)	2 (12.5)	1 (6.25)
Control group	4 (25)	4 (25)	8 (50)	6 (37.5)	5 (31.25)	5 (31.25)
χ^2		6.873			6.219	
<i>p</i> -Value		0.037			0.046	

Table 3. Comparison of self-evaluation between the two groups of students [n (%)]

Group	Self-directed Learning Ability			Teamwork		
	Significantly Improved	Slightly Improved	No Significant Change	Significantly Improved	Slightly Improved	No Significant Change
Experimental Group	14 (87.5)	1 (6.25)	1 (6.25)	11 (68.75)	4 (25)	1 (6.25)
Control Group	7 (43.75)	4 (25)	5 (31.25)	7 (43.75)	5 (31.25)	4 (25)
χ^2		6.415			2.667	
<i>p</i> -Value		0.043			0.238	

4. Discussion

4.1. PBL teaching method based on situational simulation videos can improve students' theoretical knowledge level

Firstly, situational simulation videos can present the medical environment directly and vividly, integrating abstract theoretical knowledge into specific cases, which is conducive to students' understanding and memory of key points. For example, when learning the chapter on "coronary heart disease", the video demonstrates cases of patients with coronary heart disease experiencing cardiac pain, changes in electrocardiogram (ECG), and how doctors diagnose and treat the disease. This enables students to connect theoretical contents such as the clinical characteristics and diagnostic criteria of cardiac pain with practical situations by watching the video, thereby deepening their understanding and memory of key points^[6]. Secondly, situational simulation videos contain a wealth of detailed medical information, such as methods for collecting patients' medical history data, physical examination techniques, and skills for interpreting physical examination results. Therefore, while watching the videos, students can observe these details carefully, identify problems, and think about solutions. They can then learn relevant theoretical knowledge in a targeted manner through literature review or discussions, ultimately achieving the goal of improving students' learning effectiveness^[7].

4.2. PBL teaching method based on situational simulation videos can enhance students' clinical thinking ability

This immersive learning experience encourages students to develop a habit of taking clinical practice as the starting point and using theoretical knowledge for analysis and reasoning, thereby enhancing their clinical thinking ability^[8]. During group discussions, students need to analyze problems based on the content of the videos, such as the patient's past medical history, medication status, changes in physical signs, and more. This not only requires mastery of basic medical knowledge but also reflects their ability to identify key data from complex information, and conduct summarization and analysis^[9].

4.3. PBL teaching method based on situational simulation videos can boost students' learning interest and self-directed learning ability

From the perspective of learning interest, the traditional PBL teaching method presents scenarios through paper-based media. The content is relatively dull and abstract, making it difficult to stimulate students' enthusiasm for learning. In contrast, situational simulation videos are characterized by intuitiveness, vividness and interest. They can transform abstract medical knowledge into specific and vivid clinical scenarios, thereby capturing students' attention^[10]. By watching the videos, students can more intuitively perceive the clinical manifestations of diseases and the diagnosis and treatment process, which in turn stimulates their learning interest and encourages them to actively participate in teaching activities^[11].

From the perspective of self-directed learning ability, the PBL teaching method based on situational simulation videos requires students to independently search for materials and organize key knowledge points in combination with the questions raised by teachers after watching the videos^[12]. Situational simulation videos can provide students with richer clinical information and problem orientation, helping students clarify the knowledge content they need to learn and master, and thus conduct self-directed learning in a more targeted manner. In the group discussion session, students need to share the materials they have found with group members and jointly explore solutions to problems, which further promotes the improvement of students' self-directed learning ability^[13].

4.4. Analysis of reasons for the insignificant impact of PBL teaching method based on situational simulation videos on students' teamwork ability

The results of this study indicate that there is no statistically significant difference in the self-evaluation of teamwork ability between the two groups of students ($p > 0.05$), which may be related to the following factors.

First, both the traditional PBL teaching format and the PBL teaching format based on situational simulation videos adopt the teaching model of group discussion. Students must complete role division and work collaboration within the group, and discuss with each other to achieve learning goals. The two teaching strategies have similar types and requirements for the development of teamwork ability; therefore, there is no obvious difference in their training effects on students' teamwork ability^[14].

Second, the teaching duration of this study was only 4 weeks, which may not have allowed the two teaching methods to produce significant differences in cultivating teamwork ability. However, the cultivation of teamwork ability is a long-term process that requires students to develop teamwork skills from the experience of learning tasks and practical activities. For this reason, in the future, the teaching duration can be appropriately extended according to the course content, and the complexity of task collaboration challenges can be increased to better cultivate students' teamwork ability^[15].

5. Conclusion

Based on the findings of this study, it can be concluded that the Problem-Based Learning (PBL) teaching method, when integrated with situational simulation videos, serves as an effective approach in undergraduate internal medicine education. This pedagogical strategy not only strengthens students' theoretical knowledge but also fosters the development of clinical thinking, stimulates learning interest, and enhances self-directed learning capabilities. Therefore, it is recommended that this innovative teaching model be widely promoted and applied in undergraduate internal medicine curricula to further enrich educational outcomes and better prepare students for clinical practice.

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Exploration on the Training of Geriatric Nursing Team under the Background of the Integration of Medical and Elderly Care Services

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Abstract: At present, China has entered an aging society, and there is an urgent need for a large number of high-quality geriatric nursing professionals. However, the existing geriatric nursing team is difficult to meet the actual needs both in terms of quality and quantity. In this regard, under the background of the integration of medical and elderly care services, colleges and universities should strengthen the training of geriatric nursing talents. This paper conducts an in-depth analysis on the training of geriatric nursing teams under the background of the integration of medical and elderly care services, aiming to provide some references for promoting the reform of geriatric nursing talent training in colleges and universities and improving the level of geriatric nursing services in China.

Keywords: Integration of medical and elderly care services; Geriatric nursing; Talent training

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1. Introduction

According to the 2024 National Report on the Development of Elderly Undertakings released by the National Bureau of Statistics, by the end of 2024, the number of elderly people aged 60 and above in China was 310.31 million, accounting for 22% of the total population; the number of elderly people aged 65 and above was 220.23 million, accounting for 16% of the total population^[1]. It can be seen that the aging trend of China's population is very severe, and there is an urgent need for a large number of professional geriatric nursing talents. Under the background of the integration of medical and elderly care services, geriatric nursing work has become more diversified. It is no longer limited to traditional medical care and daily living care, but has developed towards rehabilitation nursing, psychological counseling, preventive health care and other directions. This also puts forward higher requirements for the professional quality and comprehensive ability of geriatric nursing staff. As an important base for talent training in China, colleges and universities should keep up with the trend of the times, actively adapt to the needs of

social development, and constantly adjust and optimize the training program for geriatric nursing talents, so as to improve the quality of talent training, enable them to become geriatric nursing talents that meet the needs of social development, and thus lay a solid foundation for their future employment and development^[2].

2. Overview of the integration of medical and elderly care services

2.1. Connotation

The integration of medical and elderly care services is an innovative elderly care model, which mainly refers to the integration of medical resources and elderly care resources to provide higher-quality elderly care services for the elderly. This elderly care model not only focuses on the daily life care of the elderly but also attaches importance to their needs in terms of mental health, disease prevention, rehabilitation care and more. Its ultimate goal is to improve the quality and level of life of the elderly.

2.2. Current development status of the integration of medical and elderly care services in China

In 2013, the State Council issued the Several Opinions on Accelerating the Development of the Elderly Care Service Industry, and the concept of “integration of medical and elderly care services” was put forward for the first time. In 2015, the General Office of the State Council issued the National Plan for the Layout of the Medical and Health Service System (2015–2020), which formally defined the concept of “integration of medical and elderly care services” for the first time. Since then, relevant policies have been introduced one after another, laying a solid foundation for the development of the integration of medical and elderly care services. In 2025, the National Health Commission will include the “integration of medical and elderly care services” in the core indicators of the 14th Five-Year Plan for Healthy Aging, requiring the total number of institutions integrating medical and elderly care services to exceed 9,000 and the coverage rate of such services to reach 90%.

According to the 2025–2030, in-depth research on the Industry of Integration of Medical and Elderly Care Services and Forecast Report on Current Development Status and Trends released by ZYPH Industry Research Institute, the market scale of China’s integration of medical and elderly care services has exceeded 1.8 trillion yuan, an increase of 22% compared with 2024. It is expected that by 2030, the market scale will exceed 3.8 trillion yuan. Against this background, there is an urgent need for a large number of high-quality professionals in elderly care nursing^[3].

3. Challenges faced in the cultivation of geriatric nursing professionals in colleges and universities

The cultivation of geriatric nursing professionals in colleges and universities was confronted with numerous challenges. This paper provides a brief analysis from the following aspects.

3.1. Social cognition bias and low quality of student sources

Affected by traditional concepts, there exists a certain degree of cognitive bias towards the geriatric nursing profession in society. The profession is perceived as having low social status, mainly involving “serving others”, with heavy workload and low income^[4]. Such outdated notions lead many parents and students to disapprove of the nursing industry and be unwilling to choose it. In addition, society lacks sufficient understanding and attention

to geriatric nursing, unilaterally believing that it only involves taking care of the daily life of the elderly. This also results in low social recognition of the geriatric nursing major, further affecting the quality of student sources.

3.2. Unsound curriculum design and disconnection from the needs of the integration of medical and elderly care services

Under the model of integrating medical and elderly care services, higher requirements are placed on students' professional literacy and comprehensive abilities^[5]. However, the curriculum design of geriatric nursing in some colleges and universities is currently unsound. On one hand, excessive emphasis is placed on the imparting of theoretical knowledge while neglecting the cultivation of students' practical abilities, making it difficult for them to meet the needs of the integrated medical and elderly care service model. On the other hand, the curriculum content is disconnected from the actual needs of the integration of medical and elderly care. It lacks systematic teaching on rehabilitation nursing, mental health care for the elderly, disease prevention, and other related aspects. This makes it hard for graduates to adapt to the development needs of the industry, thus hindering their future employment and career development.

3.3. Weak teaching staff and lack of practical experience

Geriatric nursing is a highly practical discipline, which requires teachers to possess strong practical capabilities and rich clinical nursing experience^[6]. However, the teaching staff of the geriatric nursing major in some colleges and universities is relatively weak, with insufficient clinical nursing experience and inadequate understanding of the integrated medical and elderly care service model. In the teaching process, excessive focus is often placed on the teaching of theoretical knowledge, while the cultivation of students' practical abilities and problem-solving skills was ignored.

Besides, the structure of the teaching staff is irrational, with a lack of interdisciplinary backgrounds, making it difficult to meet the demand for interdisciplinary and compound talents in teaching.

3.4. Insufficient practical teaching resources, affecting the improvement of students' core competitiveness

Practical teaching is an important measure to cultivate students' practical abilities and a key link in improving the quality of geriatric nursing professionals^[7]. Nevertheless, the practical teaching of the geriatric nursing major in some colleges and universities is faced with the predicament of insufficient resources, which seriously affects the improvement of students' practical abilities. Some colleges and universities have outdated and insufficient practical teaching equipment, lack modern nursing simulation devices and advanced teaching tools, and thus cannot meet the needs of students for practical training.

4. The innovative paths for cultivating geriatric nursing talents in colleges and universities under the background of the integration of medical and elderly care services

4.1. Optimizing the curriculum system to highlight the characteristics of the integration of medical and elderly care services

4.1.1. Constructing a modular curriculum system

To more effectively improve the quality of geriatric nursing talent cultivation, colleges and universities can, in light

of the needs of the integration of medical and elderly care services and based on the competency requirements of geriatric nursing positions, construct a modular curriculum system^[8].

Each module includes corresponding courses, with clear course objectives and contents, while ensuring close connection between different courses. For instance, a rehabilitation nursing module was set up, which included multiple courses such as Basic Medicine and Human Function Assessment, Rehabilitation Technology and Functional Reconstruction, and the Use of Rehabilitation Equipment.

The construction of a modular curriculum system not only meets the needs of the integration of medical and elderly care services, more effectively cultivates students' professional literacy and comprehensive abilities, but also lays a solid foundation for their future employment and development.

4.1.2. Increasing the proportion of practical courses

Currently, the cultivation of students' practical abilities has received widespread attention and emphasis^[9]. In this regard, colleges and universities should arrange practical courses in a reasonable manner, appropriately increase the proportion of practical courses, and ensure that students have sufficient time to learn practical knowledge and skills. At the same time, they should keep pace with the times, continuously optimize the content of practical teaching to ensure its advanced nature and practicality, thereby more effectively cultivating students' clinical nursing abilities.

4.1.3. Integrating interdisciplinary knowledge

Geriatric nursing involves knowledge from multiple disciplines such as psychology, medicine, and management^[10]. Therefore, under the background of the integration of medical and elderly care services, colleges and universities should also integrate interdisciplinary knowledge into the curriculum design. This not only broadens students' horizons and improves their knowledge system, but also promotes the development of their interdisciplinary thinking.

4.2. Strengthen practical teaching to cultivate students' practical abilities

Currently, students' practical abilities have become the core criterion for enterprises to evaluate talents^[11]. In this context, against the backdrop of the integration of medical and elderly care services, colleges and universities as well as teachers should strengthen practical teaching. Through various methods and means, they should cultivate students' practical abilities, laying a foundation for their all-round development in the future.

4.2.1. Improve the construction of practical bases

Colleges and universities can carry out in-depth cooperation with medical institutions, enterprises, nursing homes and other units. By integrating resources from all parties, they can jointly establish comprehensive, well-equipped, stable and high-quality practical teaching bases. These bases serve as sufficient opportunities and platforms for students' practical training^[12]. Meanwhile, colleges and universities can sign cooperation agreements with all parties involved to clarify the rights and obligations of each party and scientifically define their respective scope of responsibilities. This will better realize resource sharing and complementary advantages among all parties.

4.2.2. Strengthen the management of practical teaching

Colleges and universities should establish and improve the management system for practical teaching, and

conduct regular evaluations of the effectiveness of practical teaching ^[13]. At the same time, in accordance with the requirements of the integration of medical and elderly care services and combined with the actual situation of the institutions, they should formulate scientific and reasonable practical teaching syllabuses, internship plans, assessment standards and other contents. By clarifying the responsibilities of teachers, they can ensure the standardization of practical teaching, thereby cultivating students' practical abilities more effectively. In addition, they should also conduct comprehensive inspections and evaluations of practical bases on a regular basis, promptly identify existing problems, and provide feedback and solutions to continuously improve the effectiveness of practical teaching.

4.2.3. Reform the practical teaching model

Against the backdrop of the integration of medical and elderly care services, the traditional practical teaching model can hardly meet the needs of students' development ^[14]. In response to this, it is necessary to reform and optimize it. In specific practice, teachers can adopt a variety of teaching methods such as case teaching, situational simulation, and project-based teaching. These methods aim to stimulate students' interest in learning, arouse their enthusiasm and initiative, and thus effectively cultivate their practical abilities.

4.3. Strengthen the development of teaching staff and enhance the overall quality of teachers

4.3.1. Intensify teacher training

Colleges and universities can regularly organize special training programs on geriatric nursing for teachers, so as to continuously update their knowledge systems and broaden their horizons ^[15]. At the same time, teachers can be encouraged to participate in domestic and international academic exchange activities in geriatric nursing to keep abreast of the industry's development trends and latest dynamics. In addition, more efforts should be made to cultivate "dual-qualified" teachers, with teachers have both teaching expertise and professional practical experience. Teachers should be regularly sent to elderly care institutions that integrate medical and elderly care services to engage in clinical practice, enrich their practical experience, and lay a foundation for improving the quality of professional teaching in the future.

4.3.2. Improve talent introduction

Colleges and universities should formulate talent introduction plans and actively recruit geriatric nursing talents who possess both rich practical experience and high academic qualifications to work as teachers. This measure aims to optimize the structure of the teaching staff and enhance the overall teaching quality.

4.3.3. Optimize incentive mechanisms

Colleges and universities should also improve incentive mechanisms for teachers to stimulate their work enthusiasm and lay a foundation for enhancing the quality of geriatric nursing talent cultivation. Firstly, a scientific and reasonable performance appraisal system should be established, which incorporates teachers' scientific research achievements, teaching quality, and other relevant indicators. This ensures that the appraisal results can fully reflect teachers' work performance and comprehensive capabilities. Secondly, a differentiated salary system should be implemented based on the appraisal results. Teachers who achieve excellent appraisal results should be provided with higher salaries and more promotion opportunities.

4.4. Strengthen vocational education to support students' future development

4.4.1. Actively carry out career planning education

Colleges and universities should fully recognize the importance of career planning education and integrate it into the entire process of talent cultivation. This helps students understand the development prospects and future directions of the geriatric nursing major, formulate scientific and reasonable academic plans and learning goals, strengthen their cognitive understanding of the major, and help them establish correct ideological concepts.

4.4.2. Enhance professional ethics education

Colleges and universities should also strengthen professional ethics education and integrate it into students' daily teaching and campus life. Through classroom teaching, social practice, campus activities, and other approaches, students' professional literacy can be improved, and their craftsmanship spirit and sense of responsibility can be cultivated, laying a solid foundation for their all-round development in the future.

4.4.3. Establish an employment tracking mechanism

Colleges and universities should maintain stable communication with the enterprises where students intern and the units where they are employed, and on this basis, establish a tracking mechanism for students' internship and employment. By collecting opinions and evaluations of students from internship and employment units, colleges and universities can understand students' performance during internships and employment. Based on this information, they can adjust teaching content and optimize talent cultivation programs, thereby laying a foundation for improving the quality of talent cultivation.

5. Conclusion

In conclusion, against the backdrop of the integration of medical and elderly care services, traditional elderly care professionals can hardly meet the needs of industrial development. In response to this, as important bases for high-quality talent cultivation in China, colleges and universities should keep up with the trend of the times, reform and optimize the traditional training model for elderly care professionals, and continuously improve the quality of elderly care talent cultivation through various methods and means, so as to provide solid talent support for the elderly care cause under the integration of medical and elderly care model.

Disclosure statement

The authors declare no conflict of interest.

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Study on Evidence and Methods of Traditional Chinese Medicine Nursing for Patients with Diabetic Gastroparesis

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Abstract: Diabetic Gastroparesis (DGP) is one of the common chronic complications of diabetes mellitus, with main clinical manifestations such as nausea, vomiting, postprandial fullness, and delayed gastric emptying. It seriously affects patients' quality of life and nutritional status. This paper systematically sorts out the application evidence of Traditional Chinese Medicine (TCM) nursing in DGP, verifies its effectiveness from three aspects: evidence from ancient literature, modern clinical studies, and results of Meta-analyses. It also elaborates on specific nursing methods including Syndrome Differentiation-Based Nursing, characteristic technical nursing, and health guidance, analyzes the existing problems in current research, and puts forward future development directions, so as to provide a reference for the clinical promotion and standardization of TCM nursing for DGP.

Keywords: Diabetic gastroparesis; Traditional Chinese medicine nursing; Syndrome differentiation-based nursing; Acupoint intervention; Evidence research

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1. Introduction

Diabetic gastroparesis (DGP) is a metabolic disease characterized by gastric emptying disorder, which is caused by gastrointestinal smooth muscle dysfunction and autonomic neuropathy due to long-term hyperglycemia. Epidemiological surveys show that the incidence rate of DGP among diabetic patients is as high as 20% to 50%, of which 20% to 30% of patients have clinical symptoms such as weight loss, nausea and vomiting, early satiety, and postprandial abdominal distension^[1]. Long-term delayed gastric emptying not only leads to impaired nutrient absorption in patients, but also may cause blood glucose fluctuations, increase the risk of hypoglycemia, and even form a vicious cycle of “hyperglycemia–delayed gastric emptying–blood glucose fluctuations”, which seriously affects patients' health.

Modern medicine mainly adopts “blood glucose control + symptomatic support” as the core nursing methods, such as guiding patients to use prokinetic drugs like domperidone and developing the dietary habit of small and

frequent meals. Although this nursing method can help patients control the disease and improve symptoms to a certain extent, long-term medication is likely to cause drowsiness and diarrhea in patients, and some patients may develop drug resistance. In view of the clinical characteristics and treatment status of diabetic gastroparesis, traditional Chinese medicine (TCM) has proposed new nursing measures based on the theories of “syndrome differentiation-based nursing” and “holistic concept”^[2]. In TCM, DGP is classified into the categories of “Weihuan” (gastric hypotonia), “Outu” (vomiting), and “Piman” (abdominal distension and fullness).

TCM adopts the strategies of nourishing Yin and promoting fluid production, soothing the liver and regulating Qi, and regulating the spleen and stomach, and implements multi-dimensional intervention measures including emotional nursing, acupoint nursing, and dietary nursing to improve patients’ symptoms. This not only effectively reduces drug side effects, but also improves patients’ long-term compliance. In recent years, with the development and application of the concept of evidence-based medicine, the evidence for the application of TCM nursing in DGP has been continuously accumulated, providing more new schemes for the nursing of patients with diabetic gastroparesis. However, there are still some deficiencies in relevant research work, and systematic sorting is lacking. This article aims to integrate existing evidence, clarify the effectiveness and specific methods of TCM nursing, and further provide a scientific basis for clinical practice^[3].

2. TCM understanding of diabetic gastroparesis (DGP)

2.1. Etiology and pathogenesis

Traditional Chinese Medicine (TCM) holds that the onset of Diabetic Gastroparesis (DGP) is associated with the pathological characteristics of diabetes mellitus, namely “when the disease progresses to an advanced stage, it will affect the kidney” and “a prolonged illness invades the collaterals”, and its core pathogenesis is summarized as “deficiency in the root and excess in the branch”. Among them, “deficiency in the root” refers to the long course of diabetes. Yin deficiency is the fundamental cause, and prolonged impairment of Yin consumes Qi, leading to Qi deficiency of the spleen and stomach; alternatively, Yin deficiency may affect the kidney, resulting in insufficient kidney Yang, which fails to warm the spleen Yang, further causing the spleen to lose its function of transporting and transforming, the stomach to lose its function of harmonizing and descending, and weakness in gastric emptying. “Excess in the branch” means that in patients, Qi deficiency leads to blood stasis, Yin deficiency leads to dryness-heat, and dryness-heat scorches body fluids to form phlegm; phlegm and blood stasis then bind together, blocking the stomach collaterals and further impairing the stomach’s function of unobstructed descent. In addition, patients with diabetes often experience negative emotions such as depression and anxiety due to factors like poor blood glucose control and long disease duration, which subsequently cause liver Qi stagnation; the stagnated liver Qi then rebelliously attacks the stomach, disrupting the stomach’s function of harmonizing and descending and eventually forming the “liver stagnation and spleen deficiency” syndrome type^[4]. Overall, the pathogenesis of DGP lies in “dysfunction of the spleen and stomach”, with its primary location in the stomach and also associations with the kidney, liver, and spleen; it involves deficiencies of Qi, Yin, and Yang, accompanied by excess pathogenic factors such as phlegm, blood stasis, heat, and stagnation.

2.2. Syndrome differentiation and classification

Based on the Guidelines for the Diagnosis and Treatment of Common Diseases in TCM Internal Medicine and clinical practice, the common syndrome types of DGP are as follows^[5].

2.2.1. Spleen-stomach deficiency type

Its main manifestations include obvious abdominal distension after meals, loose stools, fatigue and lassitude, poor appetite with reduced food intake; accompanied by a pale tongue with white coating and a thready-weak pulse.

2.2.2. Liver-stomach disharmony type

Its main manifestations include frequent belching, abdominal distension with hypochondriac pain, emotional depression or irritability, nausea; accompanied by a pale-red tongue with thin white coating and a wiry pulse.

2.2.3. Stomach Yin deficiency type

Its main manifestations include abdominal distension with burning pain in the gastric region, dry stools, hunger without desire to eat, dry mouth and throat; accompanied by a red tongue with scanty fluid, scanty coating and a thready-rapid pulse^[6].

2.2.4. Phlegm-dampness obstruction type

Its main manifestations include abdominal distension with a feeling of fullness, thick and greasy tongue coating, general heaviness, nausea and vomiting of phlegm-saliva; accompanied by a pale tongue with white greasy coating and a slippery pulse.

2.2.5. Spleen-kidney Yang deficiency type

Its main manifestations include abdominal distension with fear of cold, loose stools, soreness and weakness of the waist and knees, especially after eating; accompanied by a pale and enlarged tongue with white slippery coating and a deep-slow-weak pulse.

3. Evidence review of TCM nursing for diabetic gastroparesis (DGP)

3.1. Basis from ancient TCM literature

The emphasis of TCM nursing on “the downward flow and dredging function of the stomach” can be traced back to classic TCM works.

(1) Huangdi Neijing (Inner Canon of the Yellow Emperor)

Suwen (Plain Questions) puts forward the concept of “having regular eating and drinking habits and maintaining a regular daily routine”, and explores methods to protect the functions of the spleen and stomach from the perspective of diet, for example “the five grains are for nourishment, and the five fruits are for assistance”.

(2) Jinkui Yaolue (Synopsis of the Golden Chamber)

Treatise on the Pulse, Symptoms and Treatments of Vomiting, Hiccups and Diarrhea emphasizes that “for cases of vomiting with borborygmus (intestinal gurgling) and stuffiness in the epigastrium (upper abdomen), Banxia Xiexin Decoction (Pinellia Heart-Draining Decoction) is the primary treatment”. It applies drugs with the effects of warming the middle energizer and resolving phlegm, such as dried ginger and pinellia, providing ideas for the drug compatibility of nursing measures like TCM enema and acupoint application.

(3) Jingyue Quanshu (Complete Works of Jingyue)

Pi Man (Abdominal Distension) holds that “most cases of abdominal distension are caused by weakness of the spleen and stomach, insufficient transportation and transformation, and dysfunction of the body’s regulatory mechanism”, clearly pointing out that the core pathogenesis lies in the weakness of the spleen and stomach.

The ideas in classic TCM works, such as “emotional guidance”, “acupoint regulation” and “syndrome differentiation-based diet therapy”, provide a theoretical basis and practical guidance for the application of TCM nursing in DGP.

3.2. Evidence from modern clinical studies

Randomly selected samples were used in controlled trials, and the results showed that the intervention effect of TCM nursing for DGP was significantly better than that of conventional nursing.

3.2.1. Acupoint application

Eighty DGP patients were randomly selected and divided into an observation group and a control group. The observation group received “acupoint application + conventional nursing”, while the control group only received conventional nursing. Comparative analysis revealed that the scores of postprandial nausea, vomiting, and abdominal distension in the observation group were significantly lower than those in the control group; additionally, the gastric emptying time of the observation group was shortened by 28.6% compared with the control group.

3.2.2. Moxibustion nursing

Sixty DGP patients of the Spleen-Stomach Weakness Type were randomly selected and given moxibustion nursing. After 8 consecutive weeks of intervention, observations on the patients’ treatment outcomes showed that their serum motilin levels and the percentage of normal gastric electrical rhythm were significantly increased, with no obvious side effects observed.

3.2.3. Auricular point pressing

Ninety DGP patients were randomly selected and divided into three groups: an observation group treated with auricular point pressing, a western medicine control group, and a blank control group. After 4 consecutive weeks, it was found that the effective rate of symptom improvement in the observation group was comparable to that in the western medicine control group. However, the compliance of the observation group was significantly higher than that of the western medicine control group, and no side effects such as diarrhea or drowsiness occurred in the observation group.

3.3. Evidence from meta-analysis

A Meta-analysis published in Chinese Journal of Emergency Traditional Chinese Medicine in 2023 included 15 Randomized Controlled Trial (RCT) studies involving a total of 1286 patients and conducted a systematic evaluation on the application effect of TCM nursing for DGP. The results showed that.

TCM nursing (including emotional guidance, dietary nursing, and acupoint intervention) can effectively reduce the symptom scores of DGP patients, shorten their gastric emptying time, and improve their quality-of-life scores; furthermore, the incidence of adverse events was significantly lower than that in the western medicine

nursing group. Based on the results of the Meta-analysis, it was concluded that the efficacy of TCM nursing for DGP was supported by moderate to high-quality evidence and that it has higher safety.

4. Specific methods of TCM Nursing for diabetic gastroparesis

4.1. Syndrome differentiation-based nursing: Personalized nursing according to syndrome types

4.1.1. Spleen-stomach deficiency type

For patients of this type, dietary nursing measures can be adopted to achieve the goal of “strengthening the spleen and nourishing the stomach, replenishing Qi and harmonizing the middle energizer”. For example, guide patients to consume more easily digestible foods such as pumpkin, lotus seeds, Chinese yam, and millet porridge, avoid cold, raw, and greasy foods, and add Huangqi (*Astragalus membranaceus*) and Chinese Yam Porridge according to the patients’ actual conditions ^[7,8].

For patients of this type, acupoint intervention can be conducted by selecting acupoints such as Zhongwan (CV12), Zusanli (ST36), and Pishu (BL20), including moxibustion, acupoint massage and more ^[9,10].

Patients with spleen-stomach deficiency are prone to anxiety due to weight loss, poor appetite, and other reasons. Therefore, emotional counseling should be emphasized in nursing work. For instance, provide patients with verbal encouragement and guide them to listen to soothing music, so as to prevent the aggravation of symptoms caused by emotional fluctuations.

4.1.2. Liver-stomach disharmony type

The dietary nursing for patients with liver-stomach disharmony mainly focuses on “soothing the liver and regulating Qi, harmonizing the stomach and descending adverse Qi”. Patients was guided to properly consume more Qi-regulating foods such as fingered citron, dried tangerine peel, and white radish, and avoid spicy and overly sour foods.

In terms of acupoint intervention, acupoints such as Taichong (LR3), Neiguan (PC6), and Qimen (LR14) can be selected for massage.

To help patients of this type alleviate depression and anxiety, the “method of diverting emotions and changing temperament” can be adopted. For example, encourage patients to participate in painting and calligraphy activities, and guide them to practice deep breathing exercises ^[11].

4.1.3. Stomach-Yin deficiency type

The dietary nursing for patients with stomach-Yin deficiency is mainly aimed at “nourishing Yin and invigorating the stomach, moistening dryness and promoting the production of body fluid”. Foods such as *Ophiopogon japonicus*, white fungus, pear, and lily bulb are recommended; patients should avoid overly hot and spicy foods to prevent consumption of stomach Yin ^[12].

In TCM nursing, acupoints such as Sanyinjiao (SP6), Taixi (KI3), and Weishu (BL21) can be selected for massage to nourish Yin and tonify the kidney, nourish the stomach and promote the production of body fluid. If patients have obvious dry mouth symptoms, acupoint application can be used as an auxiliary treatment.

4.2. Characteristic nursing techniques: Safe and effective non-pharmacological interventions

4.2.1. Acupoint application

Select acupoints such as Zhongwan (CV12), Zusanli (ST36), and Neiguan (PC6) for application; adjust the drug compatibility according to the patient's syndrome type. Grind the drugs into powder, mix them with honey or petroleum jelly into a paste, take an amount the size of a soybean to apply on the acupoints, and fix it with adhesive tape. Each application lasts for 6 to 8 hours to avoid areas with broken skin, once a day, and 10 applications constitute one course of treatment. After application, observe the skin reaction: if redness, swelling, or itching occurs, the application time can be shortened or the treatment can be suspended^[13–15].

4.2.2. Retention enema with traditional Chinese medicine

It is suitable for DGP (Diabetic Gastroparesis) patients with obvious dry stool and abdominal distension, aiming to “clearing the fu-organs and descending Qi, moistening the intestines and relieving constipation”.

4.2.3. Tuina massage

Instruct the patient to take a supine position, then use the palm to massage the abdomen clockwise for 10 to 15 minutes each time, twice a day, to promote gastrointestinal peristalsis. Ask the patient to take a prone position, then massage acupoints such as Pishu (BL20), Weishu (BL21), and Shenshu (BL23) respectively, 3 to 5 minutes per acupoint, three times a week, so as to regulate the functions of Zang-fu organs.

5. Effect evaluation and existing problems of TCM nursing

5.1. Effect evaluation indicators

5.1.1. Subjective symptom evaluation

The Diabetic Gastroparesis Symptom Scoring Scale is adopted, with scoring based on 5 dimensions including abdominal distension, early satiety, nausea, vomiting, and abdominal pain.

5.1.2. Objective indicator evaluation

Gastric emptying time and electrogastrogram (EGG).

5.1.3. Quality of life evaluation

The SF-36 scale is used, with scoring from 4 dimensions: role-emotional, social functioning, bodily pain, and physical functioning.

5.2. Existing problems

5.2.1. Insufficient evidence quality

Most existing clinical studies are single-center, small-sample studies; some studies do not adopt the blinding method, leading to selection bias. The number of studies included in Meta-analyses is limited, and there is a lack of long-term (≥ 1 year) follow-up data, making it difficult to verify the long-term efficacy of TCM nursing.

5.2.2. Lack of standardization in nursing methods

There are no unified standards for the application duration and drug dosage of acupoint application, as well as the

duration and temperature of moxibustion. The intervention protocols used in different studies vary greatly, making these protocols difficult to promote.

5.2.3. Variations in patient compliance

Some patients discontinue nursing due to discomfort from traditional Chinese medicine (TCM) enemas or skin allergies caused by acupoint application. Elderly patients have a low acceptance level of exercise guidance and acupoint massage, which affects nursing effectiveness.

6. Outlook

6.1. Conducting high-quality research

In the future, it is necessary to design large-sample, multi-center randomized double-blind controlled trials, and improve the evidence level of TCM nursing by integrating objective indicators and long-term follow-up.

6.2. Formulating standardized protocols

Based on syndrome differentiation and typing, the Standardized Process for TCM Nursing of Diabetic Gastroparesis should be developed to clarify the nursing technical parameters for different syndrome types, thereby ensuring the consistency of nursing effects.

6.3. Integrated TCM and western medicine nursing

Explore the combined nursing protocol of “TCM nursing + Western medicine” to further enhance therapeutic effects, while effectively reducing the dosage of Western medicine and lowering drug side effects.

7. Conclusion

With “syndrome differentiation-based nursing” as its core, Traditional Chinese Medicine (TCM) adopts a variety of approaches, including emotional counseling, acupoint intervention, and dietary nursing, to provide care for patients with diabetic gastroparesis (DGP). This nursing model can significantly alleviate patients’ symptoms, promote gastric emptying, and improve their quality of life (QOL). Additionally, it features higher patient compliance and safety. Existing TCM literature, clinical studies, and Meta-analyses have provided reliable evidence for the application of TCM nursing in DGP management. However, challenges remain, such as the lack of standardization and insufficient quality of evidence. In the future, efforts should be strengthened in this field from the perspectives of high-quality research, formulation of standardized protocols, and integrated TCM-Western medicine nursing. By doing so, more efficient and scientific nursing services can be provided for DGP patients, ultimately improving their long-term prognosis.

Disclosure statement

The author declares no conflict of interest.

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Existing Problems and Countermeasures in Hospital Public Health Management

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Abstract: At the current stage, China's medical and health industry is constantly developing, and it is essential to fully attach importance to the core role of Centers for Disease Control and Prevention (CDC). For tertiary hospitals, one of their key work tasks is to carry out public health management. Based on this, this paper mainly expounds on some basic problems existing in the public health management of state-owned hospitals at the current stage, and puts forward corresponding countermeasures for the identified problems. These countermeasures include enhancing the emphasis on public health management, strengthening the intensity of medical management, effectively improving the allocation of medical management resources, and intensifying the training of relevant personnel. This paper aims to provide references for improving the level of hospital public health management.

Keywords: Hospital; Public health management; Health human resource management

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1. Brief introduction to public health management in hospitals

1.1. Public health management

Public health management refers to a management activity that safeguards public health, prevents disease transmission, improves the quality of medical services, and promotes health equity through the systematic organization, coordination, and implementation of various health policies and measures. Its core goal is to maintain and improve the health of the population, reduce disease incidence and mortality rates, and enhance the society's overall ability to respond to public health events^[1].

Health supervision and management is an important component of public health management, which mainly involves supervision and law enforcement over medical and health institutions, public places, drinking water, food hygiene, and occupational environments to ensure the effective implementation of various hygienic standards, laws, and regulations. This work emphasizes prevention as the priority and governance in accordance with the law, including standardizing the practice of medical institutions, inspecting the implementation of infectious disease prevention and control measures, and supervising the emergency preparedness for public health emergencies, so as

to prevent the spread of health risks.

Disease control and management is another core content of public health management, focusing on the prevention and control of infectious diseases and chronic non-communicable diseases (NCDs) ^[2]. In terms of infectious disease management, establishing a sound epidemic monitoring and reporting system is crucial, which involves the timely collection, analysis, and feedback of disease prevalence data to achieve early warning and rapid response to epidemics. Disease control and management also focus on building emergency response capabilities for public health emergencies, including the formulation of emergency plans, the development of emergency teams, the stockpiling of materials, and the improvement of cross-regional cooperation mechanisms. This ensures that the response mechanism can be quickly activated in the face of major epidemics or disasters, minimizing the threat to public health.

1.2. The role of hospital public health management

As a core component of the medical and health service system, hospitals not only provide clinical diagnosis and treatment services, but also play a key role in infectious disease monitoring and reporting, chronic disease prevention and control, and health education ^[3]. During major epidemics or public health emergencies, hospitals serve as key implementers of emergency responses, undertaking tasks such as patient admission and treatment, isolation and protection, and resource allocation. Efficient public health management capabilities help to quickly activate emergency plans, reduce social panic, and ensure the normal operation of medical order. A sound public health management system can also promote multi-sectoral collaboration, break down information barriers between medical institutions and disease control and prevention agencies, and form a work pattern of joint prevention and control ^[4]. The large amount of health data accumulated by hospitals in their daily operations, after standardized management and analysis, can be used for disease trend prediction and optimization of health resource allocation, thereby improving the accuracy of public health decision-making.

By continuously improving public health management processes, hospitals can enhance service quality and operational efficiency, and boost public trust and social satisfaction. Therefore, strengthening the public health functions at the hospital level is not only necessary to enrich the connotation of medical services, but also serves as a fundamental support for building a robust public health system. Good public health management practices help shape hospitals' image of social responsibility and facilitate the effective implementation of the Healthy China Strategy.

2. Problems in hospital public health management

2.1. Imperfect public health management system

Some hospitals have obvious shortcomings in the construction of the public health management system, with incomplete institutional setup and vague function allocation, failing to form a systematic and standardized management structure. In most hospitals, the Public Health Department is not granted an organizational status that matches its functions; it is usually attached to the Medical Affairs Department, Infection Control Department or other administrative departments, and lacks an independent organizational structure. This makes it difficult for the department to play a leading role in actual operation ^[5].

The internal management focus of hospitals generally leans toward clinical medical services. Mechanisms such as resource allocation, performance appraisal and staff promotion are all inclined to clinical departments,

while public health work is regarded as an auxiliary and non-core function. This value orientation of “prioritizing medical treatment over public health” directly affects the resource allocation and discourse power of public health departments.

In terms of responsibility division, public health management covers multiple fields including infectious disease prevention and control, chronic disease management, health promotion, environmental health, and occupational health. However, there is a lack of clear responsibility boundaries and cooperation mechanisms within hospitals. The Public Health Department often needs to coordinate with multiple departments such as medical affairs, nursing, infection control, and information across departments. Nevertheless, due to the lack of institutional authorization, it cannot effectively mobilize resources or supervise implementation, leading to the failure to implement work effectively.

2.2. Unreasonable staffing structure

In most medical institutions, the number of full-time staff dedicated to public health management is insufficient, which cannot meet the growing work demands such as disease prevention, health promotion, and response to public health emergencies^[6]. Some primary-level hospitals even only assign one or two staff members to be responsible for all public health affairs; the excessive workload leads to reduced management quality and slow response efficiency. To fill the manpower gap, some hospitals arrange medical staff from clinical departments to take on part-time public health tasks. Although these staff members have a certain medical foundation, they generally have not received systematic public health theoretical education and practical training. As a result, they have a shallow understanding of public health policies and limited mastery of core businesses such as monitoring and early warning, risk assessment, and health intervention.

With the advancement of the hierarchical medical system and the in-depth implementation of the national health strategy, hospitals play an increasingly prominent hub role in the regional public health system, and the requirements for professional talent teams are constantly rising. However, many hospitals have not yet established a scientific mechanism for talent introduction and cultivation. During the recruitment process, there is a lack of professional selection standards for public health positions, leading to inadequate control over the talent entry threshold^[7]. At the same time, the internal training mechanism is weak, and there is a lack of regular and systematic on-the-job training and capacity improvement programs, making it difficult for practitioners to update their knowledge and expand their skills. The unreasonable staffing structure is no longer merely a human resource issue, but a key bottleneck that directly affects the quality of public health services and the level of public safety.

2.3. Inadequate public health management system

Some medical institutions lack unified and standardized public health management systems, relying on empirical management for daily operations. There is a lack of rigid constraints on system implementation, and management behaviors are highly arbitrary, making it difficult to form standardized processes. Such problems are particularly prominent in responding to public health emergencies, where phenomena such as delayed information reporting, lagging response mechanisms, and disordered resource allocation occur frequently, exposing serious deficiencies in the design of emergency mechanisms within the management system^[8].

Human resource allocation was disconnected from the management system. The number of professional public health personnel was insufficient, and most of the existing personnel are concurrently held by clinical doctors. These personnel lack systematic public health knowledge training, and their professional capabilities are

insufficient to support complex management tasks. The performance appraisal mechanism does not include public health responsibilities as core indicators, resulting in insufficient attention from medical staff and limited work enthusiasm. In work such as regional health risk assessment and intervention for key populations, there is a lack of a unified coordination platform. Various parties act independently, leading to low resource utilization efficiency^[9].

In addition, there is an absence of supervision and evaluation mechanisms. Most hospitals have not established internal audit and quality evaluation systems for public health management, making it impossible to conduct quantitative evaluation of management effectiveness and difficult to identify and correct problems in a timely manner. Channels for public participation are limited, the social mobilization capacity for work such as health education and disease prevention is weak, and the improvement of residents' health literacy is restricted. These problems were intertwined, leaving hospital public health management in a state of passive response for a long time, making it difficult to play its fundamental role in the Healthy China Strategy.

3. Strategies for optimizing hospital public health management

3.1. Improve the management system and strengthen inter-departmental coordination

At present, some medical institutions have problems such as ambiguous responsibilities and insufficient implementation in the performance of public health functions. The root cause lies in the lack of specialized management agencies and clear division of powers and responsibilities. In this regard, the establishment of an independent public health management department is a key measure to improve management efficiency. This department should be equipped with functions such as overall planning, organization and implementation, supervision and evaluation, and fully take charge of core work including infectious disease prevention and control, health education, response to public health emergencies, chronic disease management, and nosocomial infection control^[10]. Through institutionalized setup, it is ensured that public health work has support in terms of organizational structure and guarantee in terms of resource allocation.

The establishment of an independent department needs to be accompanied by a clear list of responsibilities and scope of authority to avoid functional overlap or management gaps with other functional departments. The public health management department shall have the right to formulate in-hospital public health policies and technical specifications, supervise all departments in the implementation of relevant measures, and conduct assessment and feedback on the implementation status. Public health work should be incorporated into the overall development strategy of the hospital, making it one of the three pillars of hospital development together with medical service quality and scientific research and teaching capabilities. Quantifiable and traceable public health indicators, for example timeliness rate of infectious disease reporting, incidence rate of nosocomial infections, coverage rate of health education shall be set in the annual target responsibility system, and these indicators shall be taken as an important part of the departmental performance assessment to enhance the rigid binding force of management.

By holding regular joint meetings, establishing cross-departmental working groups, and developing an integrated information platform, administrative barriers and information silos are broken down, and response efficiency and management accuracy are improved^[11]. It is necessary to strengthen communication and coordination with other business departments, integrate the concept of public health into the diagnosis and treatment process, and form a work pattern featuring full hospital participation, clear responsibilities, and efficient operation. The improvement of the management system is reflected not only in the improvement

of the organizational structure, but also in the smooth operation mechanism and the sustainability of system implementation.

3.2. Strengthen talent introduction and improve the staff training system

The development of medical and health services is inseparable from high-quality professional talent teams. Especially in the field of public health management, the quantity and quality of talents are directly related to service capabilities and the ability to respond to public health emergencies. To improve the overall management level, the human resources department must strengthen talent introduction efforts, expand talent recruitment channels, and actively attract high-level talents with professional backgrounds in epidemiology, preventive medicine, health management, and other related fields to join the hospital's public health team. By establishing cooperation mechanisms with universities and research institutions, implementing targeted recruitment and special introduction programs, priority should be given to hiring interdisciplinary talents with practical experience and professional qualifications to reinforce frontline forces^[12].

While introducing talents, it is necessary to simultaneously promote the training and capacity improvement of existing staff. A sound, systematic, and regular training system should be established, incorporating public health theoretical knowledge, relevant laws and regulations, infectious disease prevention and control technologies, health education methods, and emergency response to public emergencies into routine training content. Annual training plans should be formulated, and special lectures, case analyses, and simulation drills should be conducted through a combination of online and offline formats to enhance the relevance and effectiveness of training. In particular, key links such as the response process for public health emergencies, information reporting mechanisms, and personal protection measures should be emphasized in training. This ensures that relevant staff master standardized operating procedures and possess rapid response capabilities^[13].

Clinical medical staff are important participants in public health work, and they have unique advantages in disease monitoring, health education, and epidemic early warning during daily diagnosis and treatment. Institutional designs should be adopted to encourage clinical doctors, nurses, and other medical technicians to actively participate in public health affairs, and their performance in fulfilling public health responsibilities should be incorporated into the performance evaluation system. A special reward mechanism should be established to recognize individuals and teams that have performed outstandingly in disease prevention and control, health management, and emergency response, thereby creating a favorable atmosphere that values public health. Continuously introducing outstanding talents and improving the internal training mechanism will help form a public health professional team with a reasonable structure, proficient professional skills, and rapid response capabilities, enhancing the hospital's service capacity in daily management. The optimal allocation of talent resources is the fundamental guarantee for promoting the modernization of the hospital's public health management system and the core support for realizing the integrated development of medical treatment and disease prevention.

3.3. Implement regionalized and hierarchical management

In the process of conducting public health management, hospitals face the realities of a large service population, diverse disease types, and heavy prevention and control tasks. Therefore, it is necessary to implement differentiated management strategies based on the functional positioning and risk levels of different regions^[14].

As places where patients concentrate for medical treatment, outpatient areas have high personnel mobility

and a high risk of cross-infection. For these areas, it is essential to strengthen the pre-examination and triage mechanism, improve the screening process for febrile patients, and implement standards for environmental disinfection frequency and medical waste disposal. For inpatient areas, the focus should be on nosocomial infection control: strictly implementing the management system for the use of antibacterial drugs, establishing a departmental infection monitoring and reporting system, and ensuring that protective measures in high-risk areas such as Intensive Care Units (ICUs) and neonatal wards are fully in place. As the frontline position for responding to public health emergencies, emergency areas should establish a rapid response mechanism, optimize the reservation and allocation process of emergency supplies, and enhance medical staff's ability in early identification and handling of infectious diseases.

In terms of management hierarchy, a three-level management system including hospital level, department level, and post level should be established. At the hospital level, the responsibility includes formulating public health management systems, coordinating resource allocation, and supervising implementation effects. A special management team led by hospital leaders should be set up to hold regular coordination meetings and promote inter-departmental collaboration. At the department level, specific implementation responsibilities are undertaken. Detailed implementation rules should be formulated in combination with the business characteristics of the department, daily training and emergency drills should be organized, and all prevention and control measures should be integrated into routine work processes.

At the post level, individual responsibility is emphasized. Medical staff must be proficient in public health operation standards, proactively participate in health education, epidemic reporting, and patient management, and form a management pattern with full staff participation ^[15].

Information technology plays a supporting role in regionalized and hierarchical management. Relying on the hospital information system, a public health data collection and analysis platform should be established to monitor key parameters in real time, such as infection indicators in various regions, vaccination rates, and coverage rates of chronic disease management, so as to provide data support for decision-making. In addition, the effectiveness of regional management can be linked to departmental performance evaluation to enhance the implementation of systems. This helps eliminate management blind spots, improve the scientificity of resource allocation and the accuracy of prevention and control measures, and promote the transformation of hospital public health management from extensive management to intensive management.

4. Conclusion

To sum up, hospitals undertake multiple functions in public health management, including disease prevention, health promotion, and emergency response. Their management level is directly related to public health and social stability. The improvement of hospital public health management is not only associated with the development of medical institutions themselves, but also an important part of the construction of the national public health system. Through systematic reforms and continuous investment, hospitals' comprehensive capabilities in major epidemic prevention and control, chronic disease management, health promotion, and other fields can be significantly enhanced, which provides solid support for building a more resilient and responsive public health network.

Disclosure statement

The author declares no conflict of interest.

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Study on the Correlation between Irisin Expression and the Healing of Diabetic Skin Injury

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Abstract: A diabetic skin ulcer model was established by combining streptozotocin (STZ) administration with full-thickness skin defect surgery to evaluate the changes in irisin levels during the healing process. The experiment was divided into 2 groups, with 6 mice in each group: the normal control group and the diabetic skin injury group. Compared with the normal group, the model injury group showed a significant increase in blood glucose ($p < 0.001$), a significant decrease in healing rate ($p < 0.001$), and a significant decrease in irisin levels ($p < 0.001$) after 14 days. Irisin levels were positively correlated with blood glucose and positively correlated with wound healing rate. In conclusion, irisin may be a potential therapeutic target for the treatment of diabetic skin injury.

Keywords: Diabetes mellitus; Skin healing; Irisin; Blood glucose

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1. Introduction

Diabetes mellitus is one of the common chronic metabolic disorders^[1]. It is accompanied by a series of complications, such as diabetic nephropathy, diabetic encephalopathy, and diabetic foot^[2]. These complications affect the quality of life of diabetic patients, and severe complications can even be life-threatening. Among them, difficult-to-heal diabetic wounds, such as diabetic foot ulcers, are a major concern. Due to significant impairment of vascular microcirculation in diabetic patients, wounds are difficult to heal. Once induced by factors such as wound infection or low immunity, these wounds can develop into diabetic skin ulcers^[3]. At present, there are still no effective treatment methods for diabetic skin ulcers, and in-depth research on the pathological mechanism of diabetic skin ulcers is lacking, which hinders the identification of specific targets for drug development.

Irisin, a myokine-derived protein, is closely related to tissue metabolism in the body^[4]. In recent years, more scholars have focused on the role of irisin in metabolic diseases, such as its effect on diabetes mellitus^[5,6]. Relevant studies have found that irisin can significantly improve body metabolism, promote blood glucose utilization, and alleviate diabetes^[7]. Meanwhile, irisin also exhibits certain anti-inflammatory and antioxidant effects^[8]. However, whether the expression of irisin in the body, especially in skin tissue, is correlated with diabetic skin ulcers remains unclear.

In this study, an animal model of diabetic skin injury was established to detect irisin levels in blood and skin tissue, and to explore its correlation with the healing of diabetic skin ulcers. This study aims to provide a theoretical basis for determining whether irisin can be a potential effective target for the treatment of diabetic skin ulcers in future research.

2. Materials and methods

2.1. Experimental animals

Adult male ICR mice, 8–10 weeks old ($n = 24$), weighing between 20 and 24 g, were purchased from the Hangzhou Medical Experimental Animal Center.

2.2. Experimental equipment and reagents

Irisin (ThermoFisher Scientific); Streptozotocin (ThermoFisher Scientific); High-fat diet (ThermoFisher Scientific); Blood glucose meter and test strips (Roche); Ultrapure water system (Millipore); Analytical balance with a precision of 0.01 mg (1/100,000 balance, ThermoFisher Scientific); Irisin detection kit (ThermoFisher Scientific).

2.3. Animal grouping

The experiment was divided into two groups: the normal control group and the diabetic skin ulcer group, with 6 mice in each group ($n = 6$ per group).

2.4. Animal model establishment

First, a diabetic animal model was established by intraperitoneal injection of streptozotocin at a dose of 50 mg/kg^[9]. Seventy-two hours later, blood samples were collected from the tail vein for the first time, and subsequent blood glucose monitoring was conducted continuously. A blood glucose level ≥ 16.7 mmol/L was considered a successful establishment of the diabetic model. On the basis of the successfully established diabetic model, a skin ulcer model was constructed. Specifically, mice were anesthetized by isoflurane inhalation, and their dorsal hair was removed using depilatory cream. A circular wound with a diameter of 20 mm was created on the dorsal skin of the mice. Mice in the normal control group only underwent the skin wound creation procedure without being induced to develop diabetes.

2.5. Evaluation of wound area in diabetic skin ulcers

On days 3, 7, and 14, the ulcer wounds of mice in both groups were photographed using a camera to measure the wound area. The wound healing rate was calculated using the formula: Wound healing rate = $[(\text{Original wound area} - \text{Unhealed wound area}) / \text{Original wound area}] \times 100\%$.

2.6. Tissue sample collection

On days 7 and 14 after wound creation, blood samples were collected from the tail vein of mice in both groups for blood glucose detection. Fourteen days after wound healing, 6 mice in each group were sacrificed, and dorsal skin tissue samples were collected.

2.7. Irisin detection using the kit

Skin tissue samples were lysed, followed by ultrasonic homogenization. The homogenate was centrifuged, and

the supernatant was collected for sample loading. After adding the antibody, a stop solution was added. The absorbance value was measured at a wavelength of 540 nm, and the irisin content in the samples was calculated by referring to the standard curve.

2.8. Statistical analysis

Experimental data were expressed as mean \pm standard error (mean \pm SE). Statistical analysis was performed using GraphPad Prism software, and the unpaired *t*-test was used for comparisons between the two groups. A *p*-value < 0.05 was considered to indicate a statistically significant difference.

3. Experimental results

3.1. Changes in body weight and blood glucose

Compared with the normal group (32.4 ± 2.1 g), the body weight of mice in the model group (24.1 ± 1.0 g) was significantly decreased 14 days later ($p < 0.01$); the blood glucose level of mice in the model group (12.6 ± 0.8 mmol/L) was significantly higher than that in the normal control group (4.2 ± 0.5 mmol/L, $p < 0.001$) (see **Table 1**).

Table 1. Changes in body weight and blood glucose levels of mice

Group	Body Weight (g)	Blood Glucose Level (mmol/L)
Normal Control Group	32.4 ± 2.1	4.2 ± 0.5
Model Group	$24.1 \pm 1.0^{**}$	$12.6 \pm 0.8^{***}$
<i>t</i> -value	3.568	8.904
<i>p</i> -value	0.0051	< 0.0001

Data from 6 mice in each group were expressed as mean \pm standard error of the mean (SEM). Student's *t*-test was used for data analysis. ** indicated a significant difference compared with the control group at $p < 0.01$; *** indicated a significant difference compared with the control group at $p < 0.001$.

3.2. Changes in wound area

The wounds of mice in both groups gradually narrowed over time. At 7 days after wound creation, the wound healing rate of mice in the model group ($22.3 \pm 0.9\%$) was significantly lower than that in the normal control group ($36.8 \pm 1.8\%$). A similar trend was also observed in mice at 14 days after model establishment (see **Table 2**).

Table 2. Changes in wound healing rate of mice

Group	3 days after wounding	7 days after wounding	14 days after wounding
Normal Control Group	12.8 ± 0.5	36.8 ± 1.8	81.8 ± 2.2
Model Group	$9.3 \pm 0.7^{**}$	$22.3 \pm 0.9^{***}$	44.3 ± 2.3
<i>t</i> -value	3.995	7.348	11.860
<i>p</i> -value	0.0025	< 0.0001	< 0.0001

Data from 6 mice in each group were expressed as mean \pm standard error of the mean (SEM). Student's *t*-test was used for data analysis. ** indicated a significant difference compared with the control group at $p < 0.01$; *** indicated a significant difference compared with the control group at $p < 0.001$.

3.3. Changes in irisin level

At 14 days after model establishment, compared with the normal control group (2.2 ± 0.3 nmol/L), the irisin level in the skin tissue of mice in the model group (0.7 ± 0.1 nmol/L) was significantly decreased ($t = 4.743, p < 0.001$).

3.4. Results of correlation analysis

The irisin level showed a negative correlation with blood glucose ($R = -0.755, R^2 = 0.57, p < 0.01$) and a positive correlation with wound healing rate ($R = 0.821, R^2 = 0.67, p < 0.01$) (see **Table 3**).

Table 3. Correlation analysis of variables in mice at 14 days after wounding

Variable	Irisin level	Blood glucose level	Wound healing rate
Irisin Level	1	-0.755**	0.821**
Blood Glucose Level	-0.755**	1	-0.902***
Wound Healing Rate	0.821**	-0.902***	1

The data represent Pearson correlation coefficients. ** indicates that the result of the correlation analysis between the two groups has a statistical significance of $p < 0.01$; *** indicates that the result of the correlation analysis between the two groups has a statistical significance of $p < 0.001$. The “-” symbol represents a negative correlation between the two sets of data.

4. Discussion

This study found that the expression level of irisin in the skin tissue of diabetic mice may be associated with wound healing. An increase in irisin level can accelerate the healing of diabetic wounds. The irisin level in the skin tissue of diabetic mice is significantly lower than that of mice in the normal group, which may be one of the reasons for the difficulty in wound healing. Irisin has anti-inflammatory and antioxidant effects, and can improve nerve and tissue functions^[10]. However, no studies have shown so far that it can promote skin tissue repair. The latest relevant research has detected the expression of irisin in dermal tissue. Combined with the biological activity of irisin, this suggests that irisin may have the effect of promoting tissue repair^[11].

This study also has certain limitations. Correlation research results indicate that there is a correlation between irisin, blood glucose, and wound healing rate; however, it remains unclear whether irisin directly promotes skin healing or improves skin healing by regulating blood glucose. It cannot be ruled out that irisin improves the local tissue microenvironment with high glucose levels, thereby alleviating microcirculatory disorders and further promoting tissue repair.

Through literature research, it is hypothesized that irisin may improve wound repair through the following pathways.

- (1) It may inhibit inflammatory mechanisms, such as the Nuclear Factor kappa-B (NF- κ B) signaling pathway, thereby optimizing the inflammatory phase of skin healing^[12].
- (2) It may activate the AMP-activated protein kinase/Phosphatidylinositol-3-kinase (AMPK/PI3K) signaling pathway to promote the secretion of growth factors, thus facilitating the formation of new blood vessels^[13].
- (3) It may activate oxidative stress-related mechanisms such as Nuclear Factor Erythroid 2-Related Factor 2 (Nrf2) to exert antioxidant effects and protect cells^[14].
- (4) It may regulate the metabolism of the microenvironment and improve microcirculation^[15].

5. Conclusion

In conclusion, irisin may be a potential therapeutic target for diabetic skin ulcers, but further experiments are required to verify its mechanism of action.

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Current Situation and Prospect of Geriatric Nursing Models Under the Background of Healthy Aging

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Abstract: With the accelerating pace of population aging in China, various issues related to elderly care have emerged one after another, becoming a severe social problem. Especially against the backdrop of increasing economic pressure, the traditional family-based elderly care model is facing significant challenges and can hardly meet the elderly care needs. At present, the geriatric nursing models are relatively backward, which directly affects the quality of daily life, physical health and mental well-being of the elderly. Therefore, it is necessary to explore an appropriate geriatric nursing model to address the aging problem. Based on this, this paper analyzes and studies the current situation of geriatric nursing models under the background of healthy aging, providing references for relevant research and practice.

Keywords: Healthy aging; Geriatric nursing model; Current situation analysis; Future prospect; Integrated care

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1. Introduction

The Healthy China 2030 Planning Outline points out that promoting the construction of Healthy China is an important foundation for building a moderately prosperous society in all respects and basically realizing socialist modernization. It is also a national strategy to improve the health quality of the Chinese nation and realize the coordinated development of people's health and economy and society. At present, the number of people over 60 years old in China is close to 250 million, and the number of disabled elderly is also relatively large. How to provide high-quality nursing services for the elderly to meet their health needs and promote healthy aging has become an important topic at this stage. Currently, the elderly care models mainly include three types, including family care model, institutional care model and community care model. In order to better provide a high-quality living environment for the elderly, it is necessary to construct a more appropriate elderly care model based on the current situation of elderly care.

2. Healthcare models for the elderly against the backdrop of healthy aging: Current status

2.1. Family care model

First, the demand for home care services is relatively high, while the quality and capabilities of the service team vary significantly. At this stage, the quantity and quality of elderly care institutions, nursing staff, and nursing medical teams across the country were continuously improving, and care models centered on the Internet have emerged as the times require. However, China is currently facing a high degree of aging, and the demand for home care is also constantly rising. Due to the decline in their own physical functions, the elderly often need long-term care, and the current home care service model is difficult to meet the actual needs. At the same time, the social recognition of home care service work is insufficient, the number of nursing service staff is inadequate, and the scale of the team is relatively small. The relatively low salary and welfare levels directly affect the development process of healthy aging^[1,2].

Second, the construction of information platforms and medical security is relatively insufficient, and the management system is not sound. At present, with the rapid development of science and technology, many advanced information technologies can be applied to home-based elderly care to achieve good service results. However, in the actual application process, the utilization rate of these technical means is relatively low. On the one hand, it is because the elderly lack understanding of technology. On the other hand, there are relatively few scientific and technological products for home-based elderly care on the market at present, which cannot guarantee the pertinence of services. The medical security under the home care model is relatively poor, the policy support is not in place, and the construction of the medical security system is not perfect. This makes it difficult for many elderly people to obtain more accurate and timely help and medical treatment.

Third, the care of disabled elderly people is relatively difficult and requires professional care. Many elderly people suffer from problems such as dementia, leading to issues like decreased cognitive ability, memory loss, and forgetfulness, which make it difficult for them to complete various daily activities. The existing home care service system is unable to meet their needs, which increases the life pressure of many elderly people, causes them to feel lonely and helpless, and thus has a negative impact on their health^[3].

2.2. Community elderly care model

First, the community care system is inadequate. At this stage, care services in most urban areas still remain in the traditional community care phase, which is at the initial stage of development. An integrated operation mechanism has not been formed, leading to an incomplete care model that lacks proper continuity. This inadequacy is mainly reflected in three aspects: There is no continuity in terms of time. The care patients receive in hospitals is disconnected from the care they get after being transferred to the community or their homes, with no effective link between the two. This results in unmet care needs and consequently leads to recurring health issues.

There is no continuity in information. The disconnect between community care and hospital care causes breaks in health information, disease-related information cannot be effectively transferred to health institutions, and rehabilitation information fails to be fed back in a timely manner. This directly reduces the effectiveness of community care and increases time costs. The lack of continuity in management means that after patients are transferred from hospitals to the community or their homes, it is difficult to achieve cohesion in corresponding care actions. Home visits lack clear arrangements, which leads to unclear planning of care measures for patients and the absence of a clear work system to provide guarantees^[4,5].

Second, there is a shortage of community service personnel. At present, there are relatively few community nurses in cities in China, and the shortage is even more severe in remote areas, making it difficult to undertake the responsibility of providing high-quality health services to the community. Currently, the professional quality and competence of community care staff are not high; most of them do not have strong professional capabilities and have not received systematic training. This results in inadequate management of community care, making it difficult to achieve good care quality and hindering the development of China's community care cause^[6].

Third, community infrastructure is inadequate and professional equipment is insufficient. The community elderly care model requires sufficient material support as a guarantee. However, at this stage, the construction of community infrastructure in China is relatively weak, and there are significant differences in development levels among different regions. In some areas, there is a problem of waste in community care premises, while in other areas, the number of community care premises is relatively insufficient, and there are also dilapidated and old buildings^[7]. Currently, the ownership rate of basic equipment configuration in community health service centers is relatively low. The basic equipment is difficult to meet the municipal-level health service needs of community residents, and there is a shortage of health care and rehabilitation equipment.

2.3. Institutional care model

First, there is a shortage of institutional resources. At this stage, the lack of institutional care resources is a major factor affecting the aging issue. Against the backdrop of intensifying population aging, the demand for institutional care is constantly increasing. However, the number of beds for institutional care is insufficient, and the number of nursing staff is relatively small, with specific situations varying across different regions. These problems directly lead to a relative shortage of care resources in some regions during specific periods, resulting in a situation where demand exceeds supply. Moreover, due to the lack of unified industry standards for guarantee, although most institutions strive to provide high-quality services, issues such as incomplete institutional facilities or inadequate management may lead to poor service quality^[8]. Under such circumstances, the elderly cannot receive more comprehensive care when accepting institutional care, which directly affects their own health conditions.

Second, health education is insufficient and the chronic disease management mechanism is not sound. At present, institutional care should not only focus on the daily life of the elderly but also pay attention to their health issues. However, many institutions do not have a sound assessment mechanism, making it impossible to effectively evaluate the health status of the elderly and difficult to identify their existing health problems. In addition, many institutions lack the awareness of providing health education to the elderly, which results in the elderly being unable to develop healthy concepts and their own health conditions failing to improve. Many institutions fail to formulate personalized care models based on the actual conditions of the elderly and lack comprehensive service management. Currently, most care services can only meet the basic daily care needs of the elderly but cannot satisfy their other needs, including those in terms of mental, recreational and social aspects. Some elderly people have difficulty communicating in-depth with nursing staff due to their own hearing and cognitive impairments, which may also lead to problems such as anxiety and depression^[9].

Third, the development of information technology is insufficient and the management of elderly care records is not in place. At this stage, most elderly people suffer from chronic diseases. However, the lack of an information-based system for managing record information directly affects the effectiveness of institutional care services. Technological innovation needs to be improved; only by freely utilizing technological means to enhance the convenience of elderly care services can the effective implementation of elderly care services be guaranteed,

and more comprehensive and sound services be provided to the elderly^[10].

3. Outlook for elderly care models against the background of healthy aging

3.1. Strengthening the development of the talent team to meet healthcare needs

Health administration departments in different regions need to fully recognize the significant value of elderly care institutions in establishing a sound health service system, thereby enhancing the development of institutional frameworks and safeguarding the basic health rights and interests of the elderly. To this end, medical institutions must increase the number of medical staff based on their actual conditions, and augment the number of nursing staff in accordance with their functional positioning, scale, and the needs of the elderly, ensuring that more targeted care is provided to elderly patients^[11].

Greater integration should be promoted between educational institutions and integrated medical-nursing facilities to facilitate in-depth learning, advance the development of school-enterprise cooperation mechanisms, and cultivate talents with strong comprehensive capabilities. Educational institutions should strengthen the establishment of majors in the elderly care service field, improve the curriculum teaching system, and intensify efforts in cultivating elderly care service talents. They should add majors related to elderly care services, incorporate courses closely linked to elderly care needs such as rehabilitation nursing, nutritional nursing, and psychological nursing, and actively explore mechanisms for training senior elderly care specialists. Hospitals should establish APN (Advanced Practice Nurse) position mechanisms, formulate technical standards for elderly care specialties and advanced nursing practice criteria, and carry out advanced nursing practices. Different care models should be implemented for elderly groups with different characteristics to ensure the provision of more comprehensive and accessible care services. In addition, an interdisciplinary team cooperation mechanism should be built to achieve the sustainable development of the elderly healthcare talent team, realize the modernization and scientization of nursing management, strengthen communication and cooperation mechanisms, and cultivate high-quality talents^[12].

3.2. Enhancing the development of management mechanisms to improve the nursing service system

Against the backdrop of population aging, the elderly's demand for long-term care and rehabilitation care is constantly increasing. As an important part of the medical team, medical and nursing staff possess significant work value. Therefore, relevant nursing institutions should strengthen institutional development, build a more comprehensive nursing mechanism on the basis of complying with the guidelines of national policy documents, form a professional nursing team, ensure the rationality of staff allocation, focus on strengthening team management, promote the high-quality development of the health industry, and meet the diverse health needs of the population.

Health administration departments also need to supervise and support the recruitment and management of medical and nursing staff in medical institutions, and formulate subsidy plans in accordance with relevant vocational training mechanisms. Market supervision and administration departments at all levels should focus on strengthening the management of registered institutions. Only by ensuring the rationality of medical institutions can the elderly care service mechanism be better improved^[13].

3.3. Developing an intelligent care model to support elderly care services

Establish an elderly care service model centered on the Internet, and build smart hospitals based on big data platforms to meet the daily medical needs of the elderly. The intelligent care model leverages internet information technology to enable telemedicine, develops comprehensive electronic medical records based on patients' actual conditions, and allows the elderly to wear smart devices to monitor their health information, thereby promptly identifying health issues that may arise. Medical institutions should also develop more diverse care service activities based on their own actual circumstances, adhere to the principle of high-quality care, and provide more comprehensive and thorough care services for elderly inpatients. Institutions with the capacity are encouraged to provide continuous care services, extending institutional care to communities and home settings to ensure the effective implementation of care work. The development of the intelligent care model can be carried out through pilot programs, which will then be promoted from a small scale to a national level. This approach will continuously improve the functional modules of the intelligent care platform, ensuring that the elderly receive higher-quality services ^[14,15].

4. Conclusions and recommendations

In summary, against the backdrop of the healthy aging strategy, China's elderly care models have shifted from a single model to diversified ones, moving toward the integration of medical and elderly care services. Considering China's current elderly care models, it is necessary to strengthen the development of the talent workforce, enhance the establishment of management mechanisms, and build intelligent care models. These measures will ensure that the elderly have access to a high-quality living environment and help foster a positive social atmosphere.

Disclosure statement

The authors declare no conflict of interest.

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The Impact of Digital-Intelligent Health Education on Dry Weight Management in Patients Undergoing Maintenance Hemodialysis

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Abstract: *Objective:* To evaluate the effectiveness of digital-intelligent health education for patients undergoing maintenance hemodialysis. *Methods:* From December 2023 to December 2024, 82 patients undergoing maintenance hemodialysis in our hospital were selected and randomly divided into an observation group ($n = 41$, receiving routine health education) and a control group ($n = 41$, receiving digital health education). The levels of knowledge, belief, and behavior related to dry weight control, as well as changes in dry weight and complications, were compared before and after intervention. *Results:* After intervention, the observation group had higher scores for knowledge (40.96 ± 6.43), belief (39.11 ± 6.39), behavior (39.66 ± 5.78), and total score (119.04 ± 13.11) compared to the control group ($p < 0.05$). The observation group also showed better dry weight control than the control group ($p < 0.05$). The total incidence of complications in the observation group (4.88%, 2/41) was lower than that in the control group (21.95%, 9/41) ($p < 0.05$). *Conclusion:* The rational application of digital-intelligent health education can effectively maintain dry weight in patients undergoing maintenance hemodialysis, reduce complications, and improve patients' knowledge, belief, and behavior levels. This approach is worthy of promotion.

Keywords: Digital-intelligent; Health education; Maintenance hemodialysis; Dry weight

Online publication: Oct 30, 2025

1. Introduction

The so-called “dry weight” refers to the lowest tolerable body weight during hemodialysis treatment, where the patient does not exhibit physical symptoms and hypotension does not occur without the assistance of antihypertensive drugs ^[1]. During dialysis for such patients, an increase in dry weight is often due to the volume load generated after water and sodium intake. If the load remains excessively heavy, the risk of adverse events such as cardiovascular and cerebrovascular diseases and hypertension also increases, directly affecting the patient's survival rate ^[2].

Therefore, it is necessary to implement necessary dry weight management and control for patients. Currently,

health education for patients is usually carried out in traditional forms, which are often lacking in specificity and have limited effectiveness. Digital-intelligent health education, on the other hand, can integrate multiple perspectives and utilize digital-intelligent methods to improve educational effectiveness^[3].

To this end, the following will focus on a comparative analysis of the differences in effects of different health education models used in the treatment of patients undergoing maintenance hemodialysis for reference.

2. Materials and methods

2.1. Baseline information

Eighty-two patients undergoing maintenance hemodialysis in our hospital from December 2023 to December 2024 were selected. Forty-one patients were randomly chosen for the control group, while the remaining patients were assigned to the observation group. The control group consisted of 22 males and 19 females, with ages ranging from 31 to 65 years old, averaging (52.07 ± 3.25) years old. In the observation group, there were 24 males and 17 females, with ages between 33 and 68 years old, and a median age of (52.04 ± 3.30) years old. The basic information of the two groups showed no significant difference ($p > 0.05$), indicating comparability.

2.2. Methods

The health education team for this study consisted of one attending physician and three hemodialysis specialist nurses. Team members were responsible for reviewing literature, discussing within the group, and clarifying the content and specific application paths of digital intelligent health education. All team members underwent professional training before participating in the intervention process for both patient groups.

The control group received conventional health education. Education sessions were fixed on Mondays, Wednesdays, and Fridays. Team members focused on the importance of controlling dry weight, factors affecting dry weight gain, and specific control techniques. Educational flyers were distributed to patients, and team members provided timely and detailed answers to questions from patients and their families.

The observation group of patients received digital intelligent health education, which was conducted both inside and outside the hospital, with sessions scheduled for every Tuesday, Thursday, and Saturday. The details are as follows.

2.2.1. Inside the hospital

(1) Measurement of patients' dry weight

Group members were responsible for measuring patients' dry weight, understanding their diet and medication status, and providing feedback-based guidance. The entire process was controlled to 8–10 minutes.

(2) Game training for patients

This involved virtual diet matching. Group members guided patients to download nutrition-related software on tablets or smartphones to complete virtual pairing of diet, drinking water, and recipes, with a time limit of 8–10 minutes.

(3) Knowledge education

During the knowledge dissemination and education process, nursing staff scientifically guided patients to watch educational materials using electronic devices, further enhancing their understanding of dry weight

control. This session also lasted for 8–10 minutes.

(4) Knowledge quiz activities

Additionally, knowledge question and answer activities were organized. Relevant questions were uploaded via an online platform, and patients could participate in the competition by answering questions. Patients were rewarded with red flower stickers based on their response time and scores, which were tallied monthly. Patients could exchange their stickers for physical prizes, which helped to motivate their participation.

(5) Preparation for outside the hospital

A WeChat group for patients was established to provide assistance to patients and their families. Software for body sensation exercise was downloaded to mobile phones, and group members could add each other as friends, facilitating future monitoring and follow-up outside the hospital.

2.2.2. Outside the hospital

The focus of the intervention was on monitoring and reminders. Patients were guided to select interesting projects in the exercise software to achieve virtual exercise goals. Nursing staff in the group could remotely view patients' daily exercise status using the software. If patients did not achieve their expected exercise goals, the software's online reminder function was used to promptly notify them, ensuring timely task completion.

Data from patients' weight scales outside the hospital was effectively shared through the smart monitoring system, allowing medical staff to obtain timely updates on any fluctuations in body weight. This real-time access enabled nurses to identify abnormal trends early and provide personalized guidance or targeted interventions to prevent fluid overload or weight-related complications. The system also supported the timely issuance of reminders, ensuring that patients maintained stable dry weight and adhered to individualized health plans.

In addition, the promotion and application of the smart medicine box data-sharing function further enhanced the continuity of care. Nursing staff were able to monitor patients' medication adherence online at any time and take prompt reminder or follow-up measures in case of missed doses or irregular medication patterns. This intelligent monitoring approach effectively bridged the gap between hospital and home care, improving treatment compliance and safety.

Patients and their families were also encouraged to actively participate in disease management by providing timely feedback on daily behaviors such as physical exercise, water intake, medication use, and diet through the designated WeChat group. This interactive communication channel facilitated two-way information flow, allowing nursing staff to evaluate patients' self-management behaviors and provide individualized advice or corrections when necessary.

Furthermore, nursing staff regularly pushed educational content about dry weight management to the WeChat group, including knowledge on its importance, influencing factors, and methods for maintaining stability. Through discussions, case sharing, and experience exchanges in the group, patients were able to learn from one another, enhance their understanding of dry weight control, and improve their self-care ability. This collaborative and technology-supported model strengthened the connection between patients and healthcare providers, fostering a sense of community and shared responsibility in managing chronic conditions.

2.3. Evaluation indicators

(1) Systematic evaluation of knowledge, attitude, and practice (KAP) levels and changes in dry weight

- between groups
(2) Evaluation of patients' comorbidity status

2.4. Statistical analysis

- (1) Data processing:
SPSS 23.0 statistical software
(2) Data description
Count data as (n %), measurement data as ($\bar{x} \pm s$)
(3) Difference testing
Count data using χ^2 , measurement data using t ; $p < 0.05$ as the basis for statistical difference

3. Results

3.1. Study on changes in KAP levels of dry weight control in observation and control groups

Before intervention, there were no significant differences in relevant indicators between groups ($p > 0.05$). After intervention, there were significant differences in indicators between the two groups ($p < 0.05$) (see **Table 1**).

Table 1. Comparison of KAP levels of dry weight control before and after intervention between the two groups

Group	n	Knowledge score		Belief score		Behavior score		Total score	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Observation	41	35.23 \pm 3.35	40.96 \pm 6.43	31.19 \pm 4.21	39.11 \pm 6.39	32.25 \pm 5.55	39.66 \pm 5.78	110.34 \pm 12.12	119.04 \pm 13.11
Control	41	35.21 \pm 3.33	35.47 \pm 5.32	31.22 \pm 4.24	34.32 \pm 4.47	32.22 \pm 5.51	33.21 \pm 4.57	110.31 \pm 12.09	113.32 \pm 10.45
<i>t</i> -value		0.0271	4.2122	0.0321	3.9330	0.0246	5.6050	0.0112	2.1846
<i>p</i> -value		0.9784	< 0.001	0.9744	< 0.001	0.9805	< 0.001	0.9911	0.0318

3.2. Analysis of dry weight changes in two groups of patients

After intervention, there was a significant difference in dry weight between the observation group and the control group ($p < 0.05$) (see **Table 2**).

Table 2. Comparison of dry weight changes between the observation group and the control group

Group	n	Before intervention (kg)	After intervention (kg)
Observation group	41	66.02 \pm 12.13	64.35 \pm 10.54
Control group	41	66.04 \pm 12.11	69.95 \pm 10.77
<i>t</i> -value		0.0075	2.3795
<i>p</i> -value		0.9941	0.0197
Observation group	41	66.02 \pm 12.13	64.35 \pm 10.54

3.3. Comparison of comorbidity status between observation group and control group

The total incidence rate in the observation group was significantly different from that in the control group ($p < 0.05$) (see Table 3).

Table 3. Study on comorbidity status between the two groups of patients (n/%)

Group	n	Hypoglycemia	Muscle Cramps	Blurred Vision	Total Incidence
Observation	41	2 (4.88%)	0 (0.00%)	0 (0.00%)	2 (4.88%) *
Control	41	3 (7.32%)	3 (7.32%)	3 (7.32%)	9 (21.95%)
χ^2					5.1447
p -value					0.0233

4. Discussion

Currently, modern science and technology have achieved considerable development achievements, and the advantages of big data and artificial intelligence have gradually become prominent. Digital intelligence empowerment has also had varying degrees of impact on multiple fields^[4-6]. Taking the field of nursing health education as an example, through the application of digital intelligence technology, a new health education model has been constructed with the help of AI technology, mobile terminals, and the Internet +, highlighting the central position of patients and featuring prominent characteristics of intelligence and digitization^[7].

In the process of controlling dry weight for hemodialysis patients, the expansion of health education service space has been achieved through the use of mobile terminals and the Internet. Based on existing oral propaganda education or promotional brochures and other channels, it combines various forms such as virtual games, somatosensory movements, and rich media videos, enabling patients to have a more comfortable experience in receiving health education and enhancing the fun and effectiveness of education^[8-11]. This model also transforms the current situation of face-to-face evaluation and monitoring, fully utilizes the characteristics of data interconnection and sharing, and achieves the goal of breaking through time constraints with the assistance of real-time feedback^[12]. It provides patients with automated online monitoring and reminder services in real time, offers new ideas for the development of health education work, and significantly enhances the effectiveness of dry weight management for hemodialysis patients during both inpatient and outpatient periods^[13].

In the above study, after clinical intervention, the observation group's knowledge, attitude, and practice (KAP) related to dry weight control were significantly better than those of the control group, with $p < 0.05$. The reason is that the digital and intelligent health education approach adopted in this study is highly engaging and impactful. Through this model, patients can quickly gain a deep understanding of dry weight control content using rich media educational resources, which is more conducive to forming healthy beliefs^[14]. After intervention, the dry weight control status of the observation group was significantly better than that of the control group, with $p < 0.05$. This is because integrating digital and intelligent methods into health education significantly improves patients' KAP levels regarding dry weight control. Additionally, it ensures that healthcare workers have real-time knowledge of patients' conditions both inside and outside the hospital, enabling dynamic adjustments to clinical interventions and enhancing the effectiveness of dry weight maintenance^[15].

The overall incidence of complications in the observation group was significantly lower than that in the control group, with $p < 0.05$. This indicates that actively conducting health education helps strengthen patients'

understanding of dry weight knowledge, leading to autonomous behavioral changes and reducing the risk of complications.

5. Conclusion

Overall, the digital and intelligent health education model combines digitalization and intelligence features, fully utilizing mobile terminals and AI technology in practice. This model demonstrates comprehensive intervention characteristics across all times and spaces. For patients undergoing maintenance hemodialysis who are controlling their dry weight, the application of this health education model enables them to further understand dry weight control-related content, achieve changes in KAP levels, and effectively avoid complications. This model has high clinical promotion and application value.

Disclosure statement

The author declares no conflict of interest.

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Correlation Study between Fetal Foot Length Measured by Ultrasound and Gestational Age

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Abstract: *Objective:* To explore the correlation between fetal foot length measured by ultrasound and gestational age. *Methods:* This study employed ultrasound to measure the fetal foot length, femoral length, and foot length/femoral length ratio in 214 pregnant women from 12 to 40 weeks of gestation, all of whom had no pregnancy complications or obstetric complications, and whose fetuses were normal. *Results:* A significant positive correlation was found between fetal foot length and gestational age ($r = 0.967, p < 0.001$); a similarly significant positive correlation was observed between fetal femoral length and gestational age ($r = 0.972, p < 0.001$); and a non-significant positive correlation was noted between the foot length/femoral length ratio and gestational age ($r = 0.943, p < 0.001$). *Conclusion:* Ultrasound can accurately measure fetal foot length and femoral length, both of which exhibit a significant positive correlation with gestational age, making them important reference indicators for assessing fetal growth and development.

Keywords: Ultrasound; Fetus; Foot length; Femur; Gestational age

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1. Introduction

Gestational age is not only related to fetal maturity but also closely associated with maternal care during pregnancy and the prevention and treatment of pregnancy complications. Traditional assessment of gestational age primarily relies on the date of the last menstrual period (LMP) of the pregnant woman. However, inaccuracies in recalling the LMP date or irregular menstrual cycles can lead to significant errors in estimating gestational age based on the LMP, thereby severely impacting the assessment of fetal growth and development and clinical decision-making^[1]. With the rapid development of ultrasound technology, its application in obstetrics has become increasingly widespread. Ultrasound, characterized by its non-invasive, real-time, and repeatable nature, is an important means of monitoring fetal growth and development during pregnancy. Ultrasonography provides a general understanding of fetal growth and various fetal indicators by measuring biological markers of the fetus, such as fetal biparietal diameter, femur length, and abdominal circumference, thereby estimating gestational age. Among the measurable biological parameters of the fetus, fetal foot length is a relatively easy-to-measure and independent parameter^[2]. The fetal foot begins to grow in early pregnancy and exhibits a relatively

consistent and stable growth rate as gestational age increases. Compared to measurements of other commonly used indicators, fetal foot length measurement is not affected by fetal position and amniotic fluid volume, resulting in high accuracy and good repeatability of the measurement results^[3]. Currently, although there have been reports on the impact of ultrasonographic detection of fetal biological parameters on gestational age, there is relatively little research on the correlation between fetal foot length and gestational age. Therefore, conducting research on the correlation between ultrasonographic detection of fetal foot length and gestational age is of great significance for accurately assessing gestational age, improving the quality of prenatal management, and enhancing perinatal outcomes.

2. Materials and methods

2.1. Research subjects

A total of 214 pregnant women who underwent prenatal ultrasonography at our hospital from January 2024 to January 2025 were selected as samples to determine the normal ranges for foot length, femur length, and foot length/femur length ratio. The women ranged in age from 20 to 38 years, with an average age of (31.44 ± 3.69) years, and gestational ages ranging from 12 to 40 weeks. They had regular menstrual cycles, with gestational age calculated from the first day of the last menstrual period, and all were singleton pregnancies. Patients with underlying diseases were excluded.

2.2. Instruments and methods

A Philips EPIQ 7C ultrasound diagnostic instrument was used, with a frequency range set at 2–5 MHz. The pregnant women were placed in a supine position, with their abdomens appropriately exposed. The examiner evenly applied coupling agent to the surface of the probe and then placed it on the abdomen of the pregnant woman, performing multi-planar scans of the fetus, with a particular focus on observing the fetal feet.

The maximum longitudinal section of the fetal foot, such as the section where the sole plane was perpendicular to the ultrasound beam, was selected. The straight-line distance from the bottom of the heel to the tip of the toes was measured as the foot length. To measure the fetal femoral length, select the longest axial section of the fetal thigh, that is, the section when the line connecting the midpoints of the femoral condyles at both ends was perpendicular to the ultrasound beam. The straight-line distance from the proximal metaphysis to the distal metaphysis of the femur was the femoral length.

All measurements were performed by the same experienced ultrasound physician. Each indicator was measured three times, and the average value was taken as the final result.

2.3. Statistical methods

Data analysis was performed using SPSS 26.0 software. Measurement data were expressed as mean \pm standard deviation ($\bar{x} \pm s$). Comparisons of fetal foot length, femoral length, and foot length/femur ratio among different gestational age groups were conducted using one-way analysis of variance (ANOVA).

Pearson correlation analysis was used to evaluate the correlation between fetal foot length, femoral length, foot length/femur ratio, and gestational age. A *p*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of fetal foot length, femur length, and foot length/femur ratio at different gestational weeks

The fetal foot length, femur length, and foot length/femur ratio from 12 to 40 gestational weeks are shown in Table 1.

Table 1. Comparison of fetal foot length, femur length, and foot length/femur ratio at different gestational weeks

Gestational Week (weeks)	Number of Cases	Foot Length (mm, $\bar{x} \pm s$)	Femur Length (mm, $\bar{x} \pm s$)	Ratio of Foot Length to Femur Length ($\bar{x} \pm s$)
12	12	8.82 \pm 1.22	9.17 \pm 1.26	0.98 \pm 0.02
13	10	11.33 \pm 1.14	10.51 \pm 1.06	0.97 \pm 0.03
14	22	14.15 \pm 2.13	13.32 \pm 1.82	0.97 \pm 0.01
15	21	17.03 \pm 2.17	16.27 \pm 1.77	0.96 \pm 0.02
16	33	20.76 \pm 2.45	20.61 \pm 2.33	0.95 \pm 0.04
17	31	23.67 \pm 2.51	22.43 \pm 2.58	0.97 \pm 0.04
18	30	25.62 \pm 2.58	27.82 \pm 2.78	0.95 \pm 0.03
19	33	28.85 \pm 2.82	30.65 \pm 2.47	0.97 \pm 0.04
20	26	32.16 \pm 2.82	32.66 \pm 2.21	0.97 \pm 0.02
21	22	33.07 \pm 2.06	36.39 \pm 2.52	0.94 \pm 0.03
22	22	36.155 \pm 3.13	40.14 \pm 1.85	0.96 \pm 0.04
23	24	40.32 \pm 1.67	41.31 \pm 2.22	0.96 \pm 0.02
24	33	42.83 \pm 3.12	44.30 \pm 2.35	0.93 \pm 0.02
25	22	45.11 \pm 2.85	47.23 \pm 2.22	0.94 \pm 0.03
26	28	47.67 \pm 3.01	47.77 \pm 2.61	0.94 \pm 0.03
27	24	48.34 \pm 2.11	52.08 \pm 3.09	0.95 \pm 0.03
28	21	52.65 \pm 3.23	54.31 \pm 2.72	0.93 \pm 0.03
29	22	55.12 \pm 3.855	55.31 \pm 2.71	0.96 \pm 0.02
30	22	54.43 \pm 3.71	56.58 \pm 2.13	0.96 \pm 0.02
31	26	55.43 \pm 3.72	60.18 \pm 2.57	0.96 \pm 0.02
32	19	57.58 \pm 2.52	61.57 \pm 1.75	0.95 \pm 0.02
33	19	60.41 \pm 3.75	63.17 \pm 2.22	0.93 \pm 0.02
34	20	64.14 \pm 2.64	64.46 \pm 2.58	0.95 \pm 0.01
35	35	66.04 \pm 3.47	66.71 \pm 2.41	0.93 \pm 0.03
36	45	70.53 \pm 4.05	67.42 \pm 2.13	0.96 \pm 0.02
37	36	70.45 \pm 3.22	68.85 \pm 2.15	0.95 \pm 0.02
38	28	71.14 \pm 3.55	70.11 \pm 2.16	0.94 \pm 0.02
39	27	72.16 \pm 3.61	71.22 \pm 3.56	0.93 \pm 0.04
40	9	74.11 \pm 6.62	74.57 \pm 3.59	0.95 \pm 0.02

3.2. Correlation of foot length, femur length, foot length/femur ratio, and gestational age at different gestational weeks

Pearson correlation analysis revealed a significant positive correlation between fetal foot length and gestational age ($r = 0.967$, $p < 0.001$), indicating a steady increase in fetal foot length with advancing gestational age. A significant positive correlation was also observed between fetal femoral length and gestational age ($r = 0.972$, $p < 0.001$), further validating the accuracy and reliability of ultrasound measurements in assessing fetal growth and development. The foot length/femur ratio showed a non-significant positive correlation with gestational age ($r = 0.943$, $p < 0.001$), while the changes in the foot length/femur ratio across different gestational weeks were relatively stable. This may reflect the maintenance of a certain degree of coordination in the relative growth proportions of the foot and lower limb during fetal growth and development.

4. Discussion

A significant positive correlation was observed between fetal foot length and gestational age ($r = 0.967$, $p < 0.001$), indicating that the increase in fetal foot length during growth and development is relatively stable and regular. The size of the fetal foot can accurately reflect changes in gestational age and is consistent with numerous previous studies. For instance, in a study by Ravisankar G et al. involving ultrasound measurements of 1,200 fetuses, it was found that fetal foot length increased linearly with gestational weeks and was closely related to gestational age^[4]. The study also suggested that the growth and morphological changes of fetal bones begin in early pregnancy, with their development having a biological basis independent of external factors such as maternal nutritional status and fetal gender.

Therefore, fetal foot length can serve as a reliable indicator for assessing gestational age. In clinical applications, for pregnant women whose last menstrual period is inaccurate, whose menstrual cycles are irregular, or for whom gestational age cannot be accurately determined by other conventional methods, ultrasound measurement of fetal foot length can be used as an alternative method for assessing gestational age. After establishing a curve between fetal foot length and gestational age, doctors can accurately determine gestational age by measuring the fetal foot length, providing a basis for subsequent pregnancy guidance, fetal growth and development monitoring, and determination of delivery time^[5]. Li Jianghua et al. believe that fetal gestational age is an important indicator for distinguishing between preterm and post-term births, and that measuring fetal foot length helps doctors accurately determine gestational age and take appropriate interventions to avoid adverse perinatal complications^[6].

In this study, a significant positive correlation was also observed between fetal femoral length and gestational age ($r = 0.972$, $p < 0.001$), further validating the reliability of femoral length as an indicator for assessing gestational age and fetal growth and development. The femur is the longest long bone in the human body, and its growth and development process can reflect the overall skeletal development of the fetus. Numerous studies have shown a relatively stable linear relationship between the increase in fetal femoral length and gestational weeks, which is consistent across different racial and geographical fetal populations^[7]. The research conducted by Aziguli Mayier and others revealed that by measuring the femoral length of 1,000 fetuses at different gestational ages and establishing detailed reference ranges for femoral length in relation to gestational age, it was found that the measurement of femoral length demonstrated good repeatability and was less influenced by the subjective factors of the operator^[8]. It serves as an objective and accurate indicator for assessing fetal growth and development.

The strong correlation between femoral length and gestational age in this study further supports this viewpoint. Clinically, femoral length is commonly used to evaluate whether there are skeletal developmental abnormalities in the fetus, such as osteogenesis imperfecta and chondrodysplasia. By comparing it with the normal femoral length at the same gestational age, skeletal abnormalities in the fetus can be detected early, enabling further relevant examinations, early diagnosis, and treatment ^[9].

The results of this study also indicated that there was a non-significant positive correlation between the foot length-to-femur ratio and gestational age ($r = 0.943$, $p < 0.001$), suggesting that the growth of foot length and femoral length may not be completely synchronized during fetal growth and development, but the overall trend remains correlated with gestational age. Some studies have pointed out that the skeletal growth rates at different sites of the fetus may be influenced by various factors, such as genetic factors, hormone levels, and local blood supply. During certain stages of fetal growth and development, differences in growth rates between the foot and femur may occur, leading to fluctuations in the foot length-to-femur ratio. However, in fetuses with certain congenital malformations or chromosomal abnormalities, the foot length-to-femur ratio may exhibit abnormal changes. Research by Soo H and others has indicated that in fetuses with Down syndrome, the foot length may be relatively shorter compared to the femoral length, resulting in a decreased foot length-to-femur ratio ^[10]. Therefore, although the correlation between the foot length-to-femur ratio and gestational age is not significant, it can still serve as a reference indicator when combined with other ultrasound indicators for fetal malformation screening and diagnosis, aiding in improving the detection rate of fetal malformations.

5. Conclusion

In summary, this study confirmed a significant positive correlation between fetal foot length, femoral length, and gestational age, providing important reference indicators for gestational age assessment and fetal growth and development monitoring. In future clinical practice, ultrasound measurements of fetal biological parameters such as foot length and femoral length will be combined with other examination methods, such as serological screening and non-invasive DNA testing, to form a more comprehensive fetal monitoring system. Through multi-indicator joint analysis, a more comprehensive assessment of fetal growth and development status and health risks can be achieved, providing pregnant women with more personalized and precise prenatal care services.

Disclosure statement

The author declares no conflict of interest.

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Analysis of Obstructive Factors for Medical Staff to Implement Respiratory Rehabilitation Evidence Based on the Theoretical Domain Framework

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Abstract: *Objective:* To explore the obstructive factors in the behavior of medical staff during the implementation of respiratory rehabilitation process, and to provide a basis for the rehabilitation management intervention of COPD. *Methods:* A descriptive nature research method was adopted. An interview outline was formulated based on the theoretical domain framework. From October to December 2024, 15 medical staff from the respiratory department of a tertiary hospital in Shaanxi Province were selected for semi-structured interviews. The interview data were analyzed using the Colaizzi 7-step analysis method. *Result:* The analysis of this study found that the obstructive factors for medical staff to implement respiratory rehabilitation include five theoretical domains. The problems are respectively the lack of knowledge about respiratory rehabilitation and insufficient training intensity, the insufficient self-recognition of implementing respiratory rehabilitation, the low awareness rate of patients and the low cooperation degree, the insufficient provision of instruments and facilities, the lack of rehabilitation training venues and respiratory rehabilitation clinics, and the lack of scientific and standardized respiratory rehabilitation management processes. *Conclusion:* There are many obstructive factors affecting the implementation of respiratory rehabilitation by medical staff. Clinical managers should take corresponding measures, continuously improve the rehabilitation management strategies for COPD, and promote the clinical application of the best evidence for respiratory rehabilitation.

Keywords: Apply evidence; COPD; Obstructive factors; Qualitative research; Respiratory rehabilitation; Theoretical domain framework

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1. Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable, and treatable chronic airway disease characterized by persistent airflow limitation. Its symptoms primarily include coughing, expectorating sputum, dyspnea, and fatigue, among others^[1]. Respiratory rehabilitation therapy, as a crucial component of chronic respiratory disease management, is currently considered one of the most effective non-pharmacological treatment options for COPD patients^[2,3]. Respiratory rehabilitation encompasses pulmonary function assessment, physical fitness assessment, respiratory training, exercise training, nutritional intervention, and psychosocial support. Studies have found that it can effectively alleviate symptoms of dyspnea and fatigue in patients, improve health-related quality of life and exercise tolerance, and enhance patients' perceived control over their disease^[4-6]. Currently, scholars both domestically and internationally have published numerous evidence summaries on respiratory rehabilitation for COPD patients^[7-11]. However, due to factors such as a lack of evidence-based concepts, the complexity of clinical work, and low patient awareness, there is a significant gap between evidence and clinical practice^[12,13]. Therefore, it is particularly important to comprehensively analyze the practical barriers encountered by healthcare professionals during the clinical implementation of respiratory rehabilitation and explore ways to overcome these barriers.

The Theoretical Domains Framework (TDF), developed in 2005, incorporates 128 theoretical constructs from 33 behavior change theories, ultimately forming 12 theoretical domains^[14,15]. It covers factors at social, organizational, and individual levels. As an interview framework or coding guide, it helps researchers comprehensively analyze the influencing factors (barriers and facilitators) of behavior change, demonstrating both practicality and scientific rigor.

This study, based on the TDF, employs a qualitative research method to analyze and explore the barriers faced by healthcare professionals in implementing respiratory rehabilitation behaviors, aiming to promote the effective application of evidence in clinical settings, optimize evidence-based respiratory rehabilitation practices, and thereby improve patients' pulmonary rehabilitation outcomes.

2. Subjects and methods

2.1. Subjects

October to December 2024, a purposive sampling method was used to select healthcare professionals from the respiratory department of a tertiary-level hospital in Shaanxi Province for interviews.

The inclusion criteria are as follows:

- (1) Having worked in the specialized department for 5 years or more;
- (2) Being familiar with the tasks involved in respiratory rehabilitation;
- (3) Providing informed consent and voluntarily participating in this study.

The exclusion criteria are as follows:

- (1) Medical staff on leave exceeding six months;
- (2) Medical staff undergoing further education or interns.

The sample size adhered to the principle of information saturation, ultimately involving interviews with 15 medical staff members. General information about the participants is detailed in **Table 1**.

Table 1. General information of participants (n = 15)

No.	Gender	Age (years)	Highest Degree	Professional Title	Years of Specialist Work
N1	Female	60	Bachelor's	Chief Physician	36
N2	Male	58	Master's	Chief Physician	29
N3	Male	42	Doctorate	Associate Chief Physician	14
N4	Female	40	Doctorate	Associate Chief Physician	11
N5	Female	34	Doctorate	Resident Physician	5
N6	Female	35	Doctorate	Resident Physician	7
N7	Female	49	Bachelor's	Associate Chief Nurse	26
N8	Female	45	Bachelor's	Senior Nurse	27
N9	Female	40	Bachelor's	Senior Nurse	20
N10	Female	34	Master's	Senior Nurse	9
N11	Female	35	Bachelor's	Senior Nurse	15
N12	Female	31	Bachelor's	Senior Nurse	10
N13	Male	27	Bachelor's	Nurse	5
N14	Female	28	Bachelor's	Nurse	5
N15	Female	28	Bachelor's	Nurse	6

2.2. Research methodology

2.2.1. Development of the interview outline

Based on a literature review, team members initially formulated an interview outline according to the research objectives and the TDF. Subsequently, they conducted pre-interviews with one doctor and one nurse, respectively, and finalized the interview outline after revising and adjusting certain sections. Details are provided in **Table 2**.

Table 2. Interview outline

Theoretical domain framework domain	Interview outline
Knowledge	Have you read and/or are you familiar with the guidelines for respiratory rehabilitation in COPD? If patients were to receive respiratory rehabilitation according to these guidelines, what aspects would be different from current clinical practices?
Skills	What difficulties do you anticipate in the clinical implementation of respiratory rehabilitation guidelines? What specific skills and professional training do you believe are necessary?
Social/professional role & identity	Do you see implementing these guidelines as compatible or in conflict with current clinical workflows? If there is conflict, please elaborate. Which clinical staff roles need to be involved for successful implementation?
Beliefs about capabilities (self-efficacy)	How confident are you in your ability to implement respiratory rehabilitation clinically?
Optimism (outcome expectations)	From your perspective, what are the potential benefits or drawbacks of implementing these guidelines for patients, the department, and healthcare staff?
Intentions (goals)	To what extent do you intend to implement these guidelines in clinical practice? What facilitating factors or barriers would encourage or discourage you from executing them?

Table 2 (Continued)

Theoretical domain framework domain	Interview outline
Memory, attention & decision processes	Under what specific circumstances do you think implementing the guidelines would be difficult? What are these difficulties? Please provide examples.
Environmental context & resources	What resources or equipment does your department currently provide for respiratory rehabilitation? What additional support do you think is needed?
Social influences	Which individuals or institutional norms within the department would influence your implementation of the guidelines? Whose opinions would encourage you, and whose would discourage you?
Emotion	How do you think implementing these guidelines would affect you emotionally? What would the psychological experience be like, and why?
Beliefs about consequences (norms)	What factors at the personal or departmental level would encourage or discourage you from implementing the guidelines in clinical practice?
Behavioral regulation	To promote the implementation of the guidelines, what aspects of the department do you think need to change (e.g., staffing, time, equipment)? Would you develop personalized respiratory rehabilitation training plans for patients?

2.2.2. Data collection, organization, and analysis

Data were collected through one-on-one, face-to-face semi-structured interviews. The two interviewers were nursing postgraduates who had undergone training in qualitative research methodology and possessed excellent communication skills. Prior to the formal interviews, the researchers contacted the participants, explaining the purpose and significance of the study. Upon obtaining consent, interviews were scheduled during the participants' free time in the department's demonstration classroom.

The interviews were conducted in a quiet environment and recorded. During the conversations, attention was paid to observing and recording the participants' facial expressions, tone changes, and body language. Each interview lasted between 30 and 60 minutes. Within 24 hours after the interviews, the audio recordings were transcribed into text, which was then sent back to each participant for verification, supplementation, or correction.

The two interviewers independently analyzed the data using Colaizzi's 7-step analysis method, categorizing specific themes and codes according to the relevant domains of the TDF. Finally, the text was further summarized and generalized. In cases of disagreement, team members discussed and reached a decision.

2.2.3. Quality control

Quality control was performed as outlined:

- (1) All members of the research team hold a bachelor's degree or higher and have over ten years of experience working in respiratory departments, possessing extensive clinical experience in managing patients with COPD;
- (2) The study adheres to the principle of maximizing differences, with interviewees varying in terms of work experience, educational background, and professional titles to ensure the representativeness of the data;
- (3) During the interviews, the interviewers maintained neutrality, primarily focusing on listening, while following the interview outline and encouraging interviewees to express themselves actively;
- (4) In the data analysis phase, the interviewers repeatedly read and deeply contemplated the textual data, prohibiting the inclusion of personal viewpoints.

3. Results

This study ultimately interviewed 15 participants, including 6 respiratory physicians and 9 respiratory nurses. Based on five domains (knowledge, social/professional roles and identity, motivation and goals, environmental factors, behavioral norms) out of the 12 domains in the TDF, the study analyzed the barriers faced by healthcare professionals in implementing respiratory rehabilitation in clinical settings.

3.1. Knowledge domain: Lack of respiratory rehabilitation knowledge and insufficient training

Healthcare professionals demonstrated inadequate familiarity with the summarized evidence-based practices of respiratory rehabilitation and lacked clinical experience. They were unclear about the specific operational steps for fitness assessment, respiratory muscle strength assessment, aerobic exercise, resistance training, and airway clearance techniques.

N6: “I have a basic understanding of respiratory rehabilitation knowledge, but I don’t conduct many exercise training programs for patients, and the training methods are relatively limited.” Two-thirds of the interviewees were unclear about the content of respiratory rehabilitation assessments for COPD patients and did not understand the purpose and significance of these assessments.

Over half of the interviewees simply interpreted respiratory rehabilitation as pursed-lip breathing and diaphragmatic breathing.

N10: “I often come across airway clearance techniques in the literature I read. I have a general understanding of what it entails, but when it comes to actually guiding patients, I’m at a loss and don’t know which method to choose.”

N13 and N15 indicated that they were only aware of the existence of airway clearance techniques but were unfamiliar with their principles and contents.

N11 and N12 said, “Monthly departmental learning and training sessions primarily focus on the treatment and nursing of respiratory diseases, with limited training on respiratory rehabilitation.”

3.2. Social/professional roles and identity: Insufficient self-recognition among healthcare professionals in implementing respiratory rehabilitation

Due to limitations in medical resources, most respiratory departments in domestic hospitals currently lack specialized rehabilitation therapists to provide respiratory rehabilitation guidance to patients. Consequently, healthcare professionals face issues such as ambiguous professional boundaries and a lack of confidence when implementing respiratory rehabilitation guidelines in clinical practice.

N5 stated, “Respiratory rehabilitation should ideally be conducted by professionally trained rehabilitation therapists. During health education sessions with patients, we only teach them some basic breathing exercises, making it difficult to provide in-depth guidance.”

N10 expressed that she always felt hesitant when conducting breathing exercises with patients.

N11 said, “When performing pulmonary function assessments and respiratory muscle strength evaluations, I worry that incorrect guidance methods may lead to inaccurate results.”

The three nurses with lower seniority all believed that their current professional expertise was limited and that they were unable to apply guideline evidence to provide professional rehabilitation training guidance to patients in clinical settings.

3.3. Motivation and goals: Low patient awareness and poor compliance in respiratory rehabilitation hinder the implementation of best evidence

During the process of adhering to respiratory rehabilitation evidence-based practices, healthcare professionals must tailor specific exercise prescriptions according to patients' wishes and needs. However, the majority of COPD patients are elderly, with low awareness and poor compliance regarding respiratory rehabilitation, which to some extent hinders the implementation of respiratory rehabilitation.

N7 stated, "Compared to respiratory rehabilitation, patients rely more on the therapeutic effects of medications. Whenever I visit the ward, patients most frequently ask about the functions of the medications. When I conduct health education and disseminate knowledge about respiratory rehabilitation, they only listen perfunctorily."

N10 expressed, "Respiratory rehabilitation requires long-term commitment.

Since most patients do not see immediate results, they become skeptical about respiratory rehabilitation, let alone persist with it."

3.4. Environmental factors: Inadequate instrumentation and facilities, as well as a lack of rehabilitation training venues and respiratory rehabilitation clinics

Environmental factors such as incomplete rehabilitation equipment, a lack of rehabilitation training venues, and the absence of respiratory rehabilitation clinics hinder the translation and application of evidence-based respiratory rehabilitation practices by healthcare professionals.

N2 stated, "Respiratory rehabilitation training encompasses a wide range of content, but due to insufficient instrumentation, currently, our department can only conduct inspiratory muscle training and airway clearance. Techniques such as inhaler guidance, diaphragmatic nerve electrical stimulation therapy, and cardiopulmonary exercise testing cannot yet be implemented."

N8 remarked, "Ideally, patients should be provided with a well-equipped, quiet, comfortable, and spacious rehabilitation training venue for a comprehensive physical fitness assessment and professional rehabilitation training guidance. However, due to departmental constraints, we can only conduct these in the ward, which indirectly affects the accuracy of assessment results and the adherence to rehabilitation training."

N3 and N4 expressed the hope for establishing a specialized respiratory rehabilitation clinic to provide convenient respiratory rehabilitation training guidance and continuous home follow-up management for patients with chronic respiratory diseases.

3.5. Behavioral norms: Lack of scientific and standardized respiratory rehabilitation management processes

Establishing a complete and scientific respiratory rehabilitation management flowchart can clearly define the responsibilities and roles of healthcare professionals and implement regular quality control supervision, effectively enhancing the level of respiratory rehabilitation services. However, the department has not yet established a standardized respiratory rehabilitation management process based on the best available evidence.

N9 said, "For COPD patients, there should be a unified operational standard based on the best evidence regarding what training can be conducted during the acute exacerbation phase, what training can be done during the stable phase, as well as the duration and intensity of exercise."

N3 stated, "Quality control management should be implemented during pulmonary function assessment and

physical fitness assessment, and managers should regularly supervise the rehabilitation training guidance process to enhance the professional skills of healthcare professionals in respiratory rehabilitation.”

4. Discussion

4.1. Strengthen respiratory rehabilitation knowledge reserves and create a favorable learning atmosphere

This study found that most healthcare professionals possess weak knowledge of respiratory rehabilitation and have a low level of understanding of the evidence-based practices in respiratory rehabilitation. They also lack confidence and communication skills when guiding patients through rehabilitation training.

These findings are consistent with those reported by Emma et al. and represent the primary obstacles to the implementation and promotion of respiratory rehabilitation services^[16]. Domestic scholars, such as Sun et al. conducted a survey of 112 community nurses in Beijing and found that nurses had poor mastery of the concepts and specific operations of COPD respiratory rehabilitation nursing and expressed a desire to participate in respiratory rehabilitation-related training^[17]. Additionally, research by Abdulelah et al. pointed out that the lack of well-trained respiratory therapists is the most common reason affecting patients’ access to respiratory rehabilitation referral services^[18].

In response, the following measures are recommended:

- (1) Strengthen the cultivation of professionals in respiratory rehabilitation by selecting key medical staff from departments for external advanced studies;
- (2) Incorporate knowledge of evidence-based practices in respiratory rehabilitation into daily departmental training and learning, develop systematic and detailed training plans, and conduct practical exercises in respiratory rehabilitation to create a favorable learning environment;
- (3) Teaching team leaders should strengthen supervision and guidance, regularly conduct quality assessments of medical staff to enhance the effectiveness of respiratory rehabilitation training.

4.2. Encourage the participation of patients’ family members

This study reveals that most patients have limited knowledge and poor comprehension of respiratory rehabilitation, making it challenging to persuade them of its importance. They also struggle to adhere to training during home-based rehabilitation, which, to some extent, undermines the confidence of healthcare professionals and hinders the implementation of evidence-based practices in respiratory rehabilitation.

The reasons for this include:

- (1) Disruption of patients’ previous treatment habits, compounded by smoking status and time constraints, leading to reluctance to continue rehabilitation training;
- (2) Limited social support from family and friends;
- (3) Psychological factors such as anxiety and depression, which affect self-management abilities.

Research has found that support from family members influences patient compliance^[19]. Xie et al. developed a family-involved respiratory rehabilitation program for COPD patients based on evidence-based practices^[20]. The results showed that a family-centered empowerment model for intervening with patients and their families effectively promoted the implementation of respiratory rehabilitation plans.

Therefore, encouraging the participation of patients’ family members can enhance patients’ awareness of

respiratory rehabilitation skills, provide them with psychological and social support, thereby improving their adherence to rehabilitation and facilitating the smooth implementation of evidence-based respiratory rehabilitation practices.

4.3. Improving hardware facilities and establishing scientific and standardized respiratory rehabilitation management processes

This study found that insufficient investment in hardware facilities such as respiratory rehabilitation assessment tools, rehabilitation training equipment, and environmental factors, as well as the lack of specific and clear operational standards, also hindered the clinical translation and application of evidence-based respiratory rehabilitation practices. In response, departmental management can coordinate internal resources to improve hardware facilities and equipment, such as the 6-minute walk test system, cardiopulmonary exercise testing equipment, precise diaphragm assessment and training systems, and external electrical stimulation technology.

Furthermore, respiratory rehabilitation clinics should be established, and remote medical services should be expanded in the future. Research by Shih-Ying et al. has shown that a web-based exercise management system can benefit COPD patients in terms of respiratory rehabilitation and continuous tracking^[21]. Additionally, departments should develop respiratory rehabilitation management processes that align with their specific circumstances based on evidence-based respiratory rehabilitation practices, clarifying the responsibilities and divisions of labor among healthcare professionals, standardizing specific operational requirements for patients' aerobic exercise, resistance training, airway clearance, etc., and ensuring the sustained and long-term effective implementation of the best evidence.

5. Conclusion

Based on the TDF, this study analyzed and identified five barriers affecting the clinical implementation of evidence-based respiratory rehabilitation practices by healthcare professionals and proposed three recommendations to provide references for the standardized clinical management of respiratory rehabilitation. The limitation of this study lies in the fact that the respondents were from the same department and failed to reflect the behavioral and psychological changes of healthcare professionals during the clinical implementation of respiratory rehabilitation evidence. Future longitudinal qualitative research can be conducted to continuously optimize the clinical application of evidence.

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Application of Traditional Chinese Medicine Hot Compress Package Combined with Kinesio Taping in Postoperative Nursing of Total Knee Arthroplasty

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Abstract: *Objective:* To explore the application of external application of Traditional Chinese Medicine (TCM) hot compress package combined with Kinesio Taping in postoperative nursing of total knee arthroplasty. *Methods:* 90 patients with severe knee osteoarthritis who underwent total knee arthroplasty in our department from January to December 2022 were randomly divided into two groups using a random number table method: one group was named the conventional group (n = 45), which received the standard orthopedic nursing process throughout, including basic pain management, incision care, and functional exercise guidance; the other group was defined as the experimental group (n = 45), which, in addition to the conventional nursing framework, incorporated the local transdermal drug delivery technique of TCM hot compress package and the biomechanical correction scheme of Kinesio Taping for collaborative intervention. Finally, the differences in postoperative resting/active pain scores (VAS) of the affected limb and satisfaction with nursing services between the two groups were compared using quantitative assessment tools. *Results:* The satisfaction with nursing care in the conventional group was significantly lower than that in the experimental group ($P < 0.05$); the VAS score after nursing in the conventional group was significantly higher than that in the experimental group ($P < 0.05$). *Conclusion:* The application of external application of TCM hot compress package combined with Kinesio Taping in postoperative nursing of total knee arthroplasty has a definite effect, reducing pain and improving patient satisfaction with nursing services.

Keywords: Acupoint hot compress; Application effect; Kinesio taping; Knee osteoarthritis

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1. Introduction

Total Knee Arthroplasty (TKA), as a key technology in the field of orthopedic reconstruction, aims to systematically alleviate pain symptoms and gradually restore joint biomechanical function by removing severely

degenerated anatomical structures of the knee joint and replacing them with biocompatible artificial prosthetic components. From the perspective of clinical practice, optimizing the therapeutic effects of TKA highly relies on three pillars: meticulous preoperative evaluation, precise intraoperative bone cutting and prosthesis positioning, and structured postoperative rehabilitation programs^[1].

Any oversight in these areas may lead to complications such as persistent postoperative pain, periprosthetic infection, or joint stiffness, significantly prolonging the functional recovery period and even raising doubts among patients about the value of surgical treatment. Therefore, the development of evidence-based perioperative care plans has become a core research topic in the modern orthopedics.

Kinesio Taping (KT) provides local support and reduces muscle or joint pressure through the traction of the skin and soft tissues by an elastic cloth, invented by Japanese physician Dr. Kenzo Kase^[2,3]. The mechanism of action of KT is not yet fully understood. Some studies suggest that KT enhances the stability of tissue structures, and the folds formed on the skin surface under tension increase the interstitial space in the subcutaneous tissue, improving circulation. Additionally, the elastic recoil of the KT after application stimulates stretch receptors, increasing sensory input and inhibiting pain signal transmission^[4].

This study found that this postoperative care method has significant clinical effects, providing a reference for clinical nursing practitioners.

2. Materials and methods

2.1. General information

90 patients with severe knee osteoarthritis who underwent TKA in the Orthopedics Department of our hospital from January 2022 to December 2022 were collected and randomly divided into a conventional group and an experimental group using a random number table method, with 45 patients in each group.

In the conventional group, there were 22 males and 23 females; aged between 43 and 73 years, with an average age of (57.79 ± 6.56) years; the affected limb locations were 21 on the left, 20 on the right, and 4 on both sides.

In the experimental group, there were 20 males and 25 females; aged between 45 and 72 years, with an average age of (58.09 ± 6.76) years; the affected limb locations were 18 on the left, 21 on the right, and 6 on both sides. There were no statistically significant differences in the baseline data between the two groups.

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

The inclusion criteria are as follows:

- (1) Meeting the diagnostic criteria for knee osteoarthritis as outlined in the “Guidelines for the Diagnosis and Treatment of Osteoarthritis” formulated in 2018^[5];
- (2) Kellgren-Lawrence Grade III to IV.

2.2.2. Exclusion criteria

The exclusion criteria are as follows:

- (1) Patients with other diseases that may affect the evaluation of nursing effectiveness, such as bone tuberculosis or bone tumors;
- (2) Patients with chronic diseases including cardiovascular and cerebrovascular diseases, liver diseases, severe

- pulmonary and renal diseases;
- (3) Patients with surgical contraindications;
 - (4) Patients who are blind, deaf, mute, or otherwise unable to communicate normally.

2.2.3. Dropout criteria

The dropout criteria are as follows:

- (1) Poor patient compliance;
- (2) Development of other significant diseases during hospitalization;
- (3) Withdrawal from the study due to various subjective or objective reasons.

2.3. Methods

2.3.1. Routine group

The routine perioperative nursing methods in the orthopedics department were employed.

2.3.2. Experimental group

Full-course nursing was provided using a combination of external application of a TCM hot compress package and KT.

A total of 5 grams each of frankincense and myrrh, 9 grams each of peach kernel, safflower, Chuanxiong (*Ligusticum chuanxiong*), and *Cyperus tuber*, and 10 grams each of angelica, scorpion, earthworm, and turmeric were selected and thoroughly mixed. They are then placed in a dense, breathable double-layered pure cotton cloth bag for encapsulation.

Before use, the herbal package was immersed in hot water at approximately 60–70°C for 30 minutes to ensure effective dissolution and penetration of the medicinal properties into the cloth bag fibers, achieving a uniformly damp state. Subsequently, the dampened herbal package was transferred into a constant-temperature wet hot compress device ($70 \pm 2^\circ\text{C}$) for 15–20 minutes to ensure the full activation and stable release of medicinal substances while avoiding skin burns or decomposition of active ingredients due to excessive heat.

After heating, the herbal package was removed and immediately wrapped in a clean, dry, thick cotton bath towel to buffer the heat, maintain humidity, and prevent burns. The wrapped herbal hot compress pack was placed on the selected acupoints with applied moderate pressure, combined with gentle techniques such as pressing, kneading, and vibrating to promote the penetration of the medicinal properties and the circulation of local Qi and blood. Each hot compress session lasted 20–30 minutes and was performed twice daily. During the procedure, the patient's skin reactions were closely observed to prevent burns. The herbal pack can be reused several times, but it is important to keep it clean and dry, replacing it with a new pack promptly when its efficacy diminishes.

Approximately 30 minutes after completing the external application of the TCM hot compress pack, when the skin was fully cooled and returned to normal, KT tape was applied to the swollen and painful areas of the affected limb as a continuation of physical therapy. This aims to further promote lymphatic drainage, reduce edema, alleviate pain, and provide mechanical support.

The specific procedure is as follows:

- (1) Carefully palpate the affected limb to identify 1-2 points of greatest subjective pain reported by the patient. Avoid any areas with rashes, skin breaks, unhealed wounds, or significant scar hyperplasia. Use a “Y”-shaped kinesiology tape. Centering on the pain point, apply the tape radially without tension from the center outward, forming an “X”-shaped cross-fixation. Rely on the elastic recoil force of the tape itself

to exert a slight lifting effect on the pain point and surrounding soft tissues, aiming to reduce local tissue pressure, improve microcirculation, alleviate stimulation of pain receptors, and provide a mechanical foundation for subsequent taping. The edges of the tape should be at least 1 cm away from the edges of the sterile dressing over the incision to ensure the sterile area remains undisturbed.

- (2) For areas with significant swelling around the surgical incision, guide the subcutaneous tissue fluid towards functionally normal lymph node groups using the tape. Use a specially designed “claw-shaped” tape. Apply the base of the tape with zero tension to the center of the nearest, functionally sound lymph node group in the target drainage area. Gently and naturally apply each tail of the “claw-shaped” tape with minimal tension in an arc towards the most swollen and painful area. Each tail should also end naturally on the skin with zero tension. Each taping session should last 24 hours, and continuous taping should be performed for 7 days. After exposure to water, use a towel to blot dry and avoid rubbing. If the edges curl, there is severe contamination, an allergic reaction occurs, or the patient perceives a decrease in effectiveness, the tape should be replaced promptly.

2.4. Observation indicators

2.4.1. VAS score

The doctor used a 10 cm rating scale, where scores ranging from 0 to 10 represent progressively increasing levels of pain. Patients indicated their own pain level by pointing to a score on the scale, with higher scores indicating more severe pain.

2.4.2. Nursing satisfaction

A self-administered nursing satisfaction questionnaire developed by the hospital was used, with three evaluation levels: satisfied, somewhat satisfied, and dissatisfied.

2.5. Statistical methods

Data was processed using R software. A *P*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. VAS score

Before treatment, there was no statistically significant difference in VAS scores between the two groups ($P > 0.05$). After treatment, VAS scores in both groups were lower than before treatment, and the VAS score in the experimental group was lower than that in the control group, with both differences being statistically significant ($P < 0.05$), as shown in **Table 1**.

Table 1. Comparison of VAS scores before and after nursing between the two groups (mean \pm SD)

Group	n	Before care	After care	t-value	<i>P</i> -value
Routine group	45	6.61 \pm 1.32	2.90 \pm 1.63	11.866	< 0.001
Experimental group	45	6.75 \pm 1.45	2.38 \pm 1.55	13.811	< 0.001
t-value		-0.479	1.551		
<i>P</i> -value		0.633	0.125		

3.2. Nursing satisfaction

Comparing nursing satisfaction between the two groups, the overall satisfaction rate in the experimental group reached 97.78%, while that in the conventional group was 66.67%. The difference was statistically significant ($P < 0.05$), as shown in **Table 2**.

Table 2. Comparison of nursing satisfaction between the two groups [n (%)]

Group	n	Satisfied	Fairly satisfied	Dissatisfied	Overall satisfaction
Routine group	45	19 (42.22)	11 (24.44)	15 (33.33)	30 (66.67)
Experimental group	45	31 (68.89)	12 (26.67)	1 (2.22)	44 (97.78)
χ^2 -value				14.899	
P -value				< 0.001	

4. Discussion

According to statistics, over 300 million people worldwide suffer from knee osteoarthritis (KOA), with a prevalence rate exceeding 22% among individuals over 40 years old ^[6]. In the early stage, conservative treatment should be the main approach, supplemented by non-steroidal anti-inflammatory drugs and analgesics to alleviate symptoms. For patients in the chronic phase, it is essential to actively engage in muscle exercises around the knee joint to enhance its stability. When the pain is severe and conservative treatment proves ineffective, surgical options can be considered, including arthroscopic debridement, reconstruction of the medial patellofemoral ligament, high tibial osteotomy, uni-compartmental knee arthroplasty, etc.

For patients with isolated patellofemoral arthritis, patellofemoral joint arthroplasty may be performed, while severe cases may require total knee arthroplasty. In daily life, it is important to establish reasonable daily activity patterns, such as protecting the affected knee joint, avoiding long-distance fatigue travel, mountain climbing, ascending and descending high-rise stairs, and various poor postures, such as prolonged standing, kneeling, and squatting.

Obese individuals should reduce their body weight, wear elastic braces to protect the joints, such as knee pads, avoid wearing high heels, and opt for soft, elastic “sneakers” with suitable insoles. For patients with medial compartment knee arthritis, wedge-shaped insoles can be used as an adjunctive treatment. During flare-ups, it is advisable to reduce the load on the affected joint and use aids like canes and walkers to assist with movement.

Simultaneously, engaging in joint muscle exercises, such as moderate aerobic activities like walking, swimming, and cycling, can help maintain joint function ^[7]. TKA is an effective intervention for clinically treating severe KOA. In 2018, the total number of knee arthroplasty cases in China was 249,000, while in 2019, over 370,000 patients underwent knee arthroplasty, with total costs exceeding 10 billion yuan ^[8]. However, due to the significant local tissue damage caused by TKA and the potential for postoperative inflammatory factors to induce sensitization of the central and peripheral nervous systems, patients often experience severe postoperative pain ^[9].

According to research on the disease course, 5% of patients even experience worsening pain 6 months after surgery ^[10]. Therefore, studying the mechanisms of postoperative pain and nursing strategies for TKA is of great importance.

The results of this study indicate that after TKA, the application of external herbal compress therapy combined with KT nursing treatment significantly reduced VAS scores compared to conventional nursing, with

statistically significant differences ($P < 0.05$). When comparing nursing satisfaction between the two groups, the experimental group achieved a total nursing satisfaction rate of 97.78%, while the conventional group had a total satisfaction rate of 66.67%, with statistically significant differences ($P < 0.05$).

This study demonstrates that the application of TCM hot compress packs combined with KT for nursing care after TKA effectively alleviates patient pain and enhances patient satisfaction with orthopedic nursing services at our hospital. The TCM hot compress pack used in our hospital contains a blend of medicinal ingredients, including olibanum, myrrh, peach kernel, safflower, *Ligusticum wallichii*, *Cyperus rotundus*, *Angelica sinensis*, scorpion, earthworm, and turmeric. Notably, olibanum and myrrh are often used together in clinical practice for their synergistic effects in promoting blood circulation, dispersing blood stasis, reducing swelling, and relieving pain.

Research has shown that the volatile oils of olibanum and myrrh act as natural amphiphilic penetration enhancers, facilitating the permeation of active ingredients. Meanwhile, curcumin in turmeric exhibits antioxidant, anti-inflammatory, antitumor, and neuroprotective properties. The combined effects of peach kernel and safflower complement each other, yielding a comprehensive action of “invigorating blood circulation, breaking up blood stasis, unblocking meridians, and relieving pain,” thereby enhancing the potency of blood circulation promotion and meridian regulation. Peach kernel is particularly effective in “breaking up blood stasis,” penetrating deeply into the blood to dissolve severe clots, while safflower excels in “unblocking meridians,” clearing obstructed blood flow within the channels. Together, they eliminate stagnant blood and promote smooth circulation, making them suitable for various conditions characterized by blood stasis obstruction and achieving the effect of “relieving pain without leaving stasis.”

The core of the *Ligusticum wallichii*-*Cyperus rotundus* herb pair lies in “simultaneously regulating Qi and promoting blood circulation,” with *Cyperus rotundus* focusing on Qi regulation and *Ligusticum wallichii* emphasizing Qi movement and blood activation. This combination not only addresses the root cause of Qi stagnation but also aids Qi circulation through blood activation, preventing prolonged Qi stagnation from leading to blood stasis.

The *Angelica sinensis*-scorpion-earthworm herb pair is beneficial for promoting blood circulation. Our research team has analyzed the synergistic mechanisms of these multi-component drugs, which manifest in three progressive layers:

- (1) Targeted stimulation of local skin and mucosal capillary networks by active ingredients significantly enhances vascular endothelial dilation function, leading to compensatory expansion of microcirculatory vessel diameters;
- (2) Based on vascular dilation, it elevates the interstitial osmotic pressure gradient, accelerating the transmembrane transport efficiency of drug molecules and achieving directional optimization of bioavailability in the lesion area;
- (3) By regulating local arterial microcirculatory perfusion and lymphatic pump function, it systematically clears inflammatory exudates and metabolic waste, ultimately achieving a gradual resolution of inflammatory swelling and bidirectional inhibition of nociceptive pain transmission pathways.

The core therapeutic value of KT lies in its unique biomechanical rebalancing and fascial regulation mechanisms. Through its special weaving process, KT generates a continuous directional retraction force after application. This mechanical effect exerts a gentle traction on the epidermis and subcutaneous connective tissue. By altering the relative positional relationship between the skin and deep fascia, it effectively reduces the viscous resistance between fascial layers, enhances fascial sliding ability, and increases the permeability of interstitial

spaces. This promotes the circulation of interstitial fluid and the clearance of metabolic waste, significantly reducing the local accumulation and stimulation of pain-inducing substances. The retraction force of the tape creates small interstitial spaces beneath the skin, reducing interstitial pressure and improving the functional status of microvessels and lymphatic vessels, thereby creating a favorable microenvironment for tissue repair in the injured area.

Continuous low-intensity stimulation promotes the release of endogenous analgesic substances, downregulates central sensitization levels, and ultimately raises the local pain threshold at the affected site, achieving long-lasting pain relief. The “wrinkle effect” formed by directional skin traction enlarges the subcutaneous tissue space, accelerates the centripetal reflux of lymphatic fluid, and reduces the compressive stimulation of inflammatory edema on nerve endings. Pain reduction alleviates reflexive muscle spasms and improves local blood flow; concurrently, the resolution of edema reduces tissue metabolic stress, forming a virtuous cycle of “edema reduction-pain cessation” that facilitates the functional recovery of the affected limb. This provides a valuable reference for nursing professionals.

5. Conclusion

In conclusion, the integrated application of TCM hot compress packs and KT demonstrates a definite effect in the postoperative nursing of patients undergoing total knee arthroplasty. This combined intervention effectively reduces postoperative pain and enhances patient satisfaction with nursing services. Therefore, it represents a valuable, non-pharmacological approach worthy of clinical promotion in postoperative TKA care.

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Disclosure statement

The authors declare no conflict of interest.

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Application Effect of SECI Program in Improving Clinical Nurses' Information Teaching Ability

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Abstract: *Objective:* To investigate the application effect of the SECI theoretical model-based training program in enhancing clinical nursing teachers' information-based teaching capabilities. *Methods:* A self-control study design was adopted, with 124 clinical nursing teachers from a tertiary hospital participating in the SECI training program from January 2024 to June 2025. The program was implemented through four stages: "Establishing Teacher Community (Socialization)", "Case Teaching (Extravagant)", "Integration of Discipline and Research (Fusion)", and "Routine Application of Teaching (Implicit)". Self-designed questionnaires were used to assess teachers' information-based teaching capabilities before and after training, covering four dimensions: awareness and attitude towards information-based teaching, foundational skills, teaching practice, and professional practice. Data analysis was performed using SPSS 26.0. *Results:* Post-training, the total score of clinical nursing teachers' information-based teaching capabilities increased from (53.47 ± 15.56) to (78.92 ± 12.34) , showing statistically significant differences ($t = 15.732, P < 0.001$). Scores in all dimensions also showed significant improvements ($P < 0.05$). Multivariate linear regression analysis revealed that educational background ($\beta = 0.198, P = 0.026$) and professional title ($\beta = 0.184, P = 0.040$) were primary influencing factors for pre-training information-based teaching capabilities, while their impact weakened post-training. *Conclusion:* The training program based on SECI theory effectively enhances clinical nursing educators' digital teaching capabilities. Its structured, spiral-up knowledge transformation process helps bridge competency gaps among teachers from diverse backgrounds, facilitates the mutual conversion and deep integration of tacit and explicit knowledge, and provides a practical new model for developing digital teaching competencies in clinical nursing education.

Keywords: Clinical nursing teachers; Effect evaluation; Information-based teaching ability; SECI model; Training program

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1. Introduction

With the deepening implementation of the "Education Informatization 2.0 Action Plan" and the "National Nursing Development Plan (2021–2025)", the deep integration of information technology with education has become the core driving force for educational reform in the new era^[1]. As a critical component of nursing education,

clinical nursing teaching directly determines the quality of future nursing professionals. Clinical instructors, as primary educators, require strong digital pedagogical capabilities ^[2]. However, research indicates that current digital teaching practices among Chinese clinical instructors face challenges including insufficient emphasis, uneven application distribution, and theoretical-practical disconnection, with widespread issues of superficial understanding, simplistic implementation, and fragmented training ^[3-4].

Traditional training models often focus on isolated skill instruction, failing to systematically enhance teachers' ability to integrate technology into specific teaching scenarios. The SECI Knowledge Transfer Theory Model, proposed by Norichiro Yano, describes a spiral innovation mechanism where tacit and explicit knowledge evolve through four processes: socialization, externalization, combination, and internalization. This model emphasizes knowledge transformation within community interactions and practical contexts, providing a solid theoretical framework for teacher training.

Based on SECI theory, this study aims to construct and implement a systematic training program for clinical nursing teachers, and verify its application effect in improving their information teaching ability, so as to provide empirical basis and strategic reference for the development of clinical nursing education informatization.

2. Data and methodology

Using convenience sampling, we recruited 124 clinical nursing instructors from the neurocritical care unit of a Grade III-A hospital between January 2024 and June 2025.

The inclusion criteria are as follows:

- (1) Hold clinical nursing instructor certification;
- (2) Provide informed consent and voluntary participation.

The exclusion criteria are participants who withdrew during the study period due to leave or resignation. The study was approved by the hospital's ethics committee, and all participants signed informed consent forms.

2.1 Study design

A quasi-experimental design with front-back contrast was adopted.

2.2. SECI training program development and implementation

Based on the training needs revealed by literature analysis and previous questionnaire survey results, the research group constructed a 6-month SECI training program, which is as follows:

- (1) Socialization by establishing a teacher community. The 124 teachers were divided into groups based on teaching styles and interests to form a learning community. Expert teachers initiated thought-provoking questions (such as "What information technology resources can be utilized in nursing skills instruction?") to guide members through brainstorming sessions and experience-sharing, facilitating the transfer of tacit knowledge within the group.
- (2) Explicit through case teaching and discussion. Expert teachers provide exemplary digital teaching cases (such as MOOC videos and micro-lectures), guiding educators to analyze their design concepts, strengths/weaknesses, and technological integration points. Subsequently, teachers independently design teaching materials and present them within groups, undergoing self-evaluation, peer review, and expert feedback. This process transforms individual tacit teaching knowledge into shareable explicit instructional solutions.

- (3) Integration of disciplinary teaching and research by organizing teaching seminars, lesson plan design competitions, and related activities to encourage teachers to systematize and organize their existing explicit knowledge into standardized teaching resource packages (such as digital lesson plan repositories and micro-lecture collections). These resources are then uploaded to platforms like WeChat groups and nursing management systems for sharing, thereby achieving the integration and networking of explicit knowledge.
- (4) Internalization through routine application of teaching by conducting teaching demonstration classes and practical teaching scenarios to create authentic instructional environments. Teachers apply their acquired knowledge to actual teaching practices through the “practice-reflection-improvement” cycle, transforming explicit knowledge into unique, transferable digital teaching competencies. This process achieves a spiral progression in knowledge transformation.

2.3. Evaluation tools and indicators

The evaluation was conducted using the “Clinical Nursing Faculty Information Technology Teaching Competency Questionnaire” independently designed by the research team. Developed based on the “Information Technology Teaching Indicator System for Nursing Majors”, this questionnaire demonstrated good content validity with a Cronbach’s α coefficient of 0.92.

The questionnaire comprises 52 items across four dimensions: awareness and attitudes toward IT teaching (8 items), foundational knowledge and skills (14 items), teaching practice (19 items), and professional practice (11 items). Each item uses a 5-point Likert scale, with total scores ranging from 52 to 260 points. For ease of interpretation, all scores were converted to percentage-based scores. Higher scores indicate stronger capabilities in information technology-assisted teaching.

3. Results

3.1. General situation of clinical nursing teachers and pre-training ability score

This study surveyed 124 clinical nursing educators, with 119 female (95.97%) and 5 male (4.03%). The majority were aged 31–35 (76 participants, 61.29%), had 6–10 years of teaching experience (72 participants, 58.06%), held bachelor’s degrees (78 participants, 62.90%), and were primarily registered nurses (77 participants, 62.10%). Their pre-training information-based teaching competency scores averaged 53.47 ± 15.56 points, with detailed breakdowns across dimensions shown in **Table 1**.

Table 1. Scores of each dimension of information-based teaching ability of clinical nursing teachers before training (n = 124, mean \pm SD)

Project	Number of entries (items)	Score (points)	Article average score (points)
Awareness and attitude towards information-based teaching ability	8	20.86 ± 7.66	2.61 ± 1.18
Basic information teaching and skills	14	38.65 ± 10.38	2.76 ± 1.08
Information-based teaching practice	19	50.33 ± 15.16	2.65 ± 1.08
Information-based vocational practice	11	29.17 ± 8.95	2.65 ± 1.09
Total points	52	53.47 ± 15.56	2.67 ± 1.10

3.2. Single factor analysis of information teaching ability score before training

One-way factor analysis showed (**Table 2**) that the differences in information teaching ability scores of clinical nursing teachers with different ages, teaching years, educational background and professional titles were statistically significant ($P < 0.05$), while the differences between genders were not statistically significant ($P > 0.05$).

Table 2. One-factor analysis of information teaching ability scores before training (n = 124)

Project	Classification	Number of people (%)	Score of information-based teaching ability	Statistic	P
Sex	Man	5 (4.03)	54.38 ± 11.59	t = 0.134	0.894
	Woman	119 (95.97)	53.43 ± 15.74		
Age	25–30 years	11 (8.87)	49.86 ± 21.75	F = 5.629	0.001
	31–35 years	76 (61.29)	50.62 ± 12.10		
	36–40 years	32 (25.81)	62.58 ± 17.59		
	Over 40	5 (4.03)	46.31 ± 14.19		
School age	1–5 years	14 (11.29)	48.13 ± 19.25	F = 4.815	0.003
	6–10 years	72 (58.06)	51.02 ± 11.56		
	11–15 years	32 (25.81)	61.95 ± 18.86		
	15 years and more	6 (4.84)	50.06 ± 15.79		
Record of formal schooling	Junior college education	13 (10.48)	46.66 ± 17.05	F = 4.397	0.014
	Undergraduate course	78 (62.90)	52.00 ± 12.11		
	Postgraduate and above	33 (26.61)	59.62 ± 20.14		
Professional ranks and titles	Nurse	12 (9.68)	57.53 ± 22.57	F = 7.310	0.000
	Primary nurse	77 (62.10)	49.43 ± 10.12		
	Nurse-in-charge	29 (23.39)	58.33 ± 16.25		
	Associate chief nurse or above	6 (4.84)	73.72 ± 29.70		

3.3. Linear regression analysis of influencing factors of information teaching ability before training

Multiple linear regression analysis was conducted using significant variables from the univariate analysis (age, teaching experience, educational background, and professional title) as independent variables. The results showed that educational background and professional title were the main positive influencing factors for information-based teaching ability before training ($P < 0.05$), as shown in **Table 3**.

Table 3. Linear regression analysis of influencing factors of information teaching ability before training

Variable	Method of assignment
Age	25–30 years = 1, 31–35 years = 2, 36–40 years = 3, over 40 years = 4
School age	1–5 years = 1, 6–10 years = 2, 11–15 years = 3, over 15 years = 4
Record of formal schooling	Specialty = 1, undergraduate = 2, graduate and above = 3
Professional ranks and titles	Nurse = 1, nurse assistant = 2, associate chief nurse = 3, deputy chief nurse and above = 4

3.4. Comparison of training effects before and after SECI program

After the training, the total score and each dimension score of clinical nursing teachers' information teaching ability were significantly improved compared with that before the training, and the difference was extremely significant ($P < 0.001$), as shown in **Table 4**.

Table 4. Comparison of information teaching ability scores before and after clinical nursing teacher training (n = 124, mean \pm SD)

Argument	Regression coefficient	Standard error	Standardized regression coefficient	t price	P
Constant	23.869	6.993		3.413	0.001
Age	0.719	2.709	0.031	0.265	0.791
School age	3.303	2.502	0.152	1.320	0.189
Record of formal schooling	5.214	2.309	0.198	2.258	0.026
Professional ranks and titles	4.166	2.009	0.184	2.074	0.040

4. Discussion

The research findings demonstrate that implementing the training program based on the SECI theory has led to a comprehensive and significant improvement in clinical nursing instructors' information-based teaching capabilities ($P < 0.001$, **Table 4**). This outcome fully validates the effectiveness and applicability of the SECI model as a systematic knowledge creation framework in clinical faculty development.

Prior to the training, clinical nursing instructors at our hospital demonstrated moderate-to-low competency in information technology-based teaching (total score 53.47), consistent with findings from Huang et al.^[3]. This reflects the prevalent challenges faced by clinical educators in deeply integrating information technology into teaching practices.

Multivariate linear regression analysis revealed that academic qualifications and professional titles were key determinants of pre-training competencies. Those with higher education degrees and senior professional titles generally exhibit stronger self-directed learning capabilities and richer teaching experience, which provides them with advantages in acquiring, understanding, and initially applying information technology. These findings highlight the uneven development of competencies under traditional training models, potentially leading to a Matthew effect where "the strong get stronger."

The success of the SECI training program lies in its effective resolution of this stalemate. Its effectiveness mechanism may stem from the following aspects:

- (1) The teacher community established during the "socialization" phase creates a safe "field" that stimulates teachers' enthusiasm for sharing tacit teaching experiences and techniques, addressing the issue of "fragmented training";
- (2) Through case study discussions and resource integration during the "externalization" and "integration" phases, experts and core teachers transform their excellent experiences into replicable and disseminated explicit knowledge (such as standardized lesson plans and micro-lectures), providing all teachers with concrete learning models and resource support. This bridges the gap in resource access caused by academic qualifications and professional titles, tackling the challenge of "uneven application distribution";
- (3) The "internalization" phase emphasizes regular teaching application and practical reflection, compelling

teachers to internalize the acquired explicit knowledge as their own “practical knowledge” in real teaching scenarios. This truly achieves the leap from “possessing technology” to “effectively utilizing technology,” resolving the core pain point of “the disconnect between theory and practice.”

This “practice-reflection-internalization” cycle is key to the upward spiral of knowledge, promoting the formation of teachers’ comprehensive application of “big capabilities.” The limitations of this study are that the samples were obtained from a single center without a control group, and a multi-center randomized controlled study should be conducted in the future to further verify the universality of the protocol. In addition, the long-term effect needs to be tracked to observe the persistence of improved ability.

5. Conclusion

This study demonstrates that training programs developed under the SECI theory framework can significantly enhance clinical nursing educators’ digital literacy. Through a systematic knowledge transformation process, these programs not only facilitate the cyclical conversion between teachers’ tacit and explicit knowledge while advancing their professional capabilities, but also foster a collaborative learning culture via community-based learning and resource sharing. This approach provides a practical solution to bridge the digital divide among educators with diverse backgrounds and systematically addresses challenges in improving digital teaching competencies for clinical nursing education. It is recommended to widely adopt this model in future nursing faculty training programs to continuously drive high-quality development of digital transformation in clinical nursing education.

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The Application of O-AMAS Teaching Model Combined with PBL Teaching in the Clinical Teaching of Neurocritical Care Trainee Nurses

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Abstract: *Objective:* This study's purpose is to explore the application of the O-AMAS teaching model combined with the PBL teaching method in the clinical teaching of neurocritical care trainee nurses. *Methods:* The nursing students who were doing internship in neurocritical care from June 2024 to September 2024 were set as the control group, and the traditional one-on-one teaching mode was adopted; From October 2024 to January 2025, the nursing students were set as the observation group and the course teaching based on the O-AMAS teaching model combined with PBL teaching was implemented. *Results:* The theoretical examination scores, operational assessment scores, teaching satisfaction, autonomous learning ability and clinical evaluation thinking ability of the two groups of nursing students were observed. The score of the experimental group was significantly higher than that of the control group (all $P < 0.01$). *Conclusion:* The application of the O-AMAS teaching model combined with PBL teaching in the clinical teaching of neurocritical care intern nursing students can improve the teaching effect and cultivate the autonomous learning ability and clinical evaluation thinking ability of nursing students.

Keywords: Clinical critical thinking; Neurocritical care trainee nurse; O-AMAS teaching model; PBL teaching method; Self-directed learning ability

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1. Introduction

A Neurointensive care unit is a medical unit dedicated to treating and managing patients with severe neurological disorders, mostly treating acute and critical cases with a high risk of death or disability^[1-3]. In the course of clinical practice, nursing staff need to have a systematic grasp of various specialized techniques in neurointensive care, possess a solid professional theoretical foundation and excellent specialized technical operation skills, so as to make correct judgments, evaluations and treatments in response to changes in the condition, thereby solving the problem^[4, 5]. However, newly graduated nursing students have poor practical ability to apply theoretical

knowledge to practice and have difficulty dealing with complex changes in the condition ^[6,7]. At present, the traditional teaching model for neurocritical care trainee nurses mainly focuses on imparting knowledge, with low initiative in learning and weak autonomous learning ability ^[8].

The result-oriented (O-AMAS) effective teaching model, developed by the effective Teaching team of Nankai University, consists of five elements: teaching objectives, interest activation, diversified teaching, effective assessment, and summary evaluation ^[9]. The project is goal-oriented, promotes teaching through teacher-student interaction, strengthens process evaluation, and achieves the synergy of precise teaching and students' independent exploration and thinking development. The research has received a good response in China ^[10, 11]. PBL teaching is an interactive teaching model that takes learners as the main body and explores through clinical cases, guiding nursing students' teaching with questions to cultivate their learning ability ^[12]. This study combined the O-AMAS effective teaching model with the PBL teaching method and applied it to neurocritical care trainee nursing students to explore its effect on clinical critical thinking and self-directed learning ability of trainee nursing students, providing a reference for the reform of clinical nursing teaching.

2. Subjects and methods

2.1. Research subjects

Nursing students in neurocritical care at a tertiary grade A general hospital were selected as the research subjects, and 37 nursing students from June 2024 to September 2024 were selected as the control group for traditional teaching. With 35 nursing students from October 2024 to January 2025 as the experimental group, on the basis of the traditional teaching model, the O-AMAS effective teaching model combined with the PBL teaching method was applied to the internship teaching.

The inclusion criteria are as follows:

- (1) Internship duration in neurocritical care ≥ 4 weeks;
- (2) Informed and voluntary participation in this study.

The exclusion criteria are nursing students who did not complete the departmental internship in full. There were 72 students in the observation group and the control group, and 70 valid answers were excluded. There was no statistically significant difference in gender, age, and admission scores between the two groups of nursing students. This study was approved by the hospital ethics committee (approval number: 2024-04-006-K01).

2.2. Study methods

2.2.1. Teaching objectives

This study follows the SMART principle (i.e., specific - measurable - achievable - realistic - time-bound) when formulating the teaching objectives, and sets specific teaching objectives based on the six aspects of the educational objectives in Bloom's cognitive domain ^[13,14]. Take traumatic brain injury as an example:

- (1) Memorization: Be able to accurately recall the clinical manifestations, complications and key points of care of traumatic brain injury;
- (2) Comprehension: Be able to explain the changes in the patient's condition and the causes, and understand the principles, procedures and precautions of nursing operations;
- (3) Application: Be able to apply theoretical knowledge to implement nursing measures correctly in actual nursing work, and be able to perform nursing operations using neurocritical care equipment;

- (4) Analysis: Be able to distinguish the key points and differences of care for the disease, analyze the patient's condition data, and determine the development trend of the patient's condition;
- (5) Evaluation: Be able to assess the effect of care, optimize the plan and make suggestions for improvement;
- (6) Creation: Be able to design personalized neurocritical care plans based on the specific circumstances of patients with traumatic brain injury and propose improvement measures for care methods.

2.2.2. Teaching methods

The control group adopted the traditional teaching method based on one-on-one knowledge transmission by the teaching instructor according to the teaching syllabus and requirements of the internship. The teaching instructor first previewed the relevant theoretical knowledge and then explained the key knowledge content in combination with common diseases of neurocritical care. Under the guidance of the instructor, the trainee nursing students completed the internship tasks in neurocritical care.

Teaching was carried out using the PBL teaching method based on the O-AMAS effective teaching model. Under this program, the teaching instructor carried out the teaching of clinical nursing students in accordance with the internship syllabus and requirements, and completed the internship tasks of neurocritical care.

The teaching instructor, based on teaching, combined with clinical practice, uses multimedia to bring in the context, and through multimedia fun guidance, arouses the interest of nursing students in learning, and encourages nursing students to discover and collect clinical problems of patients in the process of caring for patients. In the teaching process, modern teaching methods are integrated and real clinical scenarios are designed to make the teaching content both vivid and interesting as well as close to clinical practice. Based on the problems that arise from simulated discussions, and with the guidance of clinical instructors, nursing students are divided into groups of 4 to 6 people, who search for literature through retrieval platforms, read books, consult experts to solve problems, and discuss the collected answers with each other. At the same time, through forms such as role-playing, case discussions, and skills competitions, ensure that each nursing student can actively participate.

Teachers, in accordance with the syllabus, flexibly apply various teaching methods such as lecture, case study, and situational simulation, and promote comprehensive learning activities such as independent inquiry, experiential practice, and collaborative interaction among nursing students through problem-driven approaches. For example, the clinical nursing problems of patients are presented based on cases, and students are encouraged to simulate each other to conduct clinical operation training in the laboratory, integrating the basic and specialized operations of neurocritical care.

For instance, the key points of observing patients with brain herniation are introduced through TV plots, enabling students to learn how to observe pupils and consciousness in order to improve their clinical practical operation ability. For example, through the case of the care of a patient with intracranial hypertension, the group members draw lots to determine different roles (nurse, patient, doctor, etc.), and the nursing students raise relevant questions based on the drawn roles, solve them and perform them. During the summary and review stage of the learning, the instructor raises questions, and the students answer questions by means of group mutual comments, "passing the flower", question chain, etc., guiding the students to review the pathophysiological mechanism, clinical manifestations, treatment plan and personalized nursing measures of the medical record. The teacher emphasizes the key points of disease observation, complication prevention and emergency handling procedures based on the students' responses.

After learning about common neurocritical conditions through case studies, bedside teaching, and group

discussions, nursing students take online tests to assess their learning outcomes. Affirm the knowledge points that students have mastered, and provide individualized tutoring for those who have not met the standards. Analyze the weak points of the wrong questions and provide targeted guidance, and encourage intensive review. After the teaching ward round, the instructor focused on analyzing and guiding the mistakes and ambiguity in the discussions of the nursing students, and evaluated their performance and ability to formulate nursing plans.

After the clinical teaching session, the instructor and the nursing students conducted a systematic learning summary, focusing on the core concepts, diagnostic criteria, and key points of care for common neurocritical illnesses, including cerebral hemorrhage, subarachnoid hemorrhage, severe craniocerebral injury, ischemic stroke, etc., with particular emphasis on key points of disease observation, complication prevention, and emergency response procedures. Guide the nursing students to systematically sort out the solutions to clinical problems using the SOAP model and cultivate their clinical thinking ability.

For questions with a high error rate, senior instructors will give special lectures using the three-step teaching method of “error tracing - knowledge point analysis - clinical connection” to help nursing students deeply understand the reasons for errors and strengthen the memory and application of knowledge points. At the same time, an error file is established to provide a basis for subsequent teaching improvement and to achieve the teaching goal of “promoting learning through testing and teaching through evaluation”.

2.3. Evaluation methods

2.3.1. Theoretical and operational assessment results

The theoretical assessment is strictly based on the requirements of the internship syllabus. The examination is conducted in a standardized closed-book format, with a full score of 100 points and a time limit of 60 minutes. The examination and scoring process ensures standardization and fairness. The operation assessment is carried out strictly in accordance with the standard operating procedures (SOP), and is supervised and evaluated by the instructor in a real medical setting where clinical conditions permit. When the clinical environment fails to meet the assessment requirements, simulation mannequins are used for operation evaluation. The assessment scoring system is based entirely on quantified indicators of standardized operating procedures to ensure objectivity and consistency of the assessment results.

2.3.2. Teaching satisfaction

Nursing student satisfaction consists of indicators such as teaching attitude and responsibility, professional ability and teaching level, teaching management and arrangement, and learning environment. Teacher satisfaction is measured by clinical instructors who fill out standardized satisfaction survey scales based on multiple indicators such as the students' mastery of professional knowledge, clinical skill operation level, professional quality performance, and learning attitude during the internship.

2.3.3. Clinical reasoning ability scale and autonomous learning ability scale

The “Nurse Clinical Reasoning Ability Scale” revised by Wang is evaluated using the Likert 5-point scoring method, consisting of 15 items (1 point very dissatisfied; 2 points dissatisfied; 3 points average; 4 points satisfied; 5 points very satisfied)^[15]. It has a Cronbach's coefficient of 0.867, indicating good reliability.

The Self-directed Learning Ability Scale for Nursing Students, revised by Wu, consists of 20 items in four dimensions (learning motivation, planning and implementation, self-management, interpersonal communication),

and is scored on five grades: “strongly disagree 1 point, disagree 2 points, average okay 3 points, agree 4 points, strongly agree 5 points” [16]. The Cronbach’s α coefficient of the total scale was 0.914, indicating good reliability and validity.

2.4. Statistical methods

The data were analyzed using SPSS 20.0 software. The mean and standard deviation (SD) were used for the scores of students’ practical and theoretical performance and the evaluation score of teaching satisfaction. The two independent samples t-test was used for comparison between groups, with a test level of $\alpha = 0.05$.

3. Results

3.1.1. Comparison of theoretical and practical examination results between the two groups of nursing students

The theoretical and practical examination scores of the experimental group were both higher than those of the control group ($P < 0.05$), as detailed in **Table 1**.

Table 1. Examination results of the two groups of trainee nurses (n, mean \pm SD)

Group	Number of people	Theoretical grades	Operation grades
Control group	35	84.04 \pm 5.28	93.14 \pm 1.97
Experimental group	35	86.71 \pm 4.73	94.17 \pm 2.13
<i>t</i>		-2.232	-2.093
<i>P</i>		0.029	0.04

3.1.2. Comparison of student satisfaction and instructor satisfaction between the two groups

For both groups of trainee nurses, the satisfaction of teachers and students in the experimental group was better than that in the experimental group, as shown in **Table 2**.

Table 2. Satisfaction of the two groups of nursing students (n, mean \pm SD)

Group	Number of people	Nursing student satisfaction	Satisfaction of the teaching instructor
Control group	35	92.54 \pm 3.24	85.14 \pm 3.37
Experimental group	35	94.49 \pm 2.77	89.45 \pm 6.37
<i>t</i>		-2.689	-3.515
<i>P</i>		0.009	0.001

3.1.3. Comparison of clinical reasoning ability and autonomous learning ability between the two groups of nursing students

The clinical reasoning ability and self-directed learning ability of the experimental group were superior to those of the experimental group ($P < 0.05$), as shown in **Table 3** and **Table 4**.

Table 3. Comparison of clinical reasoning ability between the two groups of trainee nurses

Group	Number of people	Clinical reasoning ability
Control group	35	51.80 ± 5.22
Experimental group	35	61.03 ± 9.59
<i>f</i>		5.59
<i>P</i>		0.021

Table 4. Comparison of autonomous learning ability between two groups of trainee nurses

Group	Number of people	Learning motivation	Planning and implementing	Self-management	Interpersonal communication
Control group	35	22.69 ± 2.39	18.80 ± 2.59	18.00 ± 1.78	15.26 ± 1.27
Experimental group	35	26.09 ± 3.16	20.63 ± 3.66	20.86 ± 3.01	16.74 ± 1.38
<i>f</i>		7.745	5.514	12.131	0.93
<i>t</i>		-5.084	-2.412	-4.831	-4.691
<i>P</i>		< 0.001	0.019	< 0.001	< 0.001

4. Discussion

4.1. The O-AMAS effective teaching model combined with the PBL teaching program can improve the theoretical and operational assessment results of neurocritical care trainee nurses

The results of this study showed that the O-AMAS effective teaching model, through clear teaching objective setting, diversified teaching activity design and systematic teaching evaluation system, constructs a complete teaching loop, which not only effectively promotes the achievement of teaching objectives, but also significantly improves teaching quality and learning outcomes^[17]. In clinical practice teaching, instructors create problem situations in combination with real clinical cases to guide nursing students to think actively and explore deeply.

This immersive learning experience significantly enhances the depth of knowledge understanding and the persistence of memory^[6]. The results of this study fully confirm the superiority of the O-AMAS effective teaching model combined with the PBL teaching program in improving the clinical teaching effect of neurocritical care and provide an effective teaching paradigm for cultivating high-quality neurocritical care nursing talents.

4.2. The O-AMAS effective teaching model combined with the PBL teaching program can effectively improve the evaluation of practical teaching

Research shows that in traditional clinical teaching for intern nursing students, there is less integration of theory and practice, and nursing students are often in a passive learning state, which leads to burnout of clinical learning among nursing students in traditional teaching. This study applied the teaching model to clinical teaching, oriented towards the learning outcomes of nursing students, and driven learning through positive interaction between teachers and students. The initiative and participation of the nursing students were significantly enhanced during the teaching process, creating a positive interactive teaching atmosphere and effectively stimulating the teaching enthusiasm of the instructors^[11]. Two-way positive interaction enhanced teaching quality and promoted harmony

between teachers and students. It was observed that nursing students were more engaged in discussion, analysis and operation, which led teachers to optimize teaching and formed a virtuous cycle of “mutual growth”.

4.3. The O-AMAS effective teaching model combined with the PBL teaching program can enhance the clinical reasoning and autonomous learning ability of nursing students

In traditional clinical practice teaching, nursing students often have to rely solely on cognitive logical reasoning to deal with complex clinical situations, and this single teaching method can easily lead to a dull learning process. Especially for nursing students with insufficient professional knowledge, they often feel powerless when facing complex clinical problems and are prone to frustration, which in turn affects their enthusiasm for learning and self-confidence. This teaching program guides nursing students to use critical thinking to analyze cases through heuristic questioning, encourages personalized solutions, highlights the student-centered teaching concept, cultivates clinical thinking and problem-solving abilities, and promotes the exchange of views and deepens the understanding of professional knowledge through collaborative learning^[11].

Clinical practice instructors have individual differences, and teaching methods are not uniform^[16]. The focus of this study is on the nursing students themselves. Through the guidance of the instructor, the interest of the intern nursing students is aroused, and the nursing students participate^[6]. The core of this teaching concept is: to drive the learning process with clinical problems as the orientation, to achieve the transformation of the teaching model from “teacher-centered” to “student-centered”, and to transform the nursing students from passive acceptance of knowledge to active exploration and practice.

In this study, teachers guide students to hand over problems, and students can obtain relevant information through the Internet, literature, books, etc. Teachers guide students to solve problems by independently consulting information and expressing opinions. This diversified teaching approach enlivened the classroom, stimulated enthusiasm for learning, and developed nursing students’ autonomous learning ability, laying the foundation for clinical work.

5. Conclusion

In this study, the application of the O-AMAS teaching model combined with PBL teaching in clinical teaching of neurocritical care nursing students can effectively improve the students’ academic performance, clinical reasoning ability and autonomous learning ability, further stimulate the students’ enthusiasm for learning, and encourage them to learn more actively and effectively. The high satisfaction of the nursing students with the course also promoted the harmony of the teacher-student relationship, the successful achievement of the teaching objectives, and prepared the nursing students for more efficient adaptation to clinical work in the future. However, the number and representativeness of students included in this study are limited. It is suggested that a multi-regional and multi-disciplinary survey be conducted in the future to comprehensively analyze the application of the O-AMAS effective teaching model in clinical teaching for intern nursing students and provide a reference for the design of clinical teaching for nursing students.

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The Application of Pain Care Based on CICARE Communication Model in Patients Undergoing Minimally Invasive Breast Surgery during the Day

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Abstract: *Objective:* This study aims to investigate the effects of pain care based on the CICARE communication model on perioperative pain control, anxiety, and nursing satisfaction in patients undergoing minimally invasive breast surgery during the day. *Methods:* Using a randomized controlled trial design, 200 patients who underwent minimally invasive breast surgery at our hospital's day surgery center from January 2023 to June 2024 were selected and randomly divided into the experimental group and the control group, with 100 cases in each group. The control group received routine perioperative care, while the experimental group received standardized pain care based on the CICARE communication model in addition to routine care. The Visual Analogue Scale (VAS) was used to assess pain levels at 2 hours, 6 hours, and 24 hours after surgery, the State-Trait Anxiety Scale (STAI) was used to assess anxiety levels before and after the intervention, and a self-made nursing satisfaction questionnaire was used to evaluate patient satisfaction. *Results:* The VAS scores of the experimental group at 2 hours, 6 hours, and 24 hours after surgery [(3.2 ± 0.8) points, (2.1 ± 0.7) points, (1.2 ± 0.5) points] were significantly lower than those of the control group [(4.8 ± 1.1) points, (3.6 ± 0.9) points, (2.3 ± 0.6) points] ($P < 0.01$). After the intervention, the state anxiety score of the experimental group (38.5 ± 6.2) was significantly lower than that of the control group (46.8 ± 7.1) ($P < 0.01$). The total score of nursing satisfaction in the experimental group (94.2 ± 4.3) was significantly higher than that in the control group (82.6 ± 5.7) ($P < 0.01$). *Conclusion:* Pain care based on the CICARE communication model can effectively relieve postoperative pain in patients undergoing minimally invasive breast surgery during the day, reduce anxiety, and improve nursing satisfaction. It is worthy of promotion and application in day surgery care.

Keywords: Anxiety; CICARE communication mode; Minimally invasive breast surgery; Nursing satisfaction; Pain care

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1. Introduction

Day surgery has become the preferred option for minimally invasive resection of benign breast tumors due to its efficiency and convenience, but postoperative pain management remains a key factor affecting the patient experience and the quality of postoperative recovery. Minimally invasive breast surgery, though minimally invasive, can still cause varying degrees of pain after the operation. If not effectively controlled, it not only increases the patient's suffering but may also cause problems such as anxiety and sleep disorders, and even lead to the occurrence of chronic pain syndrome.

Effective pain management depends on precise pain assessment and good nurse-patient communication. In the traditional nursing model, nurses tend to focus on drug intervention for pain and lack a systematic communication process, easily neglecting patients' psychological feelings and individualized needs, resulting in problems such as insufficient pain assessment and untimely intervention.

The CICARE communication model is a communication tool characterized by process and standardization. Its six steps - Connect, Introduce, Communicate, Ask, Respond, Exit - provide a clear communication framework for healthcare workers, ensuring that every interaction with patients reflects respect and empathy. To build trust, obtain accurate information and implement effective interventions. The model has been widely used in foreign medical institutions and has been proven to significantly improve communication efficiency and patient satisfaction, but its application value in pain management, especially in short, efficient medical scenarios such as day surgeries, is still lacking in in-depth research and empirical support. Day surgery patients stay in the hospital for a short time and have limited nurse-patient contact opportunities, but building trust relationships accurately assess pain and implement personalized interventions within the limited time poses higher requirements for nursing work.

Therefore, this study aims to structuralize the CICARE communication model to the entire process of pain management for patients undergoing minimally invasive breast surgery during the day, improve the accuracy of pain assessment, the timeliness of intervention, and patient engagement through standardized communication, and systematically evaluate its impact on patient pain control, anxiety, and satisfaction. Lastly, to provide new ideas and evidence-based evidence for optimizing the practice of pain care in day surgery ^[1].

2. Data and methods

2.1. General information

200 patients who underwent ultrasound-guided minimally invasive breast resection at the day surgery center of our hospital from January 2023 to June 2024 were selected as the study subjects.

Inclusion criteria are as follows:

- (1) Female aged 18 to 65 years;
- (2) A benign breast tumor confirmed by preoperative pathological or imaging examination, with minimally invasive surgery scheduled;
- (3) Conscious, without communication barriers, and able to complete the questionnaire independently;
- (4) Voluntarily participate in this study and sign the informed consent form.

Exclusion criteria are as follows:

- (1) Coexisting with other sites of malignancy or severe chronic pain disease;
- (2) A history of mental illness or cognitive impairment;

- (3) Allergic to analgesic drugs used in the study;
- (4) Those who need to be transferred to the ward for further treatment after the operation.

Patients were randomly divided into the experimental group and the control group, with 100 cases in each group, using a random number table. There was no statistically significant difference ($P > 0.05$) between the two groups of patients in terms of general information such as age, tumor size, operation time and anesthesia method, and they were comparable. This study was approved by the hospital's Ethics Committee (Batch number: 2022-Yan Lun Shen - No. 088)^[2].

2.2. Methods

The control group received routine perioperative care for day surgery, including preoperative routine health education, intraoperative cooperation, postoperative monitoring of vital signs, administration of analgesic drugs (such as ibuprofen sustained-release capsules) as prescribed by the doctor, and routine discharge guidance. The experimental group received standardized pain care based on the CICARE communication model in addition to routine care.

The specific plan is as follows:

- (1) Establish a CICARE pain management team led by the head nurse and consisting of five key nurses from the day surgery center. Members of the group will receive two weeks of specialized training to master the CICARE communication process, pain assessment methods, non-pharmacological analgesia techniques and breast surgery expertise, and pass the scenario simulation assessment;
- (2) CICARE process-oriented pain care intervention
 - (a) Preoperative (connection - introduction - communication)
 - (i) Connection: When the patient is admitted, the responsible nurse greets them proactively, introduces themselves, and creates a warm atmosphere;
 - (ii) Introduction: Introduce the day surgery process, the possibility of pain occurrence, and the pain management plan to the patient;
 - (iii) Communication: Communicate in plain language, inform the patient that pain is a normal postoperative reaction, encourage them to express their pain feelings actively, and explain how to use the pain assessment tool-VAS scale);
 - (b) Intraoperative (question-response)
 - (i) Question: Closely observe the patient's non-verbal pain signals such as frowning, clenching fists during the operation and proactively ask about their feelings: "How are you feeling now?" If you feel unwell, please let me know.";
 - (ii) Response: Respond promptly to the patient's needs and provide psychological support through verbal comfort, touching the arm, etc. and administer pain relief measures accurately as directed by the doctor;
 - (c) Postoperative (Inquiry - response - Leave)
 - (i) Inquiry: In the postoperative recovery room and rest room, at regular intervals (2 hours and 6 hours after surgery), use the VAS ruler to ask: "Please use this ruler to tell me the current degree of pain, 0 is no pain, 10 is the most painful.";
 - (ii) Response: Respond promptly based on the assessment results. For mild pain (VAS1-3 points), non-pharmacological interventions such as deep breathing, distraction (like listening to music), and cold

- compresses are used; For moderate to severe pain ($VAS \geq 4$), report to your doctor immediately and take medication as directed, and explain the effects and precautions of the medication);
- (iii) Leave: Inform the patient of the next steps after each intervention: “I will keep an eye on your pain at all times. Please rest well.” Upon discharge, provide detailed instructions on home-based pain management and follow-up visits;
- (3) Provide patients with illustrated pain management manuals and VAS score cards for self-assessment and record-keeping after discharge ^[3].

2.3. Observation indicators

VAS was used to assess the degree of pain in patients 2 hours, 6 hours, and 24 hours after surgery (followed up by telephone) on a scale of 0 to 10, with a higher score indicating more severe pain.

The State Anxiety Subscale (S-AI) of the STAI was used for assessment before the intervention (1 hour before the operation) and after the intervention (at discharge), with a total score of 20 to 80, and a higher score indicated a more severe level of anxiety.

A self-made satisfaction questionnaire was used for the survey at discharge, which included four dimensions of service attitude, communication effect, pain management, and health guidance, with a total of 10 items, and a Likert 5-level score of 100 was used, with higher scores indicating greater satisfaction. The Cronbach's α coefficient of the questionnaire was 0.912 ^[4].

2.4. Statistical methods

Data analysis was performed using SPSS25.0 software. Measurement data were expressed as mean \pm standard deviation (SD), two independent sample t-tests were used for comparison between groups, and paired sample t-tests were used for comparison within groups; Count data were expressed as cases (%), 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 VAS scores at each postoperative time point between the two groups of patients

The VAS scores of the experimental group were significantly lower than those of the control group at 2 hours, 6 hours, and 24 hours after surgery, and the difference was statistically significant ($P < 0.01$). See **Table 1**.

Table 1. Comparison of VAS scores at each time point after surgery between the two groups (mean \pm SD, points)

Group	Number of cases	2 hours after surgery	6 hours after surgery	24 hours after surgery
Experimental group	100	3.2 \pm 0.8	2.1 \pm 0.7	1.2 \pm 0.5
Control group	100	4.8 \pm 1.1	3.6 \pm 0.9	2.3 \pm 0.6
t value		12.735	13.842	14.926
P value		< 0.001	< 0.001	< 0.001

3.2. Comparison of state anxiety scores before and after intervention

There was no statistically significant difference in state anxiety scores between the two groups before intervention

($P > 0.05$). After the intervention, the scores of both groups decreased compared with those before the intervention ($P < 0.05$), and the scores of the experimental group were significantly lower than those of the control group, with statistically significant differences ($P < 0.01$). See **Table 2**.

Table 2. Comparison of state anxiety scores before and after intervention between the two groups of patients (mean \pm SD)

Group	Before intervention	After intervention	t value	P value
Experimental group	52.6 \pm 7.8	38.5 \pm 6.2 * [#]	15.327	< 0.001
Control group	51.9 \pm 8.1	46.8 * 7.1 mm	5.642	< 0.001
t value	0.658	8.921		
P value	0.512	< 0.001		

* Note: Compared with the group before intervention, $P < 0.05$; Compared with the control group after intervention, [#] $P < 0.01$.

3.3. Comparison of nursing satisfaction between the two groups

The experimental group had significantly higher scores in service attitude, communication effect, pain management, health guidance and total score than the control group, and the difference was statistically significant ($P < 0.01$). See **Table 3**.

Table 3. Comparison of nursing satisfaction scores between the two groups of patients (mean \pm SD)

Group	Service attitude	Communication effect	Pain management	Health guidance	Total score
Experimental group	23.8 \pm 2.1	24.1 \pm 1.8	23.5 \pm 2.0	22.8 \pm 1.9	94.2 \pm 4.3
Control group	20.5 \pm 2.5	20.8 \pm 2.7	20.9 \pm 2.4	20.4 \pm 2.6	82.6 \pm 5.7
t value	10.842	10.125	8.934	7.856	16.327
P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

4. Conclusion

The results of this study showed that applying the CICARE communication model to pain care for patients undergoing minimally invasive breast surgery during the day significantly improves pain management, alleviates patients' anxiety, and leads to higher care satisfaction. This achievement is mainly attributed to the standardization, humanization and precision of pain management achieved by the model.

The CICARE model has improved the accuracy of pain assessment and the timeliness of intervention. In traditional care, pain assessment often relies on unilateral observation by nurses or active complaints from patients, which is prone to underassessment or delay. The CICARE model, through the "inquiry" step, requires nurses to actively, standardly, and regularly use VAS tools for pain assessment, ensuring that pain is captured in a timely and quantified manner. The subsequent "response" step compelled nurses to respond immediately and hierarchically to the assessment results, whether it was non-pharmacological intervention or pharmacological analgesia, with evidence and rules to follow, thereby significantly reducing the intensity of patients' pain experience, which was consistent with the results of significantly reduced VAS scores at each time point after surgery in the experimental

group^[5].

The CICARE model was effective in alleviating patients' anxiety. There is a widespread fear of unknown surgical procedures and postoperative pain among patients undergoing day surgery. The initial steps of the CICARE model, from “connection”, “introduction” to “communication”, establish a trusting and cooperative nurse-patient relationship with the patient before the operation. Continuous attention, proactive questioning, and empathetic responses throughout the process made patients feel respected and cared for, and their subjective feelings and emotional needs were fully valued. This psychological support greatly buffered the anxiety caused by surgical stress, as reflected in the significant decrease in state anxiety scores after intervention in the experimental group.

The CICARE model significantly enhanced the quality of nursing services and patient satisfaction. The model transforms communication into a structured care behavior, ensuring homogeneity and high levels of care services. Nurses naturally demonstrate good service attitude, professional communication skills and systematic health guidance by implementing standard procedures. Patients experienced consistent, professional and humanistic care throughout the perioperative period. Their sense of participation and control in the pain control process was enhanced, and their recognition of nursing work naturally increased significantly, which was reflected in the overall leading scores of the experimental group in all dimensions of nursing satisfaction and the total score.

In summary, pain care based on the CICARE communication model takes communication as the core nursing technique and ensures the professionalism and humanization of pain management through process-oriented steps. It is particularly suitable for promotion and application in short and efficient medical scenarios such as day surgery, providing an effective practical path for optimizing the patient experience and improving the quality of care.

Disclosure statement

The author declares no conflict of interest.

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Research on the Application of *In-situ* Simulation Teaching Method Based on the Concept of Ideological and Political Education in Curriculum in the First Aid Skills of Clinical Practice Nursing Students

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Abstract: *Objective:* To explore the application effect of *in-situ* simulation teaching method based on the concept of ideological and political education in the first aid skills training of clinical practice nursing students. *Methods:* A randomized controlled trial was used to select 220 trainee nurses from a hospital in 2024 and randomly divided them into the experimental group (n = 110) and the control group (n = 110). The control group adopted the traditional theory teaching + skill operation demonstration teaching method, while the experimental group implemented the *in-situ* simulation teaching plan integrating the ideological and political concepts of the curriculum on the basis of the traditional teaching. The scores of the first aid skills operation assessment, the Chinese version of the Jefferson Empathy Scale (JSE-NS), the Nursing Student Professional Identity Scale, and the Humanistic Care Ability Scale (CAI) were compared between the two groups after the intervention. *Results:* After the intervention, the scores of the first aid skills operation assessment, the total score of JSE-NS and each dimension, the total score of professional identity, and the total score of CAI and each dimension of the nursing students in the experimental group were significantly higher than those in the control group, and the differences were statistically significant ($P < 0.05$). *Conclusion:* The *in-situ* simulation teaching method based on the concept of ideological and political education in the curriculum can effectively enhance the first aid skills level, empathy ability, professional identity and humanistic care ability of trainee nurses, and is an effective way to achieve the deep integration of first aid skills training and ideological and political education.

Keywords: Curriculum-based ideological and political education; First aid skills; Humanistic care; In-place simulation teaching; Trainee nurses

Online publication: Nov 3, 2025

1. Introduction

The General Secretary clearly pointed out that ideological and political theory courses are key courses for implementing the fundamental task of fostering virtue and nurturing talent, profoundly revealing the core position of ideological and political education in the higher education system. As a comprehensive educational concept, “curriculum-based ideological and political education” aims to organically integrate ideological and political education into the entire teaching process of all kinds of courses to achieve the dialectical unity of knowledge imparting, ability cultivation and value guidance. Its essence lies in collaborative education and the construction of an education pattern involving all personnel, throughout the entire process and in all aspects.

Nursing, as a discipline that is both scientific and humanistic, serves people who are suffering from illness. This requires nursing education not only to impart excellent professional knowledge and skills, but also to cultivate the professional spirit and humanistic qualities of nursing students who revere life, care for patients and are willing to contribute. Emergency nursing is at the forefront of clinical nursing work, with high skill requirements and urgent situations. It is a concentrated manifestation of the comprehensive quality of nursing students and a key scenario for cultivating their professional values and ethical decision-making abilities.

At present, the post-2000s generation has become the main body of nursing interns. They are active in thinking but have limited experience, and their values are more diverse and pragmatic. The traditional first aid training model, which focuses on the practice of a single skill, is difficult to effectively guide them to deeply understand the meaning of life and social value behind first aid behavior, and is prone to the lack of humanistic care and the ambiguity of professional value perception. *In-situ* simulation teaching, as an emerging high-simulation teaching method, provides an excellent carrier for seamlessly embedding ideological and political elements in skills training by creating highly realistic clinical scenarios in the learners’ future real workplace, enabling them to integrate knowledge, refine skills, and collaborate and communicate in an “immersive” environment.

This study aims to construct an *in-situ* simulation teaching program based on the concept of ideological and political education in the curriculum, and to verify its comprehensive effect in improving the first aid skills and humanistic qualities of trainee nurses through randomized controlled trials, providing empirical evidence for innovating the teaching model of nursing practice and deepening the construction of ideological and political education in professional courses^[1].

2. Data and methods

2.1. General information

This study selected nursing students who did clinical practice in our hospital from January to June 2024 as the research subjects. A total of 220 interns were randomly grouped using the coin-tossing method, including 110 in the experimental group and 110 in the control group.

The inclusion criteria are as follows:

- (1) Full-time junior college or bachelor’s degree in nursing;
- (2) Completed basic nursing and first aid theory courses on campus;
- (3) Informed consent and voluntary participation in this study.

The exclusion criteria are as follows:

- (1) Those who interrupted training for any reason during the internship;

(2) Those who are absent from the course at least twice.

There was no statistically significant difference ($P > 0.05$) between the two groups of nursing students in terms of general information such as age, gender, educational level, and performance of first aid operations at school, and they were comparable. This study was reviewed and approved by the ethics committee of our hospital ^[2].

2.2. Methods

2.2.1. Teaching methods for the control group

The control group adopted the conventional training mode. Clinical instructors gave concentrated theoretical lessons based on the syllabus, covering first aid theories such as cardiopulmonary resuscitation, defibrillation, and balloon-mask ventilation. Then, a N2-level nurse who won a provincial skills competition gave a demonstration of skills, and students practiced in groups on mannequins. At the end of the training cycle, regular skill operation assessments are conducted.

2.2.2. Experimental group teaching methods

The experimental group implemented *in-situ* simulation teaching based on the concept of ideological and political education in the curriculum on the basis of theoretical teaching in the control group is as listed below:

- (1) Construct a teaching plan integrating ideological and political education by establish a teaching team consisting of nursing education experts, critical care nursing experts, outstanding Communist Party members and members of the research group. Through literature analysis and two rounds of Delphi expert inquiries, construct an *in-situ* simulation teaching case library and implementation plan that integrates the four major ideological and political themes of “respecting life”, “saving lives”, “professional responsibility”, and “humanistic care”;
- (2) Teacher training and collective lesson preparation via conducting specialized ideological and political education in the curriculum for all teachers involved in teaching, and unify teaching concepts and methods. Through Party building to lead the organization of collective lesson preparation, deeply explore the ideological and political elements in first aid cases to ensure that ideological and political education is “imperceptibly” integrated into skills training;
- (3) *In-situ* simulation teaching implementation, where training is carried out in the real working environment of the emergency resuscitation room or ICU using real clinical equipment (such as defibrillators, monitors, rescue vehicles) and highly realistic mannebulids. Simulated scenarios such as “sudden ventricular fibrillation cardiac arrest in patients” or “shock due to massive traumatic hemorrhage” require students to complete the entire process from assessment, decision-making, operation to communication with family members in teams.

Teachers guide students not only to be technically accurate, but also to demonstrate respect for the “patient”, reverence for life, collaboration with teammates, and comfort for the “family” in the simulation. At the end of each simulation, mentors guide students to conduct a structured review, focusing on reflecting on gains and losses in technical operations, teamwork, and humanistic care, deepening their recognition of professional value ^[3].

2.3. Observation indicators

After the training, the two groups of nursing students were evaluated uniformly using methods as outlined:

- (1) First aid skills assessment: On a 100-point scale, the assessment includes theoretical knowledge (20%),

clinical decision-making ability (20%), operational standardization (20%), teamwork ability (20%), and communication and humanistic care (20%);

- (2) Chinese version of the Jefferson Empathy Scale (JSE-NS) : It includes three dimensions of opinion selection, emotional care, and empathy, with 20 items, and is scored on a Likert 7-point scale, totaling 140 points. The higher the score, the stronger the empathy ability;
- (3) Nursing student professional identity scale: Use the scale developed by Hao, which includes five dimensions such as professional self-concept and 17 items, with a total score of 85, the higher the score, the stronger the professional identity;
- (4) Human Care Ability Scale (CAI) : Use the Chinese version of the scale translated by Xu, it includes three dimensions of cognition, courage, and patience, 37 items, total score 259, the higher the score, the stronger the care ability.

2.4. Statistical methods

Data analysis was performed using SPSS 25.0 software. Measurement data were expressed as mean \pm standard deviation (SD) and the two independent samples 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 first aid skills assessment results between the two groups of nursing students

After the intervention, the total score and individual scores of the first aid skills assessment of the nursing students in the experimental group were significantly higher than those in the control group, and the difference was statistically significant ($P < 0.05$) (Table 1).

Table 1. Comparison of the scores of the first aid skills assessment of nursing students in the experimental group and the control group

Groups	Cases	Theoretical knowledge	Clinical decision-making	Practice guidelines	Teamwork	Humanistic communication	Overall grade
Experimental group	110	18.5 \pm 1.2	18.1 \pm 1.4	17.9 \pm 1.3	18.3 \pm 1.1	18.0 \pm 1.5	90.8 \pm 4.2
Control group	110	17.1 \pm 1.5	16.3 \pm 1.8	16.8 \pm 1.7	16.0 \pm 1.9	15.2 \pm 2.0	81.4 \pm 5.7
t value		7.624	8.432	5.789	11.245	11.873	13.915
P value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

3.2. Comparison of JSE-NS, professional identity, and CAI scores between the two groups of nursing students

After the intervention, the total scores of JSE-NS, professional identity and CAI of the nursing students in the experimental group were significantly higher than those in the control group, and the differences were statistically significant ($P < 0.05$) (Table 2).

Table 2. Comparison of JSE-NS, professional identity and CAI Scores between the two groups of nursing students (mean \pm SD, points)

Group	Number of cases	JSE-NS total score	Total score of professional Identity	Total CAI score
Experimental group	110	118.6 \pm 10.4	72.5 \pm 6.8	215.3 \pm 16.7
Control group	110	103.2 \pm 11.7	65.3 \pm 7.5	198.4 \pm 18.9
t value		10.642	7.681	7.154
P value		< 0.001	< 0.001	< 0.001

4. Discussion

4.1. In-place simulation teaching integrated with ideological and political education in the curriculum can effectively enhance the comprehensive first aid ability of nursing students

The results of this study showed that the total score of first aid skills assessment and the scores of each sub-item of the experimental group of nursing students were significantly better than those of the control group. This achievement was primarily attributed to the highly realistic and uncertain clinical scenarios created by the in situ simulation teaching, which compelled the nursing students to integrate fragmented theoretical knowledge and apply it to the dynamic and complex cases, thereby significantly enhancing their clinical decision-making and critical thinking abilities.

Moreover, the practice of teamwork in real-world scenarios went beyond the limitations of individual operations, enabling nursing students to deeply understand that the success of first aid depends on clear division of labor, effective communication and close cooperation among team members, which transformed the abstract “team spirit” in the classroom into perceptible and executable practical guidelines.

More importantly, the teaching program designed in this study takes human elements such as operational norms, ethical choices, and communication with family members as core assessment indicators, guiding nursing students to consider the impact of the operation itself on the dignity and rights of patients while pursuing technical accuracy, achieving a resonance of skill training and value guidance, and ultimately comprehensively enhancing the comprehensive first aid literacy of nursing students.

4.2. The teaching model significantly enhanced the humanistic care and empathy abilities of the nursing students

Traditional skills training is mostly conducted on standardized mannequins, lacking emotional interaction and ethical challenges, which can easily lead to a one-sided perception of “technical supremacy” among nursing students. The *in-situ* simulation teaching in this study places nursing students in complex situations where they have to confront the emotions of patients and the expectations of their families by embedding carefully designed ideological and political elements, such as simulating “communication with anxious family members” and “ethical reflection after ineffective rescue”.

This “immersive” experience strongly impacted the emotional cognition of the nursing students, making them no longer simple technical operators but holistic care providers who need to take on the responsibility of emotional care and support. In the structured review guided by mentors, nursing students learned to put themselves in others’ shoes by sharing the tension, helplessness or comfort they felt in the simulation, and deeply realized the importance of the “hand” of technology and the “heart” of humanity complementing each other, thus generating

stronger empathetic motivation and more proactive humanistic care behaviors.

4.3. Teaching reform helps to consolidate the professional identity of nursing students and stabilize the nursing team

Professional identity is an intrinsic stabilizer for nursing students to engage in clinical practice and overcome professional difficulties in the future. The experimental group in this study scored higher in professional identity because the teaching model provided nursing students with a positive and profound initial professional experience. The team recognition and sense of self-achievement gained after successfully handling critical conditions and effectively comforting “family members” greatly strengthened their sense of professional value and honor as future medical workers.

Transforming the ideological and political concepts of “saving lives and healing the wounded” and “willing to contribute” into a series of successful simulated rescue operations, allowing nursing students to witness with their own eyes the life value and social significance that their professional actions can create, thus generating a deeper recognition and love for the connotation of the nursing profession. This deep-seated recognition can effectively resist burnout in future professional life and has a long-term and positive impact on cultivating a stable nursing team with both excellent skills and firm professional beliefs.

5. Conclusion

This study focused on the training of first aid skills for clinical practice nursing students. Through a randomized controlled trial (220 nursing students were divided into the experimental group and the control group), it systematically explored the application value of the *in-situ* simulation teaching method based on the concept of ideological and political education in the curriculum. The results showed that compared with the traditional “theoretical teaching + skill demonstration” model, the experimental group had significantly higher scores in first aid skills operation assessment, total scores and dimension scores of the Chinese version of the JSE-NS, professional identity scale scores, and total scores and dimension scores of the CAI ($P < 0.05$). It fully confirmed the effectiveness of the teaching method.

From the perspective of teaching value, this approach breaks through the limitations of traditional skills training that emphasizes operation over quality. It integrates the concept of ideological and political education in the curriculum into *in-situ* simulation scenarios, which not only enhances the practical proficiency of first aid skills and emergency response ability of nursing students, but also simultaneously improves their empathy awareness, professional identity and humanistic care quality through value guidance. It truly achieves the deep integration of “professional skills training” and “ideological and political education”. In terms of practical significance, this research achievement provides empirical evidence and feasible paths for the reform of clinical nursing teaching, and plays an important guiding role in cultivating high-quality nursing talents with both solid professional skills and profound humanistic qualities.

In the future, the scope of teaching application can be further expanded, *in-situ* simulation schemes can be optimized in combination with different clinical nursing scenarios, and the integration mechanism of ideological and political elements and nursing skills training can be continuously explored to promote the continuous improvement of the quality of nursing education.

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Research on the Impact of the Early Rehabilitation Management Model Based on Efficacy Linkage on Functional Recovery of Patients After Cerebral Hemorrhage Surgery

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Abstract: *Objective:* To investigate the effects of performance-linked early rehabilitation management model on the recovery of neurological function, motor function and activities of daily living in patients after intracerebral hemorrhage surgery. *Methods:* A randomized controlled trial design was adopted. A total of 120 patients after cerebral hemorrhage surgery admitted to our hospital from June 2023 to June 2024 were selected as the research subjects and were randomly divided into the experimental group and the control group, with 60 cases in each group according to the random number table method. The control group received routine postoperative care and rehabilitation guidance in neurosurgery, while the experimental group implemented an efficacy linkage early rehabilitation management model on the basis of routine care. Before the intervention, 4 weeks after the intervention, and 12 weeks after the intervention, the National Institutes of Health Stroke Scale (NIHSS), the Fugl-Meyer Assessment of Motor Function (FMA), and the Barthel Index (BI) were used to assess the degree of neurological deficits, motor function, and activities of daily living in patients, respectively. *Results:* After 4 weeks and 12 weeks of intervention, the NIHSS scores of the experimental group [(8.5 ± 2.1) points, (5.2 ± 1.8) points] were significantly lower than those of the control group [(10.8 ± 2.4) points, (7.9 ± 2.2) points] ($P < 0.01$); FMA scores [(58.4 ± 10.2) points, (78.6 ± 12.4) points] and BI scores [(55.3 ± 11.5) points, (72.8 ± 13.2) points] were significantly higher than those of the control group [(45.2 ± 9.8) points, (62.3 ± 11.7) points; (42.1 ± 10.6) points, (58.4 ± 12.5) points] ($P < 0.01$). *Conclusion:* The performance-linked early rehabilitation management model can effectively promote the recovery of neurological and motor functions in patients after cerebral hemorrhage surgery and significantly improve their ability to take care of themselves in daily living. It is an efficient rehabilitation management strategy.

Keywords: Cerebral hemorrhage; Early rehabilitation; Efficacy linkage; Functional recovery; Postoperative recovery; Randomized controlled trials

Online publication: Nov 3, 2025

1. Introduction

Cerebral hemorrhage (intracerebral hemorrhage, for example) is a common emergency and severe cases of neurosurgery, its incidence, morbidity and mortality rates are higher. Surgical removal of the hematoma is a key treatment for massive intracerebral hemorrhage, but postoperative patients often have neurological deficits of varying degrees, such as hemiplegia, aphasia, dysphagia, etc., which seriously affect their quality of life and impose a heavy burden on families and society.

Early rehabilitation intervention has been proven to be a key measure to improve the prognosis of stroke patients, with the aim of preventing complications, promoting functional compensation and reorganization, and restoring patients' ability to take care of themselves to the greatest extent. However, the traditional rehabilitation model often has problems such as poor coordination among various disciplines (neurosurgery, rehabilitation department, nursing unit, etc.), inconsistent timing and intensity of rehabilitation intervention, and low participation of patients and their families, resulting in poor rehabilitation outcomes.

Performance-linked rehabilitation management is a new type of management model that is patient-centered, emphasizes multi-disciplinary collaboration (MDT), process standardization, and maximization of effectiveness. By integrating medical, rehabilitation, nursing and family support systems to form a seamless rehabilitation chain, it aims to achieve early, individualized, continuous and efficient rehabilitation interventions.

At present, there is a lack of large-sample empirical research on the application effect of this model in patients after cerebral hemorrhage surgery. Therefore, this study constructs an efficacy-linked early rehabilitation management model and applies it to patients after cerebral hemorrhage surgery to systematically evaluate its impact on neurological function, motor function and activities of daily living in patients, with the aim of providing evidence-based evidence for optimizing the rehabilitation management process after cerebral hemorrhage surgery and improving the prognosis of patients ^[1].

2. Data and methods

2.1. Research subjects

A total of 120 postoperative patients with cerebral hemorrhage who were admitted to the neurosurgery department of our hospital from June 2023 to June 2024 were selected as the study subjects.

Inclusion criteria are as follows:

- (1) Diagnosed with supratentorial spontaneous intracerebral hemorrhage by CT or MRI and undergoing hematoma evacuation;
- (2) Age: 18–80 years;
- (3) Stable vital signs, GCS score > 8, rehabilitation assessment initiated within 24–48 hours after surgery;
- (4) Informed consent from the patient or family member and the signing of the consent form.

Exclusion criteria:

- (1) Combined with severe dysfunction of the heart, liver, kidneys, etc.;
- (2) Previous sequelae or dysfunction of neurological disorders;
- (3) Accompanied by consciousness disorder or cognitive impairment and unable to cooperate with rehabilitation training;
- (4) Expected survival time < 3 months. Patients were randomly divided into the experimental group and the control group, with 60 cases in each group, using a random number table.

There was no statistically significant difference ($P > 0.05$) between the two groups of patients in terms of gender, age, bleeding site, bleeding volume, surgical method, and general data such as preoperative NIHSS, FMA, and BI scores, and they were comparable. This study was approved by the Hospital Ethics Committee (Batch number: 2023-Yan Lun Shen - No. 045) ^[2].

2.2. Methods

2.2.1. The control group received routine postoperative care and rehabilitation in neurosurgery

It included disease observation, medication guidance, complication prevention, and routine phased rehabilitation guidance by a rehabilitation therapist (once daily, 30 minutes each time), and home rehabilitation advice upon discharge.

2.2.2. The experimental group implemented an effect-linked early rehabilitation management model on the basis of routine care

The details are as follows:

- (1) Establish MDT teams consisting of neurosurgeons, rehabilitation physicians, rehabilitation therapists, specialist nurses, nutritionists, and psychotherapists;
- (2) Develop standardized procedures:
 - (i) Rehabilitation risk assessment and functional evaluation will be conducted jointly by the MDT team within 24 hours after the operation;
 - (ii) Based on the assessment results, an individualized and phased rehabilitation program will be jointly developed and initiated within 48 hours after the operation;
 - (iii) Coordinated implementation:
 - (a) In-hospital stage: The rehabilitation therapist conducts two one-on-one training sessions daily (including good limb placement, passive/active joint range of motion training, bed movement, sitting balance, etc.) for 45 minutes each time; Nurses incorporate rehabilitation care into daily care operations and supervise the training; Physicians monitor changes in the condition and adjust medical plans; Nutritionists and psychologists provide corresponding support;
 - (b) Transition phase: Establish a discharge preparation plan and provide rehabilitation skills training to family members;
 - (c) Family/community phase: Establish We-chat follow-up groups for weekly online guidance; Home visits or outpatient follow-ups once a month for the MDT team to re-evaluate and adjust the plan;
- (3) Effectiveness assurance mechanism: Establish daily morning shift handover and weekly MDT case discussion to ensure information exchange and timely plan adjustment ^[3].

2.3. Observation indicators

The observation indicators are as follows:

- (1) Degree of neurological deficits: Assessed using the NIHSS, higher scores indicate more severe neurological deficits;
- (2) Motor function: The upper limb part (66 points) and lower limb part (34 points) were evaluated using the FMA for a total of 100 points, with a higher score indicating better motor function;
- (3) Activities of daily living: The BI is used for assessment, with a total score of 100, and a higher score

indicates better independence ^[4].

2.4. Statistical methods

Data analysis was performed using SPSS 26.0 software. Measurement data were expressed as mean \pm standard deviation (SD), repeated measures analysis of variance was used for intra-group comparison, and independent sample t-test was used for inter-group comparison; 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 NIHSS scores before and after intervention between the two groups of patients

Before the intervention, there was no statistically significant difference in NIHSS scores between the two groups ($P > 0.05$). After 4 and 12 weeks of intervention, the NIHSS scores of both groups were significantly lower than those before intervention ($P < 0.05$), and the scores of the experimental group were significantly lower than those of the control group in the same period, and the difference was statistically significant ($P < 0.01$). See **Table 1**.

Table 1. Comparison of NIHSS scores before and after intervention between the two groups mean \pm SD, n = 60)

Group	Before intervention	4 weeks after the intervention	After 12 weeks of intervention
Experimental group	15.8 \pm 3.2	8.5 \pm 2.1 * [#]	5.2 \pm 1.8 * [#]
Control group	16.1 \pm 3.5	10.8 * 2.4 mm	7.9 * 2.2 mm
t value	0.485	5.732	7.415
P value	0.629	< 0.001	< 0.001

Note: Compared with before the intervention in the same group, * $P < 0.05$; Compared with the control group of the same period, [#] $P < 0.01$.

3.2. Comparison of FMA scores before and after intervention between the two groups of patients

Before the intervention, there was no statistically significant difference in FMA scores between the two groups ($P > 0.05$). After 4 and 12 weeks of intervention, the FMA scores of both groups were significantly higher than those before intervention ($P < 0.05$), and the scores of the experimental group were significantly higher than those of the control group in the same period, and the difference was statistically significant ($P < 0.01$). See **Table 2**.

Table 2. Comparison of FMA scores before and after intervention between the two groups mean \pm SD, n = 60)

Group	Before intervention	4 weeks after the intervention	After 12 weeks of intervention
Experimental group	25.6 \pm 8.4	58.4 \pm 10.2 * [#]	78.6 \pm 12.4 * [#]
Control group	24.9 \pm 7.8	45.2 * 9.8 mm	62.3 * 11.7 mm
t value	0.461	7.318	7.842
P value	0.646	< 0.001	< 0.001

Note: Compared with before the intervention in the same group, * $P < 0.05$; Compared with the control group of the same period, [#] $P < 0.01$.

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

Before the intervention, there was no statistically significant difference in BI scores between the two groups ($P > 0.05$). After 4 and 12 weeks of intervention, the BI scores of both groups were significantly higher than those before intervention ($P < 0.05$), and the scores of the experimental group were significantly higher than those of the control group in the same period, and the difference was statistically significant ($P < 0.01$). See **Table 3**.

Table 3. Comparison of BI scores before and after intervention between the two groups of patients (mean \pm SD, n = 60)

Group	Before intervention	4 weeks after the intervention	After 12 weeks of intervention
Experimental group	20.5 \pm 9.2	55.3 \pm 11.5 * [#]	72.8 \pm 13.2 * [#]
Control group	21.2 \pm 8.7	42.1 * 10.6 mm	58.4 * 12.5 mm
t value	0.423	6.572	6.128
P value	0.673		

Note: Compared with before the intervention in the same group, * $P < 0.05$; Compared with the control group of the same period, [#] $P < 0.01$.

4. Discussion

The findings suggest that the early rehabilitation management model based on efficacy linkage significantly promotes functional recovery in patients after cerebral hemorrhage surgery. After 4 and 12 weeks of intervention, the improvement in neurological deficits (NIHSS), motor function (FMA), and activities of daily living (BI) in the experimental group was significantly better than that in the control group receiving conventional rehabilitation ($P < 0.01$). This significant advantage was attributed to the multi-faceted innovations and optimizations of the model.

Early intervention and systematicness are key to achieving good results. This study initiated the assessment within 24 hours after the operation and initiated the rehabilitation plan within 48 hours, firmly seizing the “golden window” of neurological function recovery after cerebral hemorrhage surgery. Early, scientific and moderate rehabilitation training can effectively stimulate the plasticity of the central nervous system and promote the reorganization and compensation of impaired functions. The MDT team’s co-developed program ensures the scientific and safe nature of the rehabilitation intervention and avoids rehabilitation delays or program conflicts caused by poor communication between departments in the traditional model ^[5].

MDT breaks down professional barriers and forms a rehabilitation synergy. Neurosurgeons precisely control medical safety, rehabilitation physicians and therapists formulate and execute precise rehabilitation prescriptions, and specialist nurses incorporate rehabilitation concepts into the 24-hour care process to ensure the continuity and high frequency of rehabilitation training. This “medical-nurse-treatment integration” work model achieves a “seamless connection” from treatment to care and then to rehabilitation, avoids “breakpoints” in the rehabilitation process, and greatly enhances rehabilitation efficiency.

The full-process management path ensures the continuity of the rehabilitation effect. The model not only focuses on the rehabilitation of patients during their stay in the hospital, but also effectively extends rehabilitation intervention to families and communities through family training, online follow-up, and regular re-evaluation, addressing the common problem of interrupted or reduced effectiveness of rehabilitation training after discharge

and achieving continuity and consistency in in-hospital and out-of-hospital rehabilitation, which is difficult to achieve with the traditional model.

5. Conclusion

To sum up, the performance-linked early rehabilitation management model, by systematically integrating multidisciplinary resources and optimizing the rehabilitation process, has achieved early, individualized, continuous and efficient rehabilitation after cerebral hemorrhage surgery, significantly improving the neurological function and quality of life of patients, and is worthy of clinical promotion and application.

Disclosure statement

The authors declare no conflict of interest.

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The Role of Stress-Related Inflammatory Mediators in Hepatocyte Injury in Fatty Liver Disease and Current Research Status

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Abstract: Non-alcoholic fatty liver disease (NAFLD) has become the most prevalent chronic liver disease globally, with its incidence rising annually. It can progress to cirrhosis and even hepatocellular carcinoma, posing a serious threat to human health. Stress can participate in the pathological process of NAFLD by activating inflammatory responses and regulating levels of inflammatory mediators, with hepatocyte injury being a core component of NAFLD progression. This paper focuses on three key stress-related inflammatory mediators: tumor necrosis factor- α (TNF- α), interleukin-6 (IL-6), and C-reactive protein (CRP), elucidating their core mechanisms in the pathway related to stress signal, followed by inflammatory activation and hepatocyte injury respectively, and reviewing current research. Research indicates that certain inflammatory mediators can damage hepatocytes by directly inducing apoptosis or indirectly regulating metabolic disorders and fibrosis progression. However, questions regarding causal relationships, target specificity for intervention, and quantification of psychological stress remain unresolved. This paper aims to provide theoretical support for NAFLD intervention strategies targeting inflammatory mediators, clarifying future research directions to advance clinical translation.

Keywords: Hepatocyte injury; Inflammatory cytokines; Fatty liver disease; Non-alcoholic fatty liver disease; Stress

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1. Introduction

With rising global obesity rates and lifestyle changes, NAFLD has become the world's most prevalent chronic liver disorder, affecting over 25% of the global population. In China, the prevalence of NAFLD among adults exceeds 20%. NAFLD is not a benign disease; approximately 20%–30% of patients may progress to non-alcoholic steatohepatitis (NASH), which can further develop into cirrhosis, hepatocellular carcinoma, or even necessitate liver transplantation^[1]. Hepatocyte injury serves as the core initiating event in NAFLD's pathological progression, involving a cascade of changes including steatosis, inflammatory infiltration, apoptosis, and fibrosis. Inflammatory

response acts as the pivotal link connecting these stages ^[2].

“Stress,” a pervasive physiological and psychological state in modern society, plays a significant role in the development of NAFLD. Here, “stress” carries dual connotations, where physiological stress primarily encompasses metabolic disorders, oxidative stress, and gut microbiota dysbiosis; psychological stress mainly manifests as chronic anxiety, prolonged mental tension, and sleep disorders.

These two forms do not act independently but through a common pathway: activating systemic inflammatory responses, inducing abnormal expression of inflammatory mediators, and thereby exacerbating hepatocyte injury ^[3]. Currently, inflammatory mediators such as TNF- α , IL-6, and CRP have been confirmed to be closely associated with the severity of liver damage in NAFLD patients. However, the specific activation mechanisms of these mediators under stress, their damaging effects on hepatocytes, and their interactions still require systematic clarification.

Therefore, this paper adopts the core logic of “stress-inflammatory factors-hepatocyte injury” to review the sources, classification, and mechanisms of action of three key inflammatory factors (TNF- α , IL-6, CRP) in hepatocyte injury. It also summarizes the current research landscape to provide references for selecting diagnostic biomarkers and developing therapeutic targets for NAFLD.

2. Stress-related inflammatory factors and hepatocyte injury

2.1. Classification and sources of stress-related inflammatory factors

Stress-related inflammatory factors are small-molecule proteins or peptides secreted by immune cells and parenchymal cells in response to stress stimuli, functioning to regulate inflammatory responses. Based on their functions and origins, they can be categorized into two main types:

- (1) Pro-inflammatory cytokines that are centered on TNF- α and IL-6 are primarily secreted by Kupffer cells (hepatic macrophages), hepatocytes, and hepatic stellate cells within the liver. Kupffer cells, as the primary immune cells in the liver, can rapidly activate and release TNF- α and IL-6 in response to physiological stressors (e.g., hepatic steatosis induced by high-fat diets, accumulation of oxidative stress products) or psychological stressors (e.g., elevated cortisol levels). Additionally, damaged hepatocytes can directly secrete the aforementioned factors, further amplifying the local inflammatory response ^[4];
- (2) Acute phase reactants represented by CRP are primarily synthesized by hepatic parenchymal cells under the induction of proinflammatory factors like IL-6. CRP itself does not directly initiate inflammation but serves as a sensitive marker reflecting systemic and local hepatic inflammatory severity, with its levels positively correlated with stress intensity and inflammatory response severity.

Regarding activation mechanisms, stress primarily induces inflammatory factor production through two pathways:

- (1) The physiological stress pathway, such as high-fat diets causing lipid droplet accumulation in hepatocytes, triggering endoplasmic reticulum stress and oxidative stress, activating the nuclear factor- κ B (NF- κ B) signaling pathway, and subsequently promoting TNF- α and IL-6 gene transcription and protein secretion;
- (2) The psychological stress pathway, where chronic psychological stress activates the hypothalamic-pituitary-adrenal (HPA) axis, elevating cortisol levels. Excess cortisol suppresses the anti-inflammatory function of immune cells, disrupting the “pro-inflammatory-anti-inflammatory” balance. This leads to abnormal increases in pro-inflammatory factors like TNF- α and IL-6 while inducing hepatocyte synthesis of CRP ^[5].

2.2. Mechanisms of core inflammatory factors in hepatocyte injury

2.2.1. Mechanism of TNF- α

TNF- α is the earliest pro-inflammatory factor activated under stress. Its hepatocyte damage occurs primarily through two pathways: “direct apoptosis induction” and “indirect pathological regulation”:

In the activation pathway, physiological stressors (such as lipotoxicity induced by high-fat diets or oxidative stress products from alcohol metabolism) directly stimulate Toll-like receptor 4 (TLR4) on Kupffer cell surfaces, activating the NF- κ B pathway and prompting Kupffer cells to secrete large amounts of TNF- α . Elevated cortisol levels induced by psychological stress enhance Kupffer cell activation, further increasing TNF- α release.

On the other hand, TNF- α exacerbates liver injury through indirect effects, whereby it activates hepatic stellate cells, promoting collagen fiber synthesis and deposition, thereby accelerating liver fibrosis progression. Concurrently, TNF- α inhibits hepatic lipase activity within hepatocytes, reducing lipolysis and causing massive lipid droplet accumulation within hepatocytes, thereby worsening steatosis. Clinical studies confirmed that TNF- α expression levels in liver tissue from NAFLD patients positively correlate with hepatocyte apoptosis rates and the stage of liver fibrosis.

2.2.2. Mechanism of action of IL-6

IL-6 serves as a pivotal link between stress, inflammation, and metabolic disorders, with its hepatocellular damage centered on “inflammatory amplification” and “metabolic imbalance.”

The activation pathway of IL-6 exhibits duality, where under physiological stress, endoplasmic reticulum stress triggered by hepatic lipid accumulation directly induces IL-6 secretion from hepatocytes; Kupffer cells stimulated by TNF- α can further release IL-6, forming an inflammatory cascade reaction. Elevated cortisol levels induced by psychological stress promote IL-6 gene expression by activating signal transducer and activator of transcription 3 (STAT 3) within hepatocytes ^[6].

Its pathogenic mechanisms are outlined below:

- (1) IL-6 binds to its receptor (IL-6R) on hepatocyte surfaces, activating the Janus kinase (JAK)-STAT3 signaling pathway. This promotes STAT3 phosphorylation and nuclear translocation, where it regulates the expression of acute-phase proteins like CRP and serum amyloid A, thereby amplifying local hepatic inflammation;
- (2) IL-6 reduces hepatic insulin sensitivity by inhibiting the phosphorylation of insulin receptor substrate 1 (IRS-1) in the insulin signaling pathway. This leads to abnormal hepatic glucose and lipid metabolism, decreased glucose uptake, impaired glycogen synthesis, and increased fatty acid synthesis, thereby exacerbating steatosis.

Additionally, IL-6 promotes the proliferation and activation of hepatic stellate cells, accelerating the progression of liver fibrosis. Animal studies demonstrated that in IL-6 knockout mice, hepatic steatosis and inflammation induced by a high-fat diet are significantly milder compared to wild-type mice.

2.2.3. Mechanism of action of CRP

As an acute-phase reactant protein, CRP does not directly initiate inflammation but exacerbates hepatocyte damage through “inflammatory amplification” and “cytotoxic” effects.

CRP activation depends on IL-6 induction. Elevated IL-6 under stress binds to IL-6R on hepatocyte surfaces, activating the acute-phase response pathway within hepatocytes and promoting CRP synthesis and secretion.

CRP itself lacks direct pro-inflammatory activity but binds to CRP receptors on hepatocyte surfaces to activate the complement system. This releases complement fragments (e.g., C3a, C5a), recruiting inflammatory cells like neutrophils to infiltrate the liver and amplify local inflammation. Concurrently, CRP induces reactive oxygen species (ROS) production in hepatocytes, triggering oxidative stress that impairs mitochondrial function and disrupts cellular energy metabolism, thereby exacerbating hepatocyte damage ^[7].

Clinical studies indicate that serum CRP levels in NAFLD patients are significantly higher than in healthy individuals. Moreover, CRP levels correlate positively with liver function markers (e.g., alanine aminotransferase [ALT], aspartate aminotransferase [AST]) and the degree of liver fibrosis, making it a potential biomarker for assessing NAFLD disease progression.

2.3. Synergistic interactions among inflammatory cytokines

TNF- α , IL-6, and CRP do not act independently but form an inflammatory cascade through “mutual regulation and synergistic amplification,” collectively exacerbating hepatocyte injury ^[8].

TNF- α serves as the initiator of the inflammatory cascade. It directly promotes IL-6 gene transcription and secretion by activating the NF- κ B pathway, while simultaneously upregulating IL-6R expression on hepatocyte surfaces to enhance IL-6's effects. IL-6 also acts as an intermediate regulator, where it further promotes TNF- α release while inducing CRP synthesis in hepatocytes, creating a positive feedback loop (TNF- α -IL-6-CRP). Additionally, CRP activates the complement system to recruit inflammatory cells, which in turn stimulate Kupffer cells to secrete TNF- α and IL-6, amplifying the inflammatory response.

This synergistic interaction ultimately produces a “compounding effect” of hepatocyte damage: TNF- α -driven apoptosis, IL-6-regulated metabolic dysfunction and fibrosis, and CRP-amplified inflammation collectively led to hepatic steatosis, increased apoptosis, and advanced fibrosis. This accelerates the progression of NAFLD from simple steatosis to NASH and cirrhosis.

3. Current research status

Regarding the relationship between stress-related inflammatory factors and hepatic cell damage in fatty liver disease, multiple cross-sectional studies and meta-analyses have demonstrated that serum levels of TNF- α , IL-6, and CRP in NAFLD patients are significantly higher than in healthy individuals. These levels correlate closely with the severity of liver damage as serum inflammatory factor levels are markedly elevated in NASH patients compared to those with simple fatty liver disease, and cirrhosis patients exhibit even higher levels than NASH patients. Concurrently, serum TNF- α , IL-6, and CRP levels positively correlate with liver function markers (ALT, AST) and fibrosis staging (e.g., FIB-4 score, transient elastography values), positioning them as potential biomarkers for assessing NAFLD progression ^[9–12].

Mechanistic evidence from animal studies confirms that gene knockout or pharmacological inhibition of TNF- α and IL-6 expression significantly attenuates hepatic steatosis, inflammatory infiltration, and apoptosis in mice induced by high-fat diet or stress. *In vitro* cell experiments also indicate that adding TNF- α and IL-6 to hepatocyte culture systems induces hepatic steatosis and apoptosis, while adding corresponding neutralizing antibodies reverses such damage. Furthermore, clinical studies reveal that reducing stress levels in NAFLD patients through lifestyle interventions significantly lowers serum TNF- α , IL-6, and CRP levels while improving hepatic cell injury ^[13].

Despite these advances, several controversies and unresolved issues persist:

- (1) The causal relationship remains debated. Most existing studies are cross-sectional, confirming elevated inflammatory factor levels in NAFLD patients but failing to clarify whether “elevated inflammatory factors are the cause or consequence of NAFLD”^[14]. Some scholars propose that hepatic steatosis itself induces cellular stress, which in turn triggers inflammatory cytokine secretion, establishing a vicious cycle of “steatosis → elevated cytokines → further damage” rather than cytokines directly initiating NAFLD. Confirming this causal relationship requires additional prospective cohort studies and interventional trials (e.g., evaluating whether early cytokine suppression prevents NAFLD development);
- (2) The issue of intervention target specificity, as inhibitors targeting TNF- α (e.g., etanercept, adalimumab) demonstrate significant efficacy in autoimmune diseases like rheumatoid arthritis. However, in clinical studies of NAFLD, their improvement in hepatic cell injury is limited, and they may induce side effects such as infections and abnormal liver function^[15-18]. This may stem from TNF- α ’s multifaceted physiological roles, where systemic inhibition disrupts the “pro-inflammatory-anti-inflammatory” balance. Additionally, synergistic interactions among inflammatory mediators exist; single-target inhibition of TNF- α may trigger compensatory increases in other factors like IL-6, negating therapeutic effects. Thus, enhancing the specificity of inflammatory mediator interventions while avoiding systemic side effects remains a key research challenge;
- (3) The quantification of psychological stress poses challenges because there is no unified assessment standard for the impact of psychological stress on inflammatory factors. Existing studies predominantly employ self-reported stress scales (e.g., the Perceived Stress Scale, PSS) or cortisol level measurements. However, stress scales exhibit significant subjectivity, while cortisol levels are susceptible to circadian rhythms and testing timing, leading to poor reproducibility across studies^[19].

Furthermore, the synergistic mechanisms linking psychological and physiological stress to inflammatory factors remain unclear. Establishing more precise stress assessment systems is essential to quantify stress’s impact on inflammatory factors and hepatocyte damage^[20].

4. Conclusion

Stress-related inflammatory factors (TNF- α , IL-6, CRP) serve as the core bridge connecting “stress” to “fatty liver hepatocyte damage.” Both physiological and psychological stress activate signaling pathways such as NF- κ B and JAK-STAT3, inducing abnormal expression of these inflammatory factors. This leads to exacerbated hepatocyte injury through direct induction of apoptosis and indirect regulation of metabolic disorders and fibrosis progression. Simultaneously, synergistic interactions among inflammatory factors amplify the inflammatory response, accelerating NAFLD progression. Current research confirms that TNF- α , IL-6, and CRP serve as potential biomarkers for assessing NAFLD progression, and their targeted intervention offers new therapeutic directions.

However, three core challenges remain:

- (1) Prospective studies are needed to establish the causal relationship between inflammatory cytokines and NAFLD;
- (2) Developing liver-specific inhibitors for these cytokines is essential to enhance intervention efficacy while reducing side effects;
- (3) Establishing a precise stress assessment system to quantify the impact of psychological stress on

inflammatory factors and hepatocyte damage.

Future efforts should integrate multi-omics technologies (e.g., genomics, metabolomics) with clinical translational research to deeply explore the regulatory network linking stress, inflammatory factors, and hepatocyte damage, thereby providing a more robust theoretical foundation for the precise diagnosis and treatment of NAFLD.

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Application of MBSR Combined with Relaxation Training in the Perioperative Period of Interventional Therapy for Lumbar Disc Herniation

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Abstract: *Objective:* To explore the application effect of MBSR combined with relaxation training in the perioperative period of radiofrequency ablation combined with ozone interventional therapy for lumbar disc herniation. *Methods:* 90 patients with lumbar disc herniation who underwent radiofrequency ablation (RFA) combined with ozone interventional therapy in the Orthopedics and Traumatology Department of our hospital from January to December 2019 were included as research samples. They were randomly divided into two groups using a random number table method: the control group (45 cases) received routine perioperative nursing and health education; the experimental group (45 cases) received a comprehensive psychological intervention program consisting of MBSR combined with relaxation training in addition to the control group's treatment. Changes in pain perception (VAS), sleep quality (PSQI), psychological state (SAS/SDS), and life satisfaction (SWLS) were compared between the two groups before and after the intervention. *Results:* After the intervention, both groups showed a significant decrease in SAS and SDS scores ($P < 0.05$), with a greater decrease in the experimental group ($P < 0.05$); the experimental group had lower PSQI total scores and scores in each dimension compared to the control group ($P < 0.05$); the experimental group had a significantly lower VAS score (3.56 ± 0.88) compared to the control group (5.94 ± 0.62) ($P < 0.05$); the experimental group had a higher SWLS score (28.59 ± 5.61) compared to the control group (22.46 ± 4.15) ($P < 0.05$). *Conclusion:* MBSR combined with relaxation training can significantly optimize the perioperative psychological state of patients undergoing RFA combined with ozone interventional therapy, reduce pain sensitivity and stress responses, and simultaneously improve sleep quality and treatment satisfaction.

Keywords: MBSR; Radiofrequency ablation combined with ozone interventional therapy; Relaxation training;

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1. Introduction

Lumbar disc herniation (LDH) imposes a heavy burden on individuals, families, and society due to its highly recurrent nature^[1–2]. Radio Frequency Ablation (RFA) is a commonly used minimally invasive interventional treatment for LDH. When combined with ozone injection, it not only achieves nucleus pulposus ablation and alleviates nerve compression but also exerts anti-inflammatory and analgesic effects, thereby aiding in the control of patients' clinical symptoms^[3].

In current clinical practice, some middle-aged and elderly patients exhibit a triple cognitive-trust barrier chain:

- (1) They lack a structured understanding of the pathological staging, progression trajectory, and the necessity for systematic treatment of their disease;
- (2) Limited by their educational background and health literacy, they struggle to effectively interpret key decision-making parameters, such as the risk-benefit ratio of surgery and the survival rate of prostheses;
- (3) Due to previous negative medical experiences or the spread of medical rumors, they develop defensive skepticism towards the professional judgment of healthcare teams^[4].

Our team believes that this leads to inadequate preoperative psychological preparation and exacerbated intraoperative stress responses; indirectly causing a decline in treatment adherence, such as self-adjusting medication dosages and refusing rehabilitation training, ultimately resulting in clinical outcomes deviating from the expected therapeutic window. Psychological nursing interventions are particularly effective in addressing these issues.

Mindfulness-Based Stress Reduction (MBSR) is an emotion and stress management method based on mindfulness meditation, guided by the core principles of “being present” and “non-judgment”^[1]. Mindfulness therapy combined with relaxation training, as an important component of psychological nursing interventions, helps alleviate intraoperative tension and stress responses, enhancing surgical satisfaction.

This study applied MBSR combined with relaxation training to the perioperative care of patients undergoing RFA combined with ozone intervention, yielding significant clinical effects. The findings are reported as follows to provide references for clinical nursing practitioners.

2. Materials and methods

2.1. General information

90 patients with lumbar disc herniation who underwent RFA combined with ozone intervention in the Orthopedics Department of our hospital from January 2021 to December 2021 were collected and randomly divided into an experimental group and a control group, with 45 patients in each group, according to the random number table method. Among them, the experimental group comprised 20 males and 25 females, with an average age of (49.82 ± 9.76) years; the conventional group comprised 22 males and 23 females, with an average age of (50.20 ± 9.56) years. There were no statistically significant differences in the baseline data between the two groups.

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

The inclusion criteria are as follows:

- (1) Diagnostic criteria specified in the “Guidelines for the Diagnosis and Treatment of Lumbar Disc Herniation” issued by the Orthopaedic Branch of the Chinese Medical Association in 2020^[5];

- (2) Aged between 18 and 80 years;
- (3) Signed informed consent and actively cooperated with the treatment.

2.2.2. Exclusion criteria

The exclusion criteria are as follows:

- (1) Patients with severe cardiovascular and cerebrovascular diseases, severe infectious diseases, tumors, or other conditions that affect the assessment of nursing outcomes;
- (2) Severe liver and kidney dysfunction, coagulation disorders, or blood system diseases;
- (3) Severe spinal stenosis, cauda equina nerve injury, lumbar spondylolisthesis, etc.;
- (4) Female patients planning pregnancy, in pregnancy, or during lactation;
- (5) Patients with severe mental disorders or conditions such as blindness, deafness, or muteness that prevent normal communication.

2.2.3. Dropout criteria

The dropout criteria are as follows:

- (1) Poor patient compliance;
- (2) Development of other major diseases during hospitalization;
- (3) Withdrawal from the study for various subjective or objective reasons.

2.3. Intervention methods

2.3.1. Experimental group

MBSR combined with relaxation training was adopted:

- (1) A mindfulness-based stress reduction team, consisting of healthcare professionals with over 10 years of work experience, was trained by a professional psychology professor on topics such as “Methods and Applications of Mindfulness Therapy” and “Psychological Interventions for Patients Experiencing Stress Reactions,” followed by relevant assessments;
- (2) Specific nursing plan: MBSR (Mindfulness-Based Stress Reduction):
 - (i) Body scan: The responsible nurse instructs the patient to lie down flat, relax completely, or assume a “space traveler” lying position, breathe slowly, and feel the breath entering through the tip of the nose, traveling down the Ren Meridian to the lower Dan Tian (a point below the navel); then ascending from the tailbone along the Du Meridian to the Bai Hui point at the top of the head, allowing the patient to enter a state of utmost natural relaxation;
 - (ii) Sitting meditation: Guide the patient to sit comfortably, close their eyes gently, and engage in a one-minute abdominal relaxation exercise, adjusting their breathing autonomously. When pain arises, encourage the patient to observe the location and intensity of the pain, suggesting that the pain will dissipate with the breath. Spend 10–15 minutes daily on this, followed by a 1–2 minute rest before proceeding with other medical activities;
 - (iii) Walking meditation: Guide the patient to engage in “movement meditation,” such as standing in the ward with feet parallel and shoulder-width apart, hands overlapping below the navel, closing their eyes and taking three deep breaths, then walking slowly, attentively feeling each movement while walking, and recording a journal;

- (iv) Three-Minute breathing space technique: The responsible nurse instructs the patient to sit quietly, guiding them into a meditative state with full-body relaxation, viewing the body as an object of attention. Focus on the breathing movements to calm the mind, trying to perceive one's current thoughts and inner emotions. When negative emotions arise or a sense of tension and resistance exists, guide the patient to gently dispel them through deep breathing. Maintain an appropriate breathing frequency, performing the exercise for about 3 minutes each time, with no limit on the number of repetitions.
- (v) Relaxation training:
 - (a) Breathing relaxation therapy: During exhalation, feel the breath descending from the Bai Hui point along the Ren Meridian to three inches below the navel; then from the Hui Yin point to the Yong Quan point; during inhalation, feel the breath ascending along the Foot Three Yang Meridians to the crown of the head via the Du Meridian;
 - (b) Music relaxation therapy: Play some Beethoven music through the ward television to uplift the patient's mood.

2.3.2. Control group

Adopt routine orthopedic perioperative nursing methods.

2.4. Observation indicators

2.4.1. Self-rating anxiety scale (SAS)

It was used to assess the level of anxiety, comprising 20 items rated on a 4-point scale ranging from 1 (none or very little time) to 4 (most or all of the time). The higher the score, the more severe the anxiety of the assessed individual.

2.4.2. Self-rating depression scale (SDS)

This scale is used to evaluate the degree of depression, with a total of 20 items rated on a 4-point scale from 1 (none or very little time) to 4 (most or all of the time). The total score is out of 100 points, with 53 points serving as the cutoff. The final score is positively correlated with the severity of depression; the higher the score, the more severe the depression.

2.4.3. Pittsburgh sleep quality index (PSQI)

The PSQI scale is used to evaluate patients' sleep quality over the past month, divided into seven dimensions. A higher score indicates poorer sleep quality.

2.4.4. Satisfaction with life scale (SWLS)

Comprising five items, a higher score indicates greater life satisfaction.

2.4.5. VAS score

Pain intensity was assessed using a standard Visual Analogue Scale (VAS), as detailed in **Table 1**. The VAS consisted of a 10-cm horizontal line anchored by the descriptors "No Pain" on the left end (0 cm) and "Worst Pain Imaginable" on the right end (10 cm). Patients were instructed to mark a point on the line that best represented their current pain level. The VAS score was determined by measuring the distance from the left anchor to the

patient's mark, providing a continuous score ranging from 0 to 10.

Table 1. VAS pain score scale

Feature	Description
Scale name	Visual Analogue Scale (VAS) for Pain
Format	A 10-cm (100-mm) horizontal line
Left anchor	0 cm: "No Pain"
Right anchor	10 cm: "Worst Pain Imaginable"
Scoring	Patients mark a point on the line to indicate their pain level. The score (0-10) is determined by measuring the distance in centimeters from the left anchor ("No Pain") to the mark.

2.5. Statistical methods

Data were analyzed using Python software. A *P*-value less than 0.05 indicates statistical significance.

3. Results

3.1. Psychological status

There was a statistically significant difference in psychological status scores between the two groups of patients (*P* < 0.05), as shown in **Table 2**.

Table 2. Comparison of psychological status before and after intervention between the two groups (mean ± SD)

Group	n	SAS		t-value	p-value	SDS		t-value	p-value
		Before	After			Before	After		
Experimental group	45	52.36 ± 3.28	31.29 ± 2.98	-27.42	< 0.001	59.63 ± 5.13	38.54 ± 2.65	-29.63	< 0.001
Control group	45	51.88 ± 3.86	44.33 ± 4.82	-10.72	< 0.001	58.79 ± 4.32	48.96 ± 4.11	-17.25	< 0.001
t-value		0.636	-15.432			0.840	-14.294		
p-value		0.526	< 0.001			0.403	< 0.001		

3.2. Sleep quality

A statistically significant difference (*P* < 0.05) was observed in the sleep quality scores between the two groups, as shown in **Table 3**, **Table 4**, and **Table 5**.

Table 3. Comparison of sleep quality scores between the two groups before and after intervention (mean ± SD)

Group	n	Sleep onset time		t-value	p-value	Sleep duration		t-value	p-value
		Before	After			Before	After		
Experimental group	45	1.82 ± 0.45	1.13 ± 0.22	1.247	< 0.001	2.56 ± 0.37	1.88 ± 0.21	3.457	< 0.001
Control group	45	1.90 ± 0.35	1.65 ± 0.44	1.332	< 0.001	2.49 ± 0.24	2.23 ± 0.79	1.004	< 0.001
t-value		-0.941	-7.094			1.066	-2.871		
p-value		0.349	< 0.001			0.289	0.005		

Table 4. Comparison of sleep quality scores between the two groups before and after intervention (mean \pm SD)

Group	n	Sleep disorder score		t-value	p-value	Sleep quality score		t-value	p-value
		Before	After			Before	After		
Experimental group	45	1.98 \pm 0.78	1.15 \pm 0.59	1.260	< 0.001	2.33 \pm 0.17	1.29 \pm 0.37	6.492	< 0.001
Control group	45	1.88 \pm 0.32	1.63 \pm 0.44	1.741	< 0.001	2.22 \pm 0.41	1.87 \pm 0.57	3.715	< 0.001
t-value		0.795	-4.375			1.663	-5.724		
p-value		0.428	< 0.001			0.100	< 0.001		

Table 5. Comparison of sleep quality scores between the two groups before and after intervention (mean \pm SD)

Group	n	Sleep efficiency score		t-value	p-value	Dysfunction score		t-value	p-value
		Before	After			Before	After		
Experimental group	45	2.01 \pm 0.63	1.19 \pm 0.33	1.231	< 0.001	2.45 \pm 0.78	1.39 \pm 0.74	4.571	< 0.001
Control group	45	1.92 \pm 0.45	1.62 \pm 0.18	0.095	< 0.001	2.39 \pm 0.66	2.01 \pm 0.37	0.225	< 0.001
t-value		0.779	-7.674			0.394	-5.024		
p-value		0.438	< 0.001			0.694	< 0.001		

3.3. Life satisfaction scores

A statistically significant difference ($P < 0.05$) was observed in the life satisfaction scores between the two groups, as shown in **Table 6**.

Table 6. Comparison of SWLS scores (mean \pm SD)

Group	n	Before intervention	After intervention	t-value	p-value
Experimental group	45	19.82 \pm 3.59	28.59 \pm 5.61	-13.27	< 0.001
Control group	45	20.79 \pm 3.32	22.46 \pm 4.15	-4.71	< 0.001
t-value		-1.331	5.892		
p-value		0.186	< 0.001		

3.4. VAS scores

A statistically significant difference ($P < 0.05$) was observed in the pain scores between the two groups, as shown in **Table 7**.

Table 7. Comparison of VAS scores between the two groups before and after intervention (mean \pm SD)

Group	n	Before intervention	After intervention	t-value	p-value
Experimental group	45	8.36 \pm 0.79	3.56 \pm 0.88	-28.15	< 0.001
Control group	45	8.21 \pm 0.86	5.94 \pm 0.62	-3.12	0.003
t-value		0.861	-14.829		
p-value		0.391	< 0.001		

4. Discussion

LDH is a degenerative spinal disease and a common cause of low back pain and leg pain. The etiology of this disease typically stems from the degeneration of the intervertebral disc. When the annulus fibrosus partially or completely ruptures, the protrusion of the nucleus pulposus can stimulate or compress the nerve roots, leading to pain and other symptoms. Patients often have a history of prolonged bending, labor, or extended periods of sitting or standing. Groups with a high prevalence of the disease include adolescents, athletes involved in throwing, high jump, long jump, etc., drivers, the elderly, pregnant women, and individuals with a family history.

Prompt medical attention is necessary if there are abnormalities in urination or defecation, or abnormal sensations in the saddle area. Diagnosis primarily relies on the patient's symptoms, physical signs, and imaging examinations such as magnetic resonance imaging. Non-surgical treatments are the mainstay for lumbar disc herniation, including lifestyle management, physical therapy, and medication. For patients with severe symptoms that do not respond to non-surgical treatments, minimally invasive spinal techniques or open surgery may be considered.

Pharmacological treatments typically include non-steroidal anti-inflammatory drugs, muscle relaxants, dehydrating agents, and short-term use of corticosteroids. As a degenerative condition, the prevention and management of LDH involve avoiding prolonged poor postures, such as bending over or sitting for extended periods, strengthening the lumbar muscles, maintaining a healthy weight, paying attention to dietary intake, avoiding excessive lifting of heavy objects, and undergoing regular medical check-ups for high-risk individuals to monitor disease progression^[6]. According to the World Health Organization, approximately two-thirds of adults experience lower back and lower limb pain at some point in their lives, with about 85% of LDH patients also suffering from sciatica^[7].

RFA is a commonly used minimally invasive interventional treatment method, widely applied due to its simplicity, minimal trauma, and rapid recovery. Ozone injection can oxidize polysaccharide proteins in the nucleus pulposus, effectively reducing inflammation and alleviating pain^[8]. However, since the patient population is predominantly middle-aged and elderly, their tolerance decreases. The physical discomfort and pain caused by the disease, uncertainty about RFA treatment, anxiety and fear due to intraoperative puncture, and even a lack of sufficient trust in doctors can easily lead to irritability, anxiety, and other emotions, resulting in a fear of movement. This psychological state and physical discomfort interact, leading to sleep disturbances and forming a vicious cycle.

In such pathological states, the sympathetic-adrenal medullary axis shows excessive activation, prompting the postganglionic nerve fiber endings to release large amounts of catecholamine neurotransmitters such as norepinephrine, while the adrenal medulla simultaneously secretes supra-physiological concentrations of adrenaline into the bloodstream. This neuroendocrine cascade reaction mediates positive chronotropic/inotropic effects on the myocardium via $\beta 1$ receptors, causing sinus tachycardia with palpitations in patients during surgery. Consequently, it triggers abnormal peripheral vascular constriction and respiratory muscle spasms via $\alpha 1$ receptors, manifesting as progressively worsening chest tightness and subjective dyspnea.

More notably, sustained activation of skeletal muscle $\beta 2$ receptors induces continuous muscle fiber fasciculations, which can then progress to painful muscle tension. In cases of extreme stress, the aforementioned multisystem disorders can synergistically trigger acute anxiety attacks, with patients often reporting sensations of "suffocation" or "near-death panic." These prodromal symptoms of neurogenic shock significantly elevate the risk of intraoperative cardiovascular accidents, severely impacting the smooth progress of interventional treatment

and postoperative outcomes^[9]. Therefore, targeted professional psychological nursing protocols should be applied during the perioperative period.

Our research team posits that MBSR, as a core branch of third-generation cognitive-behavioral therapy, is theoretically grounded in structured attentional regulation training, such as focused meditation, somatic dynamic awareness, or yoga asanas. These practices guide patients to anchor cognitive resources in immediate internal and external stimulus experiences, thereby reconstructing neural plasticity pathways for emotion regulation.

This psychosomatic intervention model operates through two parallel mechanisms:

- (1) By enhancing prefrontal cortex inhibitory control over the limbic system, lowering the threshold for negative emotional responses and achieving top-down regulation;
- (2) By modulating vagal tone to suppress overactivation of the sympathetic-adrenal medullary axis, promoting physiological relaxation and achieving bottom-up feedback.

Quantitative analysis in this study revealed that the experimental group receiving integrated MBSR-relaxation training intervention demonstrated significant reductions in Self-Rating Anxiety Scale scores compared to baseline, with statistically significant intergroup differences in Self-Rating Depression Scale scores. These objective data provide evidence-based confirmation that this combined intervention effectively disrupts the vicious cycle of “anxiety-depression-pain.”

Study results indicated that sleep quality and life satisfaction scores in the experimental group were significantly higher than those in the control group ($P < 0.05$). These findings suggest that the combined nursing approach not only alleviates depressive symptoms but also improves sleep quality through meditation and breathing exercises, enabling patients to more easily enter deep sleep states. This further mitigates depressive states, gradually forming a positive feedback loop that encourages patients to more actively confront their illness and rehabilitation process^[10].

Postoperative recovery of physical function, reintegration into social roles, and psychological state all influence patients' quality of life. A positive psychological state facilitates active participation in rehabilitation and social activities, enhancing quality of life, which in turn promotes physical recovery, improves role and cognitive functioning, and even elevates pain thresholds.

5. Conclusion

In summary, the combination of MBSR and relaxation training can significantly improve the psychological state of patients undergoing intervertebral disc radiofrequency ablation combined with ozone intervention during the perioperative period, reduce intraoperative and postoperative pain perception and psychological stress responses, effectively enhance patients' sleep quality, and increase postoperative satisfaction.

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Disclosure statement

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Analysis of the Application Effect of Multi-Role Positioning Service Model in Hypertensive Patients in Health Examination Center

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Abstract: *Objective:* To study the application effect of the multi-role positioning service model in hypertensive patients in the health examination center. *Methods:* A total of 152 hypertensive patients admitted to the hospital's health examination center from January 2024 to January 2025 were selected as the subjects. They were randomly divided into two groups using a random number table method. The control group (76 cases) received conventional physical examination service mode, while the observation group (76 cases) adopted the multi-role positioning service model. The nurse proficiency and physical examination quality were compared between the two groups. *Results:* The nurse proficiency scores in the observation group were higher than those in the control group ($P < 0.05$). The physical examination quality scores in the observation group were higher than those in the control group ($P < 0.05$). *Conclusion:* The adoption of the multi-role positioning service model for hypertensive patients in the health examination center can improve nurse proficiency and physical examination quality.

Keywords: Hypertension; Health examination center; Conventional physical examination service mode; Multi-role positioning service model

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1. Introduction

Residents in China face issues such as high life stress, inadequate physical activity, and unhealthy diets, leading to a continuous increase in the incidence of chronic diseases like hypertension^[1]. Long-term hypertension elevates the risk of cardiovascular and cerebrovascular accidents, posing a threat to life safety^[2]. Regular outpatient follow-up or health checkups can assess hypertension status, provide timely individualized guidance to patients, and enable early detection and effective treatment of cardiovascular and cerebrovascular accidents^[3]. As health awareness among Chinese residents grows, the number of hypertensive patients undergoing regular health checkups increases. To assist hypertensive patients in completing health checkups smoothly and efficiently, it is crucial to provide excellent service. The multi-role positioning service model, a novel service approach based

on multi-role positioning theory, can enhance the overall proficiency of nurses conducting health checkups and improve the quality of health services. This study analyzed the effectiveness of the multi-role positioning service model in health checkups among 152 hypertensive patients.

2. Materials

2.1. General information

The sample size was estimated using the formula $n_1 = n_2 = 2[(u\alpha + u\beta)/(\delta/\sigma)]^2 + 0.25u\alpha^2$, where n represents the sample presentation mode, and n_1 and n_2 denote the sample sizes of the observation group and control group, respectively. The initial calculated sample size was $n_1 = n_2 = 60$ cases, meaning at least 120 patients were required for the study. However, to account for potential sample loss during the research period, the sample size was increased to 76 cases per group, resulting in a total sample size of 152 cases. From January 2024 to January 2025, a total of 152 hypertensive patients were admitted to the hospital's health examination center. All participants were randomly assigned using a random number table method, with 76 cases in the control group and 76 cases in the observation group. In the control group: 45 males and 31 females; age range 32–62 years (mean 47.31 ± 5.06 years); disease duration 1–7 years (mean 4.25 ± 1.06 years); 34 cases with junior high school education or below, and 42 cases with education beyond junior high school. In the observation group: 41 males and 35 females; age range 34–61 years (mean 47.89 ± 5.25 years); disease duration 1–8 years (mean 4.66 ± 1.21 years); 31 cases with junior high school education or below, and 45 cases with education beyond junior high school. No significant differences were observed between the groups in baseline characteristics ($P > 0.05$).

2.1.1. Inclusion criteria

- (1) Meeting the diagnostic criteria outlined in the National Guidelines for Primary Hypertension Prevention and Management (2020 Edition).
- (2) Possessing independent communication and writing abilities.
- (3) Having stable vital signs and being able to cooperate with health examinations and related surveys.
- (4) Providing informed consent for the study.

2.1.2. Exclusion criteria

- (1) Presence of major organ dysfunction.
- (2) Suffering from infectious diseases.
- (3) Having psychiatric disorders.
- (4) Experiencing auditory or visual impairments.

3. Methods

The control group received the conventional health examination service model: Upon entering the health examination center, participants were provided with a physical examination form and informed about the requirements, purposes, and precautions of the examination. After completing all examination items, they were notified about the time, location, and method for obtaining their examination reports.

The observation group received a multi-role positioning service model, which included the following aspects:

(1) Training

Nurses in the health examination center underwent training focused on the principles, procedures, and precautions of multi-role positioning services. This training aimed to enhance their knowledge and service capabilities, enabling them to adapt to various roles and provide high-quality services to examinees.

(2) Service provider

Upon arrival, examinees were warmly received and offered proactive assistance, such as retrieving examination forms and logging information. Nurses maintained patience and a smiling demeanor throughout, demonstrating respect for the examinees. They presented themselves with a polite, dignified, and neat appearance to uphold the image of the department and hospital. A clean, comfortable, and safe examination environment was maintained, with clear and standardized signs placed in all corridors to guide examinees through each step. The waiting area was equipped with an adequate number of chairs, bottled drinking water, free paper cups, health examination booklets, and educational materials on common chronic diseases, allowing examinees to wait comfortably, hydrate, and read. Additionally, wheelchairs and stretchers were provided in visible locations for free use by those with mobility difficulties or physical weakness.

(3) Executor

Nurses proactively inquired about examinees' information and patiently explained the requirements, procedures, and precautions for each examination item based on the selected package. They listened attentively to questions and provided detailed answers. Using the computer system, nurses monitored the waiting status of each department and guided examinees to complete each item efficiently. They also helped plan examination routes for those with time constraints. Examinees were informed about the methods and timing for obtaining their reports, with options for electronic or paper versions. A green channel was established to facilitate appointments, specialist consultations, and hospitalization services for those requiring immediate medical attention or further examination.

(4) Demonstrator

After accompanying examinees through all items or upon issuing reports, nurses actively assisted in interpreting the results and conducting comprehensive health assessments. Special attention was given to individuals with suspected conditions, followed by gentle and patient targeted education, encouraging further examination until diagnosis and treatment. For results indicating slightly abnormal values without confirmed disease but suggesting high risk of chronic conditions, targeted explanations were provided along with corresponding preventive measures. Examinees were urged to correct unhealthy habits and adopt healthier lifestyles.

(5) Manager

With the aid of computer systems, nurses strictly monitored foot traffic in the health examination center across different time slots and tracked waiting times for each examination item. They proactively updated examinees on current conditions, adjusted examination sequences appropriately, or deployed nurses to disperse crowds, preventing congestion in specific areas. After completing examinations, with the examinees' consent, personal health records were created to document each result in detail, assisting physicians in comprehensive health evaluations and guiding patients in daily life and medication management, especially for those with chronic conditions like hypertension.

(6) Counselor

For examinees showing significant anxiety or depression during the examination, nurses communicated with

them promptly, preferably in a private room to protect their privacy. They encouraged open expression of concerns, alleviating psychological burdens induced by chronic diseases like hypertension, helping maintain a positive mindset to complete examinations optimistically, and thoughtfully follow medical advice.

(7) Tracker

For those who established health records or were diagnosed with chronic diseases such as hypertension, nurses accurately communicated results and explained the necessity of continuous and effective management. Follow-up sessions were scheduled to track symptoms, signs, and recent re-examination results. Professional guidance and assistance were provided based on the examinees' needs.

3.1. Observation indicators

- (1) Nursing competency: Evaluated using a self-developed Comprehensive Nursing Competency Assessment Questionnaire designed by the Health Examination Center. The questionnaire demonstrated high reliability (Cronbach's $\alpha = 0.884$) and validity (content validity index = 0.897). It assessed six dimensions: professional ethics, service attitude, communication skills, organizational ability, appearance and demeanor, and humanistic literacy. Each item was scored on a scale of 0–10, with higher scores indicating better performance in the respective dimension.
- (2) Physical examination quality: Evaluated using a self-developed Physical Examination Quality Assessment Questionnaire designed by the Health Examination Center. The questionnaire showed high reliability (Cronbach's $\alpha = 0.891$) and validity (content validity index = 0.902). It evaluated five aspects: examination environment, examination duration, examination process, examination guidance, and privacy protection. Each item was scored on a scale of 0–20, with higher scores indicating better quality in the respective aspect.

3.2. Statistical methods

Data analysis was performed using SPSS 27.0. Categorical data were expressed as percentages (%) and compared using the χ^2 test. Continuous data that followed a normal distribution were presented as $\bar{x} \pm s$ and compared using the t-test (or F-test for ANOVA). A p -value < 0.05 was considered statistically significant.

4. Results

4.1. Comparison of nursing competency scores between the two groups

As shown in **Table 1**, the nursing competency scores of the observation group were significantly higher than those of the control group ($P < 0.05$).

Table 1. Comparison of nursing competency scores between the two groups ($\bar{x} \pm s$, points)

Group	n	Professional ethics	Service attitude	Communication skills	Organizational skills	Appearance and demeanor	Humanistic quality
Observation	76	9.35 \pm 0.56	9.45 \pm 0.53	9.40 \pm 0.57	9.38 \pm 0.59	9.43 \pm 0.57	9.31 \pm 0.59
Control	76	8.62 \pm 0.47	8.78 \pm 0.45	8.82 \pm 0.49	8.69 \pm 0.52	8.80 \pm 0.53	8.72 \pm 0.52
t-value		8.705	8.401	6.727	7.649	7.056	6.540
p-value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

4.2. Comparison of physical examination quality scores between the two groups

As shown in **Table 2**, the observation group had significantly higher physical examination quality scores than the control group ($P < 0.05$).

Table 2. Physical examination quality scores of the two groups (Mean \pm SD, Points)

Group	n	Examination environment	Examination time	Examination process	Examination guidance	Privacy protection
Observation	76	18.76 \pm 1.16	18.91 \pm 1.07	18.59 \pm 1.25	18.65 \pm 1.29	18.80 \pm 1.16
Control	76	17.02 \pm 1.05	17.45 \pm 1.00	17.00 \pm 1.13	17.09 \pm 1.13	17.00 \pm 1.05
t-value		9.695	8.691	8.226	7.930	10.029
p-value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

5. Discussion

Health examination is a simple, affordable, and easily manageable healthcare approach. Through various examination items, it allows for a comprehensive analysis of an individual's physical functions and assessment of their health status ^[4]. Regular health examinations help individuals track changes in their health status and detect diseases at an early stage, particularly chronic conditions ^[5]. Early identification and timely intervention can facilitate prompt control of health issues, reduce the risk of severe complications resulting from disease progression, and ultimately promote overall well-being ^[6]. With the rapid development of the socioeconomy, public awareness of the importance of health examinations has increased. Consequently, health examination centers are experiencing growing patient volumes, and examinees now have higher expectations for service quality ^[7]. It is essential for health examination centers to actively analyze the needs of examinees, promptly address their reasonable demands, and continuously improve the quality of examination services.

In this study, both the nursing competency scores and physical examination quality scores of the observation group were higher than those of the control group ($P < 0.05$), indicating that the multi-role positioning service model is more advantageous compared to the conventional physical examination service model. The reason for this may be that hypertension is a chronic disease that cannot be cured, making regular health examinations crucial for patients' condition control and prognosis improvement ^[8]. The service model of health examinations directly affects the experience of hypertensive patients, necessitating the exploration of a more ideal service model. The conventional physical examination service model fails to meet the diverse needs of different examinees and lacks initiative in service provision ^[9, 10]. The multi-role positioning service model addresses issues such as substandard examination quality and poor patient experience by focusing on improving nurses' comprehensive competency and professional skills. Through personnel training, this approach enhances various abilities of nurses, helps them understand the responsibilities of different roles, and transforms their service mindset ^[11]. It encourages nurses to shift from passive to active service, providing continuous and personalized care to examinees. This model helps examinees gain a comprehensive understanding of the health examination process, enabling them to complete various examination items quickly, efficiently, and accurately, thereby improving their overall experience and the quality of the examination.

6. Conclusion

In conclusion, the implementation of the multi-role positioning service model in health examinations for hypertensive patients can enhance nursing competency and service quality. However, this study has certain limitations, such as a limited number of evaluation indicators, the absence of metrics like examination duration and patient satisfaction, and a lack of comprehensive analysis regarding the overall impact of different service models on examination outcomes. Future clinical studies should include larger sample sizes and more in-depth investigations.

Disclosure statement

The author declares no conflict of interest.

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Analysis of the Current Status and Influencing Factors of “Future Work Self-Clarity” Among Chinese Intern Nurses: A Cross-Sectional Survey

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Abstract: *Background:* The shortage of nurses in China is still a serious problem, how to improve the future work self-clarity of nursing students is very important. *Objective:* To evaluate the future work self-clarity among nursing students regarding their future careers and the factors influencing it. *Methods:* A total of 204 undergraduate nursing students from Guangzhou, Guangdong, China, were selected as participants for an online cross-sectional questionnaire survey. *Results:* The scores of the “Future Work Self-Clarity Scale”, Spiritual Climate Scale, and Career Calling Questionnaire for nursing students were (18.34 ± 3.64) , (14.43 ± 3.77) , (39.25 ± 10.45) , respectively. Multiple linear regression analysis results indicated that satisfaction with clinical teachers, spiritual climate, and occupational calling were the influencing factors of future work self-clarity for intern nursing students ($t = -3.230, 2.92, 4.68$; all $P < 0.05$). *Conclusion:* The level of future work self-clarity among nursing students requires further improvement. Nursing managers should provide comprehensive attention and encouragement to nursing students to enhance their future work self-clarity and facilitate the construction and development of the nursing team.

Keywords: Career adaptability; Nursing students; Self-clarify; Spirituality

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1. Introduction

The aging population and the surge in national health demands pose significant challenges to the medical industry. The World Health Organization predicts that by 2030, the world will need to increase 400 million medical workers to meet the medical service requirements of the global population^[1]. The National Nursing Development Plan (2021–2025) points out that by the end of 2020, the total number of registered nurses in China was over 4.7 million, with 3.34 registered nurses per thousand people, and a national doctor-nurse ratio of 1:1.15. The shortage

of nurses in China is still severe, and there is a large gap between the supply of nursing services and the diverse and differentiated medical needs of the people ^[2]. The study of Wang et al. indicated that the turnover rate of junior nurses (working years < 5 years) was as high as 3.68% because the internship process did not meet their expectations ^[3].

Improving the professional cognition and clarity of nursing students during the clinical practice stage and increasing their career choice rate are of great significance for expanding the nursing talent reserve and promoting the development of the nursing discipline.

“Future Work Self-Clarity” refers to the clarity of an individual’s self-image cognition in future work, which has been proven to be significantly correlated with many positive traits and positive behavior tendencies of an individual and can predict the initiative of individual career development and the active planning behavior of an individual’s career ^[4]. Individuals with a clear future work self are more aware of or sensitive to the information and feedback related to the work self in the outside world and can receive and understand this information with an open attitude, thus generating more proactive professional and assertive behaviors. The easier it is for an individual to realize or construct a self-image in future work, and the higher the clarity of this self-image, the greater the individual’s “Future Work Self-Clarity” ^[5,6].

Spiritual climate refers to the atmosphere in which nursing students are respected and encouraged to express their personal views in the workplace. It can not only effectively relieve work pressure and enhance departmental cohesion but also effectively promote the common progress of individuals and teams and contribute to their career success ^[7]. The subtle spiritual climate is like a link connecting individuals and work, forming an invisible organizational culture within the organization. This organizational culture enables individuals to enhance their perception of the meaning and purpose of work through the working process, establish a sense of connection with others, and achieve the integration of self and organization ^[8].

Career calling refers to a strong passion for a certain field and has the attribute of positive emotions ^[9]. It is a motivating force at work, reflecting the internal motivation of the individual and having an important impact on the individual’s work attitude and behavior ^[10]. Zhang et al. found that career calling could effectively improve the job satisfaction of nursing students, reduce job fatigue and burnout, and play a positive role in maintaining the stability of nursing team members ^[11].

Currently, research on “Future Work Self-Clarity” in China’s nursing industry is in its infancy, and there are no relevant investigations for nursing students. Nursing students urgently need to establish correct professional values, clear work goals, and work positioning and respond to challenges with a positive attitude. Based on this, this study aims to explore the current status and influencing factors of “Future Work Self-Clarity” among nursing students, providing a reference for the future stability and high quality development of reserve talents in the nursing industry.

2. Methods

2.1. Aim

The aim of this study is to investigate the current status and influencing factors related to nursing students’ “Future Work Self-Clarity”, in order to provide a reference for promoting the stability and high - quality development of reserve talents in the nursing industry in the future.

2.2. Design

We designed a cross-sectional survey of the “Future Work Self-Clarity” in Chinese nursing students using a quantitative design, specifically a cross-sectional, descriptive, and correlational study.

2.3. Participants

This study was conducted among nursing internship students from 6 nursing schools in Guangzhou, Guangdong, China, from Jan to Jun, 2024.

A total of 220 nursing undergraduates were selected by convenience sampling. Inclusion criteria were:

- (1) Undergraduate students participating in a nursing internship at the hospital;
- (2) Having completed the internship for more than 6 months;
- (3) Voluntarily participating and willing to provide informed consent.

Students who studied elsewhere or were on leave during the survey period were excluded.

2.4. Sample size

Statistical sample size estimation was used to calculate the required sample size. This method suggests that the number of respondents should be 5–10 times the number of variables. 10 variables were considered, including gender, place of origin, single-child status, being a student leader/participating in community organizations, participating in career planning courses, liking for nursing work, satisfaction with clinical teachers, experience of medical disturbance, patient death during internship, and current employment environment.

The “Future Work Self-Clarity” Scale, Spiritual Climate Scale, and Occupational Calling Scale were all single-dimension scales. Thus, the required sample size was 130–260 participants. Given that approximately 20% of the questionnaires were likely to be invalid, the sample size was determined to be 220 participants.

2.5. Data collection

With the approval of the ethics committee, an online questionnaire survey was conducted with the assistance of the head of nursing teaching in the hospital from Jan to Jun, 2024. The Questionnaire Star software was used to create an electronic questionnaire, and the link and QR code of the questionnaire were sent via WeChat.

Before starting the questionnaire, a brief description of the purpose and significance of the study was provided. All participants provided informed consent by selecting “yes” or “no” before completing the questionnaire. The questionnaire could only be filled out once per IP, and all questions had to be completed as required before submission. After the questionnaires were completed, two people checked the integrity of the questionnaires one by one, and invalid questionnaires were removed.

A total of 220 questionnaires were distributed in this survey, and 204 complete and valid questionnaires were collected, with an effective recovery rate of 92.7%.

2.6. Instruments

2.6.1. Basic information questionnaire

After reviewing relevant literature, a personal information questionnaire with 10 items was developed, including gender, students’ place of origin, whether they were the only child, serving as a student cadre/participating in community organizations, participating in career planning courses, liking for nursing work, satisfaction with clinical teachers, experience of “medical disturbance” events, patient death during internship, and current

employment environment.

2.6.2. “Future Work Self-Clarity” scale

The “Future Work Self-Clarity” scale was developed by Strauss et al. and then translated into Chinese by Chinese scholar, Guan et al.^[12,13].

The scale contains five items such as “I can easily imagine my future working self,” etc. A Likert 5–point scoring method was used, with “strongly disagree” to “strongly agree” scored as 1–5 points. The total score ranged from 5 to 25 points, and the Cronbach’s α coefficient of the scale was 0.92.

2.6.3. Spiritual climate scale

The spiritual climate scale was developed by Sexton et al. and then translated into Chinese by Chinese scholar, Wu et al.^[14,15]. The scale contains a total of 4 items such as “In the department, I am encouraged to speak my mind and can listen to each other’s hearts”.

A Likert 5–point scoring method was used, with “strongly disagree” to “strongly agree” scored from 1 to 5 points. The total score ranged from 4 to 20 points, and the higher the total score, the stronger the perception of the spiritual climate scale of the working environment. The Cronbach’s α coefficient of the scale was 0.84.

2.6.4. Career calling questionnaire

The career calling questionnaire was developed by Dobrow et al. and then translated into Chinese by Chinese scholar, Pei et al.^[16,17]. The scale contains 12 items such as “I am willing to make some sacrifices for my current job”.

A Likert 5–point scoring method was used, with “strongly disagree” to “strongly agree” scored as 1–5 points. The total score range was 12–60 points, and the higher the score, the higher the career calling level of nursing students. The Cronbach’s α coefficient of the scale was 0.94.

2.7. Data analysis

The data were analyzed using SPSS 26.0 software (IBM Corp., Armonk, NY, USA). Measurement data were described by mean \pm standard deviation (SD), and count data were described by frequency and percentage. The t-test or analysis of variance was used to analyze the “Future Work Self-Clarity” of nursing students. Multiple linear regression analysis was used to analyze the multiple factors of “Future Work Self-Clarity” of nursing students. The test level $\alpha = 0.05$.

2.8. Ethical issues

Our study meets the requirements of the Declaration of Helsinki for conducting research involving humans. This study was approved by the Institutional Review Board of the Sun Yat-sen University Cancer Center (Approval No.: B2023-658-01) in Dec 26th, 2023.

We began with a detailed description of the study. Participants were informed that they could withdraw from the study at any time, and prior written informed consent was obtained. Then, the survey was conducted anonymously. The students were also clearly informed of the benefits (sharing their valuable opinions with relevant stakeholders) and risks (the investigation would take up some of their time) of participation.

3. Results

A total of 220 questionnaires were distributed in this study, and 204 valid questionnaires were recovered, with an effective recovery rate of 92.7%. Of the 204 participants, 39 (19.1%) were male and 165 (80.9%) were female. Among them, 56 (27.5%) were from urban areas, 38 (18.6%) were from counties, and 110 (53.9%) were from rural areas. 35 (17.2%) were the only child in their family, 130 (63.7%) were student leaders or involved in community organizations, 171 (83.8%) had participated in career planning courses, etc. (see **Table 1**).

Table 1. Item scores of “Future Work Self-Clarity” in nursing interns (n = 204)

Variable	Range of scores	Score	Score order
I have a very clear idea of what I want to be in my future job.	1–5	3.86 ± 0.88	1
I can easily visualise my self-image in my future job.	1–5	3.76 ± 0.92	2
The type of work-related future I want is very clear in my mind.	1–5	3.64 ± 0.98	3
This future is easy for me to visualise	1–5	3.57 ± 0.89	4
The mental image of this future is very clear	1–5	3.52 ± 0.87	5

The results showed that the score of the “Future Work Self-Clarity” scale for nursing students was (18.34 ± 3.64). The score of the spiritual climate scale was (14.43 ± 3.77). The score of the career calling questionnaire was (39.25 ± 10.45).

The scores for individual dimensions are shown in **Table 2**. The results of this study indicated that being a student leader, liking for nursing work, satisfaction with clinical teachers, and the current employment environment were the influencing factors of “Future Work Self-Clarity” for practice nursing students, and the differences were statistically significant ($P < 0.05$) (see **Table 2**).

Table 2. Demographic characteristics of nursing interns and their level of “Future Work Self-Clarity” (n = 204)

Variable	Grouping	Total	Score	t/F	P
Sex	Male	39	18.72 ± 4.29	0.72	0.470
	Female	165	18.25 ± 3.47		
Place of origin	City	56	18.73 ± 3.19	0.95	0.390
	County	38	17.68 ± 3.53		
	Rural	110	18.36 ± 3.88		
Are you an only child	Yes	35	18.25 ± 2.79	-0.15	0.885
	No	169	18.35 ± 3.79		
Are you a student leader/participate in clubs and organisations	Yes	130	18.97 ± 3.76	3.37	0.001
	No	74	17.23 ± 3.13		
Have you participated in a career planning programme	Yes	171	18.43 ± 3.72	0.79	0.429
	No	33	17.88 ± 3.18		
Enjoyment of nursing	Favourite	62	19.73 ± 4.00	7.56	0.001
	Average	132	17.83 ± 3.36		
	Dislike	10	16.50 ± 2.12		

Table 2 (Continued)

Variable	Grouping	Total	Score	t/F	P
Satisfaction with clinical instructors	Satisfaction	157	19.19 ± 3.35	19.34	< 0.001
	Average	39	16.51 ± 2.08		
	Dissatisfied	8	10.50 ± 2.33		
Have you ever experienced any “medical malpractice”?	Yes	41	19.24 ± 3.84	1.79	0.074
	No	163	18.11 ± 3.56		
Patient death during internship	Yes	63	18.65 ± 3.76	0.82	0.413
	No	141	18.19 ± 3.59		
What do you think of the current employment environment?	Good	68	19.74 ± 3.59	10.05	< 0.001
	Average	118	17.86 ± 3.61		
	Poor	18	16.17 ± 1.69		

The results of this study also showed that the “Future Work Self-Clarity” scale for nursing students was positively correlated with the spiritual climate scale ($r = 0.62$, $P < 0.01$) and positively correlated with the career calling questionnaire ($r = 0.65$, $P < 0.01$). The spiritual climate scale was positively correlated with the career calling questionnaire ($r = 0.73$, $P < 0.01$).

Taking the “Future Work Self-Clarity” scale for nursing students as the dependent variable, multiple linear regression analysis was conducted with the scores of whether being a student leader, liking for nursing work, satisfaction with clinical teachers, current employment environment, spiritual climate, and career calling as independent variables.

The assignment of independent variables is shown in **Table 3**.

Table 3. Assignment of independent variables

Independent variable	Assignment
Serving as a student leader	Yes = 1, No = 2
Enjoyment of nursing work	Favourite = 1, average = 2, dislike = 3
Satisfaction with clinical instructors	Satisfied = 1, average = 2, dissatisfied = 3
Employment environment status	Good environment = 1, fair environment = 2, poor environment = 3
Spiritual climate	Substitution of original values
Career calling	Substitution of original values

The results showed that satisfaction with clinical teachers, spiritual climate, and career calling were the influencing factors of “Future Work Self-Clarity” for practice nursing students ($P < 0.05$), as shown in **Table 4**.

Table 4. Results of multiple-factor analysis of nurse interns’ “Future Work Self-Clarity”

Variable	Regression coefficient	Standard error	Standard regression coefficient	<i>t</i>	<i>P</i>
Constant	11.91	1.93	-	6.17	< 0.001
Whether serving as a student leader	-0.56	0.40	-0.07	-1.42	0.159
Enjoyment of nursing work	0.31	0.42	0.05	0.72	0.467
Satisfaction with clinical instructors	-1.38	0.42	-0.20	-3.30	0.001
Employment environment status	-0.03	0.36	-0.01	-0.09	0.930
Spiritual climate	0.22	0.08	0.23	2.92	0.004
Career calling	0.13	0.03	0.39	4.68	< 0.001

Note: $F = 32.84$, $P < 0.001$, $R^2 = 0.50$, adjusted $R^2 = 0.49$

4. Discussion

4.1. Status of “Future Work Self-Clarity” of practice nursing students

The results of this study show that the score of “Future Work Self-Clarity” for nursing students in practice is (18.34 ± 3.64), which is lower than the survey results of Chinese scholar, Chen et al. on nursing students in vocational colleges, indicating that the overall planning and individual development of nursing students in practice need to be improved^[18]. Their ability to take career risks in the future is relatively low, and their career goals are not clear.

The reasons may be as follows:

- (1) Differences in the subjects as the research population is nursing students in the hospital. Nursing clinical practice is a necessary process for them to change their individual roles and complete professional socialization. During the clinical practice process, nursing students continuously improve their clear image of the future nursing work scene, but at the same time, they are also faced with the double pressure of study and work, the relative difference between theory and practice, and the complex and changeable clinical environment. This makes nursing students prone to have negative experiences such as ambiguous orientation and self-denial tendencies, and it is difficult for them to be recognized by clinical workers. There is a large psychological gap between expectation and reality, a lack of confidence in future work, and a reduced “Future Work Self-Clarity”^[19];
- (2) Differences in learning styles since the data acquisition time of this study was from September to November 2023. Due to the impact of COVID-19, nursing students mainly used online teaching during their school study, lacking face-to-face communication and interaction with nursing teachers. It is difficult for both sides to receive real and effective teaching feedback. At the same time, online teaching also places higher requirements on the self-management ability of nursing students. Nursing students must have good learning ability and self-control. Otherwise, it is difficult to ensure the online learning effect. However, in real clinical work, patients’ demand for high-quality nursing care and the assessment requirements of clinical practice are increasing, and it is difficult for nursing students to meet these requirements, bear higher learning pressure, and experience deeper frustration, further reducing the level of “Future Work Self-Clarity”.

Among the items of “Future Work Self-Clarity”, the item “I know very well what kind of person I want to be

in the future work” had the highest score (3.86 ± 0.88). The item “The mental image of the future is very clear” had the lowest score (3.52 ± 0.87).

The results reflect that nursing students have positive internal motivation for future career development, with high expectations and strong aspirations, hoping to create better career development prospects and actively realize their self-worth. However, they lack effective means and a correct path to achieve their future career goals, and their individual autonomy needs cannot be met, which leads to or aggravates the fear of failure.

At present, the training of nursing students in teaching hospitals in China mainly focuses on the accumulation of theoretical knowledge, clinical skills training, clinical thinking training, and team cooperation ability training, etc., while there are deficiencies in career planning and employment guidance^[20]. This suggests that nursing managers should pay more attention to the combination of science and education, the integration of theory and practice, and the integration of production and education in hospital nursing teaching to improve the quality of nursing students’ training.

Nursing educators should help nursing students comprehensively understand clinical work, clarify individual occupational orientations, and enable them to gradually extract a relatively complete future working self from their subconscious, gradually realize their future self - image, and gradually adapt to their roles^[21]. At the same time, we should actively provide practical and effective career counseling services for nursing students to help them find career goals that match their own values, develop recognition and strong emotions for nursing work, and improve “Future Work Self-Clarity”.

4.2. Analysis of influencing factors of “Future Work Self-Clarity” among practical nursing students

4.2.1. The higher the satisfaction with clinical teachers, the higher the “Future Work Self-Clarity” level of nursing students

Clinical teachers are not only the initiators of clinical practice for nursing students but also the most influential figures during their clinical practice. Excellent clinical teachers can serve as excellent professional examples for nursing students. They can not only demonstrate the skills, qualities, and emotions required for the role of clinical nurses in front of nursing students but also promptly answer their questions, relieve their negative emotions, and offer them care and encouragement, which is highly praised by students^[22].

This can more positively and effectively guide students to build a favorable professional self- image and enhance their recognition of nursing work, thereby indirectly or directly enhancing the “Future Work Self-Clarity” of nursing students^[23]. Chinese scholar, Yang et al. indicated that most nursing practice teachers in China are young and middle-aged backbone nurses, and clinical teaching focuses more on the professional knowledge and skill training of nursing students, generally lacking attention to the practice adaptability of nursing students^[24]. Good practice adaptability can effectively reduce the stress response during practice, cultivate independent learning motivation, improve nursing professional identity and professional confidence, and increase the likelihood of forming a clear future self for nursing students.

We suggest that while maintaining high-quality nursing teaching, clinical nursing teachers can actively communicate with nursing colleges and universities, focus on the future development of nursing students, and provide more information and guidance related to the comprehensive ability cultivation and career growth of nursing students according to their own conditions. For the questions raised by nursing students, they should give positive and comprehensive positive feedback to help them get out of the confusion during the internship, quickly adapt to

the clinical environment, grasp the future development direction, and improve their “Future Work Self-Clarity”.

4.2.2. The higher the perception of the spiritual climate by nursing students, the higher the level of “Future Work Self-Clarity”

The spiritual climate of the working environment reflects the spiritual and cultural atmosphere created by the collective staff in the common working environment^[25]. The results of this study showed that nursing students with a higher perception of the spiritual climate had a higher “Future Work Self-Clarity”. A good spiritual climate provides a supportive working atmosphere for practical nursing students, which can meet their emotional trust needs, allowing them to obtain good emotional support and emotional catharsis in clinical work, further enhancing the cohesion and good-will among groups, and effectively reducing the pressure of role transformation for practical nursing students. This helps nursing students improve their “Future Work Self-Clarity”^[26]. Cruz et al. showed that the higher the nurses’ perception of the spiritual climate, the higher their recognition of the nursing profession, the stronger their dedication to the nursing profession, and the easier it is to achieve their career goals^[27].

Nursing managers should pay more attention to the pressure and obstacles faced by nursing students during the internship, provide them with more opportunities for experience exchange and emotional sharing, and make them feel the importance of the department. For the reasonable and innovative suggestions put forward by nursing students, the department should actively adopt and implement them, give full play to their subjective initiative and creativity at work, create a positive and harmonious spiritual climate in the workplace, and promote the improvement of “Future Work Self-Clarity”.

4.2.3. The higher the career calling level of nursing students, the higher the level of “Future Work Self-Clarity”

Career calling is a positive, internal, and deep-level psychological structure, and individuals with a high-level career calling tend to show sufficient career preparation, a good career attitude, and high-quality career outcomes^[28]. Nursing students with a stronger career calling will regard the nursing career as an indispensable part of their lives, arouse strong enthusiasm for work during the clinical work process, truly experience the sense of mission and satisfaction brought by their profession, and pursue excellence to realize their professional value^[29].

A study by Xie et al. has shown that career calling can significantly improve an individual’s internal motivation^[30]. The higher the career calling level of nursing students, the stronger their internal driving force, the clearer their goals and implementation plans for the nursing work they are engaged in, and the higher their level of “Future Work Self-Clarity”. This suggests that nursing managers should strengthen the regular evaluation of the career calling of nursing students, accurately identify low-career calling groups, and take various targeted measures in a timely manner. They should carry out nursing career calling education, correct the professional cognition of nursing students, strengthen the sense of the nursing professional mission, stimulate self-work shaping, cultivate and improve the career calling level of nursing students, and promote the improvement of “Future Work Self-Clarity”.

4.3. Limitations

This study had certain limitations in terms of using convenience sampling and collecting online questionnaires, which led to difficulties in quality control. Additionally, representativeness may be affected as the sample was only from one province in China. Subsequent studies should use multi-center and large-sample-size methods to improve reliability.

5. Conclusions

The level of “Future Work Self-Clarity” of nursing students needs to be further improved. Satisfaction with clinical teachers, spiritual climate, and career calling were the influencing factors of “Future Work Self-Clarity” among practical nursing students. It is recommended that nursing managers should pay more attention to and encourage nursing students, improve the comprehensive ability of the hospital’s nursing education teaching team, create a positive and harmonious spiritual climate in the workplace, and carry out nursing career calling education, so as to comprehensively improve the “Future Work Self-Clarity” level of nursing students. It is suggested that researchers can include multi-center research objects and use longitudinal and qualitative research methods to further explore the “Future Work Self-Clarity” of nursing students in the future and formulate targeted interventions to help the growth of new nursing students.

Disclosure statement

The authors declare no conflict of interest.

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The Role of the Quorum Sensing Signaling Pathway in Clinical Drug Resistance of *Escherichia coli*: A Review and Outlook

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Abstract: Quorum sensing (QS) represents a mechanism through which bacteria engage in communication via chemical signals, a phenomenon prevalent across diverse bacterial species. Recent investigations have elucidated that QS signaling pathways are pivotal in governing bacterial physiological processes, collective behaviors, and the emergence of drug resistance. *Escherichia coli* (*E. coli*), a prominent pathogenic bacterium, is increasingly exhibiting severe drug resistance issues, posing substantial hurdles for clinical interventions. Presently, a burgeoning body of research is exploring the connection between QS signaling pathways and the drug resistance mechanisms in *E. coli*, unveiling the coordinating function of QS within bacterial communities and its influence on antibiotic resistance. Despite some research advancements, the precise mechanisms underlying the QS signaling pathway remain ambiguous, and its potential applications are somewhat constrained. This article endeavors to systematically review the research progress concerning the QS signaling pathway in the context of clinical drug resistance mechanisms in *E. coli*, delving into its potential clinical applications and future research avenues, with the aim of offering novel insights and strategies to counteract drug resistance.

Keywords: Antibiotic resistance; Biofilm; *Escherichia coli*; Quorum sensing; QS inhibitors

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1. Introduction

Escherichia coli (*E. coli*) is a common bacterium found in the intestines of humans and animals. However, certain specific strains are significant pathogens widely associated with foodborne illnesses and hospital-acquired infections. In recent years, with the widespread use of antibiotics, the problem of antibiotic resistance in *E. coli* has become increasingly severe, particularly resistance to β -lactam antibiotics, posing a major challenge to global public health ^[1,2]. Antibiotic resistance not only leads to treatment failures but also increases patient mortality rates

and healthcare costs. Therefore, exploring new treatment strategies to address antibiotic resistance is a crucial direction in current medical research.

Recent studies have indicated that the quorum sensing (QS) signaling pathway in bacteria may play a significant role in the development of antibiotic resistance. QS is a mechanism by which bacteria regulate group behaviors through the secretion and perception of small molecule signals (such as autoinducers), affecting bacterial growth, pathogenicity, and biofilm formation, among other things^[3,4]. In *E. coli*, the activation of the QS signaling pathway is associated with antibiotic resistance, particularly by regulating the expression of genes related to biofilm formation and drug resistance, thereby enhancing the bacteria's resistance to antibiotics^[5,6].

Research has found that the *LuxS* gene in *E. coli* plays a crucial role in QS, as the enzyme it encodes is involved in the synthesis of the autoinducer AI-2, which is closely related to bacterial biofilm formation and drug resistance^[4, 7]. Furthermore, certain QS inhibitors (such as plant extracts and synthetic small molecules) have been shown to interfere with the QS signaling pathways in *E. coli*, thereby inhibiting biofilm formation and reducing drug resistance^[8,9].

Although there is a preliminary understanding of the mechanisms by which QS contributes to drug resistance in *E. coli*, further in-depth research is needed to elucidate the specific molecular mechanisms and signaling pathways involved. This will provide new insights and targets for clinical anti-infective strategies. Future research should focus on developing interventions targeting QS signaling pathways to reduce drug resistance in *E. coli* and enhance the efficacy of existing antibiotics^[5,10]. Through this approach, new solutions to the problem of antibiotic resistance may be found, thereby improving patient treatment outcomes and prognosis.

2. Basic mechanisms of the QS signaling pathway

QS is a biological mechanism by which bacteria recognize their population density through the release and perception of signaling molecules (such as autoinducers). This allows bacteria to coordinate their behavior and exhibit collective characteristics, including biofilm formation, expression of virulence factors, and drug resistance. The core mechanisms of QS signaling pathways encompass multiple levels, including the types and functions of signaling molecules, interactions between bacteria, and signal transduction^[11,12].

2.1. Types and functions of QS signaling molecules

QS signaling molecules mainly include N-acyl-L-homoserine lactones (AHLs), autoinducer-2 (AI-2), and other small molecules^[13]. As the population density of bacteria changes, the concentrations of these signaling molecules also vary, playing a crucial role in physiological activities. For example, AHLs primarily function in Gram-negative bacteria, participating in the regulation of group behaviors and the synthesis of virulence factors. Against this backdrop, AI-2 is regarded as a universal signal among various bacteria, facilitating their mutual communication and the coordination of group behaviors^[14].

Moreover, variations in the types and concentrations of signaling molecules can directly influence bacterial growth, metabolic activities, and biological functions such as biofilm formation^[15]. These characteristics enable bacteria to adapt to complex environments.

2.2. Interactions and group behaviors

The interactions among bacteria constitute a crucial part of the QS signaling pathway. Relying on the QS

mechanism, bacteria can perceive the presence of other bacteria in their surroundings and adjust their behavior accordingly. For instance, when bacteria are in a high-density environment, they may choose to form biofilms to enhance their survival capabilities; conversely, in low-density conditions, they may remain in a motile state to explore new nutrient sources. The regulation of such group behaviors not only affects bacterial survival strategies but is also closely linked to host immune responses and drug resistance ^[16]. Research has shown that certain bacteria can inhibit the QS systems of their competitors through QS signaling molecules, thereby enhancing their own competitiveness and demonstrating mechanisms of social adaptation ^[17].

2.3. Signal transduction mechanisms

The QS signal transduction mechanism involves the interaction of multiple signaling pathways. Bacteria utilize specific receptors to recognize signaling molecules and activate relevant downstream signaling pathways. For example, in *E. coli*, the LuxS/AI-2 system influences bacterial growth and biofilm formation by regulating the expression of various genes ^[18]. Furthermore, the complexity of signal transduction is also reflected in the interactive behaviors among different bacterial species. Some bacteria can interfere with the QS signals of other bacteria by producing specific QS inhibitors, thereby gaining an advantage in the ecosystem. The diversity of such mechanisms enables bacteria to flexibly respond to complex environmental challenges and optimize their survival strategies ^[19].

In summary, the QS signaling pathway plays a pivotal role in bacterial physiological activities. The complexity and diversity of its mechanisms offer new perspectives for a deeper understanding of bacterial group behaviors and drug resistance. Future research will continue to unveil the detailed mechanisms of the QS signaling pathway, laying a theoretical foundation for the development of new-generation antimicrobial strategies.

3. Characteristics of QS in *E. coli*

3.1. Major QS signal molecules

In *E. coli*, the QS signaling pathway primarily relies on AHLs as key signaling molecules. The synthesis of AHLs is catalyzed by LuxI family proteins, and these molecules can transmit signals in a concentration-dependent manner within bacterial populations. Recent studies have revealed the presence of multiple AHLs in *E. coli*, such as C4-HSL and C6-HSL.

When the bacterial population reaches a certain density, these signaling molecules interact and effectively initiate the expression of specific genes. This process is crucial for biofilm formation and the secretion of various virulence factors ^[20]. Meanwhile, *E. coli* also possesses the SdiA receptor, which can recognize exogenous AHLs, enhancing its adaptability in complex environments and providing advantages in different competitive scenarios. This mechanism demonstrates the potential role of bacteria in developing drug resistance through the QS system, particularly in the evolution of multidrug-resistant strains ^[21].

3.2. Impact of QS on biofilm formation

During the biofilm formation process in *E. coli*, the QS signaling pathway plays a crucial role. Research has shown that QS-related signaling molecules significantly influence biofilm generation and maturation. For instance, C4-HSL is considered an important component that enhances the biofilm-forming potential of *E. coli*. In high-cell-density environments, bacteria can regulate biofilm-related genes, such as curli and cellulose synthesis genes,

through QS mechanisms, thereby promoting their attachment and aggregation on solid substrates.

Biofilm formation can be divided into multiple stages:

- (1) Initial attachment;
- (2) Microbial community formation;
- (3) Maturation;
- (4) Release.

The initial stage of this process involves bacteria binding to solid surfaces through their surface structures, and QS signals enhance the stability of this binding. Henly et al. pointed out that C4-HSL regulates relevant genes by activating specific transcription factors, promoting the early development of biofilms^[22]. As the growth density of *E. coli* increases, the activity of QS signals intensifies, further enhancing the thickness and complexity of biofilms and forming a more effective protective barrier, thereby improving its resistance to drugs. Bai et al. also emphasized that QS not only affects bacterial adhesion capacity but also influences biofilm stability by regulating motility. Bacteria enhance the integrity of biofilms by synthesizing exogenous polymers, such as polysaccharides and adhesive proteins. These mechanisms not only facilitate biofilm formation but also endow bacteria with stronger survival competitiveness when facing antibiotic treatment^[23].

In recent years, multiple researchers have conducted in-depth explorations of the role of QS signaling pathways in biofilm formation, providing new perspectives for understanding the drug resistance mechanisms of *E. coli*. For instance, Dobretsov et al. confirmed the function of QS signals in regulating intercellular interactions within biofilms^[24], Ząbek et al. discovered the crucial role of specific QS molecules in the maturation process of biofilms^[25]. These findings not only offer new insights into drug resistance mechanisms but also point the way for future research and development of therapeutic strategies.

4. Relationship between QS and drug resistance

During the survival and adaptation processes of bacteria, the QS mechanism plays a pivotal role. Particularly in *E. coli*, QS not only influences bacterial growth and reproduction but is also closely related to its drug resistance. With the escalating issue of antibiotic resistance, exploring the association between QS and drug resistance has become increasingly important.

4.1. The role of QS in the expression of drug resistance genes

Research has found that the QS system can directly affect bacterial sensitivity to antibiotics by regulating the expression of drug resistance genes^[26]. The SdiA receptor in *E. coli* can perceive exogenous signaling molecules and regulates the expression of corresponding drug-resistance genes in the presence of antibiotics.

This mechanism is particularly evident when responding to antibiotics at sub-inhibitory concentrations. The transcriptional response of SdiA exhibits variations under different induction conditions, highlighting the significant role of QS in the regulatory mechanisms of drug resistance^[27]. Meanwhile, QS enhances bacterial tolerance to antibiotics by regulating biofilm formation capacity, as bacteria within biofilms are more difficult to eradicate^[28].

4.2. Regulation of drug targets by QS

In addition to influencing the expression of drug-resistance genes, the QS system also alters bacterial drug

sensitivity by regulating the expression of drug targets. In *Pseudomonas aeruginosa*, QS signaling molecules can affect the expression of genes related to drug efflux pumps, thereby influencing changes in antibiotic resistance ^[29].

Intervention strategies targeting the QS system can effectively reduce bacterial resistance to antibiotics. Certain natural compounds have been found to inhibit the production of QS signals, thereby enhancing bacterial sensitivity to antibiotics ^[30]. This regulatory mechanism provides a novel approach for the development of new antibiotics, namely by targeting the QS system to reduce bacterial resistance.

4.3. Impact of QS on bacterial survival strategies

QS not only affects drug resistance but also has a profound impact on bacterial survival strategies. In environments with high cell density, bacteria regulate group behaviors through QS mechanisms, such as biofilm formation and toxin release, which enhance their survival capabilities. In *E. coli*, QS signaling molecules promote biofilm formation, enabling bacteria to survive and resist antibiotic attacks in unfavorable environments ^[31].

Additionally, QS is closely related to bacterial metabolic activities and influences their efficiency in utilizing nutrients and their ability to withstand environmental stress ^[32]. Therefore, interfering with QS signal transmission can effectively alter bacterial survival strategies, reduce their pathogenicity and resistance trends, and provide new approaches for infection treatment.

5. Recent research advances

5.1. Latest achievements in research on QS signaling pathways

In recent years, significant progress has been made in the study of QS signaling pathways in *E. coli* and its related pathogens. Current research indicates that these signaling pathways play a pivotal role in various aspects of bacterial behavior, including group dynamics, pathogenicity, and antibiotic resistance. The AHL-type QS system found in *Acinetobacter baumannii* effectively regulates its biological functions and pathogenicity, offering a new perspective for understanding its role in clinical infections ^[33]. Additionally, QS signals have a profound impact on bacterial growth, metabolism, and biofilm formation, contributing to increased antibiotic resistance during treatment ^[34].

In the study of *E. coli*, researchers have identified new QS signaling molecules and their associated regulatory mechanisms. These signaling molecules play a crucial role in regulating biofilm formation and the production of virulence factors in bacteria. The discovery of the LuxS enzyme has highlighted its importance in QS and bacterial growth regulation, with the presence of autoinducer AI-2, it catalyzes being considered a key mediator for effective bacterial communication ^[35].

Through comparative studies of various strains, scholars have revealed the diversity of QS signaling pathways and their adaptability in different environments, laying a theoretical foundation for developing new antimicrobial strategies ^[21].

5.2. Clinical case analysis of antibiotic resistance

The issue of clinical antibiotic resistance in *E. coli* has become increasingly prominent. Research shows that QS signaling pathways play a critical role in the development of bacterial resistance. Studies on *Lactobacillus rhamnosus* GG with a deleted *LuxS* gene have demonstrated a significant reduction in its resistance to intestinal pathogens such as Enterotoxigenic *E. coli* (ETEC). This finding underscores the importance of QS signals in host

immune regulation^[35].

Further analysis of the drug resistance of different clinical isolates revealed a positive correlation between the expression levels of QS genes and bacterial drug resistance. In particular, among multidrug-resistant *Pseudomonas aeruginosa*, a clear association was observed between the high expression of QS genes and biofilm formation as well as drug resistance^[36].

Researchers have found that specific QS signaling molecules, such as AI-2, play a facilitating role in the process of bacterial tolerance to β -lactam antibiotics. This suggests that by regulating QS signaling pathways, it may be possible to reduce bacterial resistance to antibiotics, thereby enhancing their efficacy^[37].

These research findings not only provide a new perspective for exploring bacterial resistance mechanisms but also lay an important scientific foundation for formulating clinical treatment plans.

5.3. Development and application prospects of QS inhibitors

In response to the challenges posed by bacterial resistance and biofilm-related infections, the development of QS inhibitors has become a research hotspot. In recent years, researchers have explored the potential of various natural and synthetic compounds as QS inhibitors. For instance, studies have shown that certain plant extracts (such as eucalyptus oil and cinnamon oil) exhibit significant QS inhibitory activity against multidrug-resistant *Pseudomonas aeruginosa*. These natural products reduce bacterial biofilm formation and the production of virulence factors by interfering with QS signaling pathways^[38,39].

Additionally, synthetic QS inhibitors (such as certain small-molecule compounds) also show promising clinical application prospects. Research indicates that these compounds can effectively inhibit bacterial QS signaling, thereby enhancing the efficacy of antibiotics. For example, some novel compounds have demonstrated strong anti-biofilm capabilities *in vitro* and have shown potential to reduce infection severity in animal models^[40].

In the future, with a deeper understanding of QS mechanisms and the integration of modern biotechnology with drug development approaches, QS inhibitors are expected to become a new strategy for combating bacterial infections.

6. Future research directions and clinical prospects

6.1. Improved experimental models and techniques

When exploring the role of the QS signaling pathway in clinical drug resistance of *E. coli*, improved experimental models and techniques are of paramount importance. Traditional experimental models often fail to fully simulate the complex microbial environment within the human body, leading to limitations in research findings.

Therefore, future research should focus on developing more precise *in vivo* and *in vitro* models. For instance, leveraging three-dimensional cell culture techniques and microfluidic chip technology can better mimic the growth and interactions of bacteria under physiological conditions^[41].

These technologies provide a more authentic microenvironment, enabling researchers to observe bacterial behavior under different environmental conditions and their responses to antibiotics. Additionally, gene editing techniques (such as CRISPR-Cas9) can be employed to precisely regulate key genes within the QS signaling pathway, thereby aiding in the investigation of their specific roles in drug resistance mechanisms^[42].

The introduction of these new technologies will significantly advance our understanding of the QS signaling pathway and offer novel insights for the development of anti-drug resistance strategies^[30,31].

6.2. Controversies and challenges surrounding the QS signaling pathway

Although the QS signaling pathway plays a crucial role in regulating bacterial group behaviors, its specific role in clinical drug resistance remains controversial. Different research findings suggest that the QS signaling pathway may promote bacterial resistance in some cases, while in others, it may inhibit the development of resistance. These contradictory results may stem from variations in bacterial species, environmental factors, and their interactions under different experimental conditions. Furthermore, the complexity and diversity of the QS signaling pathway pose challenges for researchers in determining its specific mechanisms.

Future research needs to systematically analyze the QS signaling pathways of different bacterial species, particularly in clinically relevant environments, to better understand their roles in the development of drug resistance. Additionally, researchers should also pay attention to the diversity of QS signaling molecules and their variations under different physiological states, which will provide a basis for formulating targeted treatment strategies ^[43,44].

6.3. Possibilities for multidisciplinary interdisciplinary research

Interdisciplinary research has demonstrated tremendous potential in uncovering the relationship between QS signaling pathways and antibiotic resistance in *E. coli*. By integrating knowledge from multiple fields, including microbiology, molecular biology, pharmacology, and clinical medicine, researchers can explore the functions of QS signaling pathways and their impact on antibiotic resistance in a more systematic and comprehensive manner. For instance, advancements in microbiomics have enabled researchers to gain a deeper understanding of the interactions between host microbial communities and QS signaling pathways, providing new perspectives for elucidating bacterial resistance mechanisms.

Meanwhile, innovations in drug development, such as QS signaling pathway inhibitors based on small-molecule compounds, have opened up new prospects for anti-resistance strategies. Through close interdisciplinary collaboration, research teams can design more practical experimental protocols and explore innovative therapeutic approaches, thereby providing more effective support and guidance for clinical disease intervention ^[45,46].

7. Conclusion

The resolution of the antibiotic resistance issue necessitates multidisciplinary cooperation and efforts, encompassing coordination in basic research, clinical applications, and public health policies. By synthesizing perspectives and findings from diverse studies, we can more effectively tackle this global public health challenge. It is hoped that future research will further unravel the complexity of QS signaling pathways, providing us with more effective anti-infective strategies and ultimately improving patient prognosis and health outcomes.

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Disclosure statement

The authors declare no conflict of interest.

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The Effectiveness and Safety of Multimodal Pre-Emptive Analgesia in the Perioperative Period of Mid to Advanced Hepatocellular Carcinoma Undergoing TACE

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Abstract: *Objective:* To evaluate the analgesic effect and safety of hydromorphone hydrochloride in PCIA combined with flurbiprofen axetil and pre-emptive analgesia in patients with TACE treatment for hepatocellular carcinoma. *Methods:* Backward observation was made on 90 patients with advanced liver carcinoma who performed TACE treatment in the First Affiliated Hospital of Sun Yat-sen University from January 2022 to October 2023, dividing them into Group A (continuous pump injection of 6 mg hydromorphone + 50mg flurbiprofen ester as background injection for 2 ml/h, additional single injection of 3 ml/10min, 15 minutes before surgery) and Group B (intravenous injection of 50 mg flurbiprofen ester during the operation, additional injection of tramadol 100 mg intramuscular injection if necessary). Groups were compared and analyzed at different time points in surgery and post-operation time from pain level (NRS), side effects, inflammatory indexes (PCT, IL-6), satisfaction rate. *Result:* NRS scores at 5 time points, during operation, immediately post-surgery, 12, 24 hours post-operation, Group A were significantly lower than Group B (Group A during operation 3.0, immediate postoperation 3.0 to 24h 1.0; Group 4.0 to 24h 1.0, all $P > 0.05$). The rate of adverse reactions were comparable between the two groups (all $P > 0.05$). The amount of PCT (0.23 ng/ml vs 1.15 ng/ml) and IL-6 (54.49 pg/ml vs 233.49 pg/ml) decreased post-surgery in Group A compared to Group B, but were not statistically significant difference ($P = 0.424/P = 0.502$), and more patients in Group A were relieved to grade score of pain relief 4 or above (86.7% vs. 60%, $P = 0.001$). *Conclusions:* Pre-emptive analgesia treatment using PCIA of hydromorphone hydrochloride combined with flurbiprofen axetil has better analgesic effect than routine analgesic therapy in postoperative care of mid to advanced hepatocellular carcinoma TACE, has good safety, and is worth of further promotion and verifying.

Keywords: Multimodal analgesia; Patient-controlled intravenous analgesia; Pre-emptive analgesia; TACE

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1. Introduction

Transarterial chemoembolization (TACE) is one of the main treatment methods for mid and advanced liver carcinoma, which can also cure some early-stage liver carcinoma, and is often used as an adjuvant treatment after resection of primary liver carcinoma, which can effectively improve the survival rate of liver carcinoma patients ^[1]. However, more than 70% of patients will experience different degrees of pain after TACE ^[2], and such severe pain not only affects the therapeutic efficacy and reduces patient satisfaction but also leads to serious cardiovascular and cerebrovascular complications ^[3]. Effective perioperative pain control is a concern for patients and an important factor in improving the success rate of surgery and patient satisfaction. In 2022, China introduced the first special guideline, Expert Consensus on Perioperative Pain Management in Interventional Treatment of Hepatic Malignancies, but it did not provide the best way.

The mechanism of TACE induced pain involves several elements: chemotherapeutic agents and embolic agents irritate the endothelium, and embolisation results in ischaemic necrosis of the tumour, which leads to local inflammatory oedema and an increase in hepatic peritoneal tension ^[3].

Ischemic necrosis of the tumour tissue often results in the release of painful inflammatory mediators ^[4]. For moderate pain caused by TACE, the 2022 Expert Consensus on Perioperative Pain Management in Interventional Treatment of Malignant Liver Tumours suggests using opioids as needed ^[5]. Hydrochloride hydromorphone is a potent semi-synthetic derivative of morphine that selectively activates μ -receptors in the central nervous system and is superior to morphine in terms of physical and chemical properties and clinical analgesia ^[6]. However, TACE is often accompanied by pain caused by inflammatory mediators released due to tumour necrosis, such as prostaglandin E and bradykinin, and the anti-inflammatory effects of opioid drugs are relatively weak ^[4]. Therefore, the analgesic efficacy of these drugs alone remains suboptimal ^[7].

As a non-steroidal anti-inflammatory drug, flurbiprofen ester inhibits cyclooxygenase, blocks arachidonic acid metabolism, stabilises the kinin-kinin-kininase release system, inhibits the synthesis of prostaglandins that cause pain and inflammation, and blocks the transmission of pain signals from the injured site to the central nervous system, thereby exerting anti-inflammatory, analgesic, and antipyretic effects ^[8]. Therefore, hydromorphone combined with flurbiprofen ester possesses the dual analgesic advantages of reducing somatic pain and visceral pain and presents significant advantages in postoperative analgesia after TACE for hepatocellular carcinoma. Patient-controlled intravenous analgesia (PCIA) achieves on-demand analgesia by setting a background dose and allowing patients to control their analgesia. For patients with moderate to severe pain caused by TACE, multiple guidelines also recommend PCIA for perioperative analgesia throughout the entire process ^[5].

To this end, this study analyzed the efficacy and safety of a combined analgesic regimen of hydromorphone and flurbiprofen ester during PCIA patient-controlled intravenous analgesia in the special period before and after TACE surgery, aiming to provide ideas and practical experience for perioperative analgesia management of TACE.

2. Objects and methods

2.1. Research subjects

This study included 90 patients with advanced hepatocellular carcinoma admitted to the First Affiliated Hospital of Sun Yat-sen University.

The inclusion criteria included:

- (1) Liver carcinoma patients diagnosed with a history of hepatitis or HBsAg- positive according to the 2019

edition of the National Health and Health Commission's Guidelines for the Diagnosis and Treatment of Primary Liver Cancer;

- (2) Age between 18–80 years old;
- (3) Child-Pugh liver function of class A or B;
- (4) Laboratory tests must meet the following criteria:
 - (i) Peripheral blood leukocytes $\geq 1.5 \times 10^9/L$;
 - (ii) Platelets count $\geq 50 \times 10^9/L$;
 - (iii) Haemoglobin concentration $\geq 80 \text{ g/L}$;
 - (iv) Serum ALT and AST not exceeding twice the upper limit of normal;
 - (v) Serum creatinine not exceeding 1.5 times the upper limit of normal;
 - (vi) INR < 1.5 or prothrombin time not exceeding the upper limit of normal + 4s;
 - (vii) Albumin $\geq 30 \text{ g/L}$;
 - (viii) Total bilirubin $\leq 34 \text{ mmol/L}$.

Exclusion criteria:

- (1) People with previous allergy to iodine;
- (2) People with severe mental illness or psychological diseases;
- (3) People taking analgesic drugs for a long period;
- (4) Concurrent severe cardiopulmonary diseases;
- (5) People with obvious fever or pain symptoms.

2.2. Research methods

2.2.1. Grouping and analgesic regimen

Using the random number table method, 90 patients were randomly divided into a multimodal analgesic group and a control group, with 45 patients in each group.

The analgesic regimen of the experimental group was as follows: hydromorphone hydrochloride 6 mg (2 ml: 2 mg, Hubei Yichang Renfu Pharmaceutical Co., Ltd.) and flurbiprofen ester 50 mg (5 ml: 50 mg, Beijing Taide Pharmaceuticals) were dissolved in saline until the total amount reached 100 ml and administered via PCIA. The drug dose for the PCIA pump was calculated based on 48 hours, and the pump was activated 15 minutes before the operation, with a background dose set at 2 ml/h, a single bolus dose of 3 ml, a lockout time of 10 minutes, and a maximum dose of 20 ml.

The analgesic regimen for the control group was as follows: when the patient experienced pain, 50mg of flurbiprofen ester was administered via intravenous infusion in 100ml of saline; if the analgesic effect was inadequate, an additional intramuscular injection of tramadol 0.1g (2ml: 0.1g, Granta GmbH, Germany) was administered.

Both groups of patients received prophylactic intravenous administration of 0.25 mg of palonosetron (5 ml: 0.25 mg, Hangzhou Jiuyuan Gene Engineering Co., Ltd.) before surgery. If significant nausea and vomiting discomfort recurred within 48 hours postoperatively, 10 mg of metoclopramide (10 mg/vial, Henan Runhong Pharmaceutical Co., Ltd.) was administered via intravenous push.

2.2.2. Programmatic pain education

Pain education is conducted on the day of admission, one day before surgery, and on the day of surgery. During the

education sessions, informational brochures are distributed, and various forms of instruction are used, including video presentations, demonstrations, and electronic educational devices, which last between 10 and 20 minutes. The educational content covers medical knowledge related to pain, multimodal pain management methods, pre-emptive pain management strategies, operation of patient-controlled intravenous analgesia pumps, and pain assessment methods.

2.2.3. TACE treatment

After local anesthesia with 2% lidocaine, both groups of patients underwent femoral artery puncture on the right side using the Selinger puncture method. After selectively inserting the catheter into the celiac trunk or superior mesenteric artery, selective angiography was performed. Based on the angiographic characteristics, microcatheter super-selective technology was used for precise infusion into the tumour-supplying arteries. Iodized oil (10 ml: containing 480 mg/ml iodine, Jiangsu Hengrui Medicine Co., Ltd.) and Pharmorubicin RD (10 mg/bottle, Wuxi Pfizer) were slowly injected. The infusion rate was adjusted based on the pharmacokinetic characteristics of the drugs. After blood flow slowed, a 40 mg suspension of Callisphere (100–300 μ m, Jiangsu Hengrui Medicine Co., Ltd.) and Pharmorubicin RD (10 mg/bottle, Wuxi Pfizer Pharmaceutical Co., Ltd.) was injected for embolization.

During embolization, the procedure is performed based on the anatomical location of the tumour's blood supply vessels. After the embolization material has stabilized and settled, the catheter is withdrawn. The puncture site is compressed for 15 minutes to stop bleeding, then bandaged under pressure. After returning to the ward, the right hip joint is immobilized for 6–8 hours.

2.2.4. Observation indexes and methods

(a) Pain score

The Numerical Rating Scale (NRS) was used to assess variations in pain intensity at specific perioperative time points (intraoperative, immediate postoperative, and 1, 6, 12, and 24 hours postoperatively). The NRS scoring range was 0–10 points, with 0 points representing no pain, 1–3-point interval representing mild pain, 4–6-point interval representing moderate pain, and 7–10-point interval representing severe pain.

(b) Dosage of hydromorphone hydrochloride and rate of remedial analgesia

The dosage of hydromorphone hydrochloride and the corresponding remedial measures were recorded in detail for intraoperative and postoperative bursts of pain. If pain remains unrelieved, an intravenous bolus of 50 mg dexketoprofen in 100 mL saline solution or an intramuscular injection of 0.1 g tramadol was administered.

(c) Serum inflammatory factor

Fasting venous blood samples were collected from patients upon waking in the morning, both preoperatively and 24 hours postoperatively.

(d) Patient satisfaction score

Patient satisfaction was continuously monitored using a 5-point Likert scale: 5 as very satisfied, 4 as satisfied, 3 as average, 2 as dissatisfied, 1 as very dissatisfied.

(e) Occurrence of adverse reactions

Record adverse events within 24 hours after operation, primarily noting nausea and vomiting, dizziness, respiratory depression, skin pruritus, and urinary retention, among others. Tabulate the number of patients

experiencing the above adverse reactions.

2.2.5. Statistical analysis

Statistical analysis was performed using SPSS 25.0 software. The count data were expressed as constituent ratios; normally distributed measurements were expressed as mean \pm standard deviation (SD); the t-test was used for inter-group comparisons, and one-way analysis of variance (ANOVA) was used for multi-group comparisons. Non-normally distributed measures were expressed as median (interquartile range), with the Mann-Whitney U test for comparisons between two groups and the Kruskal-Wallis H rank sum test for comparisons between multiple groups. In correlation studies, Spearman's correlation analysis was used. $\alpha = 0.05$ (two-tailed) was the significance level, and $P < 0.05$ was deemed statistically significant.

3. Results

3.1. General information

The study commenced by enrolling 160 patients with intermediate and advanced hepatocellular carcinoma admitted to the First Affiliated Hospital of Sun Yat-sen University. Following the exclusion criteria, 58 patients were excluded.

Among these, 17 patients had a history of long-term analgesic use; 11 patients experienced significant postoperative fever or pain; 2 patients were over 80 years of age; 7 patients had severe preoperative cardiopulmonary disease; 13 patients had incomplete records; and 8 patients had platelet counts $< 50 \times 10^9/L$. A total of 12 patients in both groups were lost in the follow-up process. Ultimately, 90 patients were included in this study, with the inclusion and exclusion process detailed in **Figure 1**.

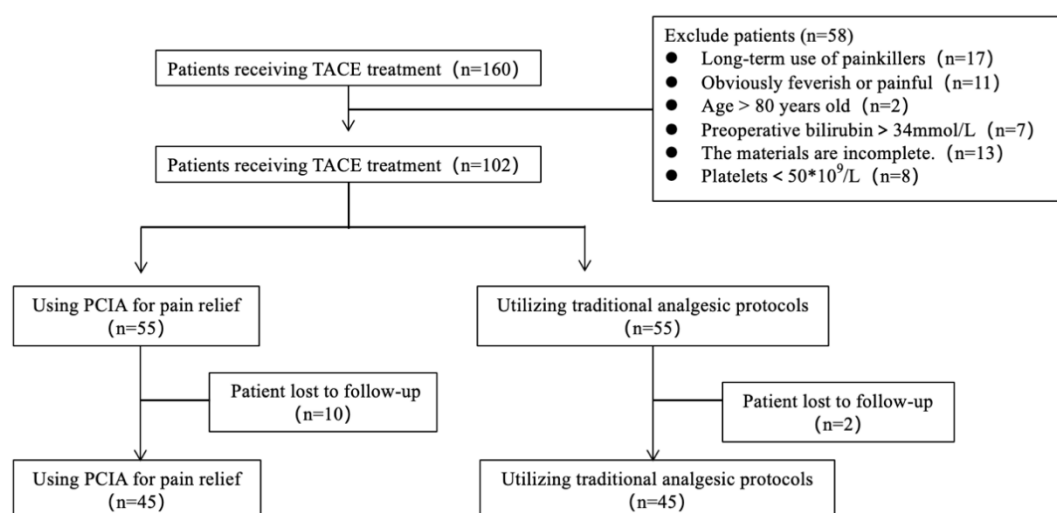


Figure 1. Patient admission and discharge process.

There was no statistically significant difference between the two groups in terms of gender, age, BMI, Child-Pugh classification, CNLC stage, prior TACE treatment history, or surgical duration ($P > 0.05$), as shown in **Table 1**.

Table 1. Clinical baseline characteristics of the two patient groups

Item	Experimental group (n=45)	Control group (n=45)	P-value
Gender			
Male	38	35	0.419
Female	7	10	
Age (years, mean \pm SD)	54.64 \pm 12.60	55.80 \pm 11.94	0.609
BMI	22.12 \pm 2.97	22.04 \pm 3.16	0.899
Child-Pugh classification			
Grade A	45	40	0.205
Grade B	0	5	
CNLC stage			
Stage II	12	15	0.490
Stage III	33	30	
Tumour size			
< 5cm	33	29	0.362
\geq 5cm	12	16	
Tumour number			
Single	11	12	0.809
Multiple	34	33	
ECOG score			
0 point	10	8	0.598
1 point	35	37	
TACE treatment history			
Yes	7	11	0.292
No	38	34	
Duration of surgery(min)	65.00 (35.00–120.00)	60.0 (40.00–174.00)	0.551

3.2. Pain control status

There were significant differences in the NRS scores between the two groups at five time points: intraoperative, immediately postoperatively, and at 1 hour, 6 hours, and 24 hours postoperatively ($P < 0.05$), as shown in **Figure 2** and **Table 2**.

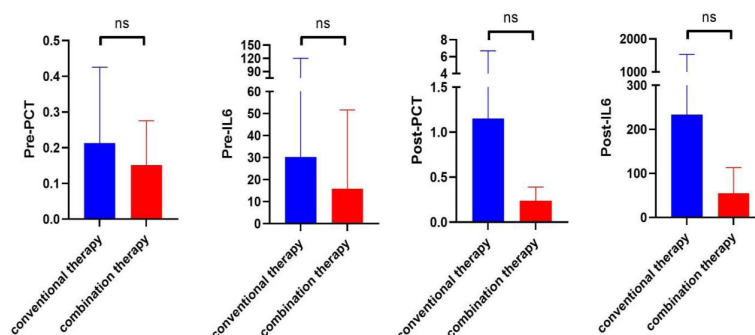
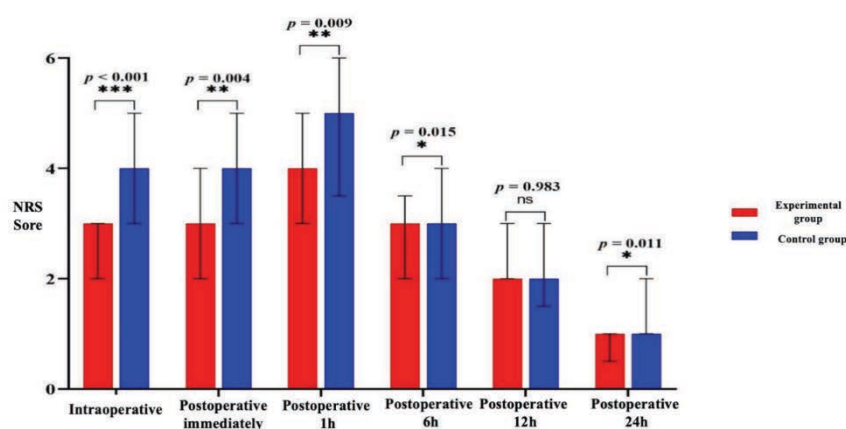
**Figure 2.** Comparison of NRS scores at different time points after TACE between the two patient groups.

Table 2. Comparison of NRS scores at different time points post-TACE between two patient groups

Group	Intraoperative	Immediately	1h after	6h after	12h after	24h postoperative
Experimental group (n=45)	3	3	4	3	2	1
Control group (n=45)	4	4	5	3	2	1
P-value	< 0.001	0.004	0.009	0.015	0.983	0.011

3.3. Comparison of preoperative and 24-hour postoperative serum inflammatory index levels between the two groups

There was no significant difference in the preoperative PCT and IL-6 levels between the two groups. Postoperative PCT (0.23 ng/ml vs. 1.15 ng/ml, $P = 0.424$) and IL-6 (54.49 pg/ml vs. 233.49 pg/ml, $P = 0.502$) levels of the patients in Group A were lower than those in Group B, with no statistically significant difference, as shown in Figure 3.

**Figure 3.** Comparison of preoperative PCT and IL-6 levels between the two groups of patients.

3.4. Adverse drug reactions

Common adverse reactions observed in patients during clinical application of hydromorphone include nausea, vomiting, dysuria, pruritus, and bradycardia. Analysis comparing adverse event incidence between the multimodal group and control group revealed no statistically significant difference in adverse reaction rates between the two groups ($P > 0.05$). See Table 3 for details.

Table 3. Comparison of postoperative adverse reactions between the two groups of patients

Group	Nausea and vomiting	Dizziness	Respiratory depression	Pruritus	Dysuria
Experimental group (n = 45)	20	13	0	3	1
Control group (n = 45)	13	7	0	3	1
Chi-square value	2.344	2.314	0.000	0.000	0.000
P-value	0.126	0.128	1.000	1.000	1.000

3.5. Analgesic satisfaction scores

Analgesic satisfaction reflects the quality of perioperative pain control. At 48 hours postoperatively, patients in the multimodal analgesia group demonstrated significantly higher satisfaction with pain relief compared to the control group. Within the experimental group, 86.7% of patients reported satisfaction scores of 4 or above, whereas this figure stood at 60.0% in the control group. This difference was statistically significant ($P < 0.05$), as detailed in **Table 4**.

Table 4. Comparison of analgesic satisfaction scores between the two patient groups

Number of cases [n (%)]	1 point (Very poor)	2 points (Poor)	3 points (Fair)	4 points (Good)	5 points (Very good)
Experimental group	0 (0.0)	1 (2.2)	5 (11.1)	30 (66.7)	9 (20.0)
Control group	0 (0.0)	2 (4.4)	16 (35.6)	20 (51.1)	4 (8.9)

4. Discussion

China accounts for approximately 50% of global primary liver cancer cases, with an extremely high mortality rate, making it the second most common malignant tumor after lung cancer^[9]. TACE involves injecting embolization agents and chemotherapy drugs into the hepatic artery to block the blood supply and kill tumour cells. It is currently recognized as the most effective non-surgical treatment for primary liver cancer, with nearly 100,000 TACE procedures performed annually in China^[10]. While TACE treatment can slow tumour growth and prolong patient survival, it also induces adverse reactions and complications.

Postoperative pain is one of the common clinical symptoms following TACE. According to relevant studies, 75% of patients experience varying degrees of hepatic pain postoperatively, with 93% reporting severe pain^[11]. Traditional analgesia relies on single drugs or monotherapy, yielding limited efficacy and often accompanied by significant adverse effects. Multimodal analgesia, however, combines analgesics with different mechanisms of action, employing a multi-pathway, multi-level, and multi-stage strategy. This approach has demonstrated significant efficacy in alleviating postoperative pain following TACE^[12].

Hydrocodone, as a potent μ -opioid receptor agonist, exhibits a more rapid onset of action than morphine, delivers superior analgesia, offers greater safety, and is associated with fewer adverse reactions. Consequently, it has gained increasing application in patient-controlled intravenous analgesia (PCIA)^[13]. However, high-dose hydromorphone may induce adverse reactions such as nausea, vomiting, and respiratory depression, and its analgesic efficacy remains inadequate in some patients^[6]. This may be related to the release of pain-inducing inflammatory mediators from tumour tissue necrosis following TACE^[4].

Flurbiprofen esters, a non-steroidal anti-inflammatory drug, effectively suppress acute pain by acting on tumour cells, surgical wounds, and vascular injury sites. They exert analgesic and anti-inflammatory effects by inhibiting cyclooxygenase activity, thereby reducing or blocking prostaglandin synthesis^[14–18]. However, the analgesic effect of NSAIDs exhibits a ‘ceiling effect’, meaning that beyond a certain dose, further increases yield limited improvement in pain relief. When used alone, they typically alleviate only mild pain and often fail to adequately relieve moderate to severe pain in the early postoperative period. Consequently, combination with opioid analgesics is frequently required^[19]. Research demonstrates that combined systemic administration of opioids and non-steroidal anti-inflammatory drugs yields superior postoperative analgesia compared to

monotherapy, whilst concurrently reducing the incidence of postoperative nausea, vomiting, and respiratory depression, thereby promoting patient recovery ^[20].

A retrospective study indicated that combining PCIA with flurbiprofen ester and hydromorphone yields superior analgesic effects in surgical patients ^[21]. The results of this study demonstrate that patients receiving combined hydromorphone and flurbiprofen ester via PCIA for perioperative analgesia during TACE exhibited lower pain scores than the control group during surgery, immediately postoperatively, and at 1, 2, and 24 hours postoperatively. No significant differences were observed in adverse reactions, suggesting that combined analgesic therapy based on PCIA demonstrates superior efficacy and safety in reducing perioperative pain during TACE compared with conventional monotherapy.

Once patients experience pain, they often develop a subjective desire to eliminate it urgently. During the period of waiting for medication to exert its analgesic effect, treatment comfort and satisfaction may diminish due to perceived excessive waiting times, excessive medication dosages, or excessive side effects. Consequently, this study employs the concept of pre-emptive analgesia within a multimodal pain management framework. This approach involves early intervention to inhibit central sensitisation before peripheral and central neural sensitisation occur, thereby reducing or eliminating nociceptive pain induced by injurious stimuli. Research indicates that pre-emptive analgesia yields favourable pain relief outcomes in patients undergoing uterine artery embolization, inhibits inflammatory mediators, and reduces both analgesic consumption and adverse drug reactions. Further studies indicate that administering analgesics before TACE treatment elevates the patient's analgesic threshold for TACE, effectively enhancing pain relief and comfort ^[22]. Consequently, the approach adopted in this study, initiating the analgesic pump 15 minutes preoperatively, adheres to the principles of pre-emptive analgesia, thereby reducing perioperative pain levels during TACE and improving patient satisfaction.

The severity of perioperative pain in patients undergoing TACE may be associated with inflammatory responses and inflammatory mediators ^[23,24]. Previous studies indicate that hyperalgesia and hypoalgesia induced by inflammatory responses and mediators are significant factors influencing pain intensity ^[24]. This study found no significant preoperative differences in PCT or IL-6 levels between the two groups. Postoperatively, PCT and IL-6 levels in Group A were lower than those in Group B, though the differences were not statistically significant, potentially due to the small sample size. This result aligns with the previously mentioned conclusion that tumour tissue necrosis following TACE leads to the release of pain-inflammatory mediators. It further suggests that combined analgesic methods based on PCIA can effectively reduce the degree of inflammatory response after TACE.

Additionally, we assessed the safety and patient experience of multimodal analgesia by monitoring perioperative adverse reactions during TACE and evaluating patients' pain relief satisfaction scores. Results indicated no statistically significant difference in adverse reaction incidence between the two groups, suggesting that the combined analgesic approach based on PCIA demonstrated comparable safety to conventional analgesic methods. The proportion of patients reporting satisfaction or higher in the experimental group was significantly higher than in the control group, indicating that multimodal analgesia provides patients with a better healthcare experience. This may enhance patient compliance in subsequent treatments.

5. Conclusion

The findings of this study suggest that, compared to traditional single-drug administration, PCIA-based combined

pre-emptive analgesia with hydromorphone hydrochloride (6 mg) and flurbiprofen ester (50 mg) significantly reduced postoperative pain intensity across all time points during the perioperative period of TACE treatment. This approach may mitigate postoperative inflammatory responses and markedly enhance patient satisfaction with perioperative analgesia, and does not increase adverse reactions, holding significant implications for perioperative pain management in TACE procedures. However, this study has limitations. Procedures were performed by the same medical team, and as the data originated from a single centre and were retrospective, generalisability may be constrained. Validation through larger prospective studies is warranted.

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Disclosure statement

The authors declare no conflict of interest.

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Application of Tripartite Collaborative Nursing in Enhancing Resilience Among Families of Pediatric Leukemia Patients

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Abstract: *Objective:* To investigate the efficacy of a tripartite collaborative nursing intervention in enhancing resilience among families of pediatric leukemia patients. *Methods:* Based on Walsh's family resilience theory and collaborative nursing principles, and after reviewing a large amount of literature, a tripartite intervention was constructed, which was led by the nursing team, coordinated by medical social workers, and supported by volunteers. Caregivers of pediatric hematology inpatients at a tertiary-level Class A hospital were selected as research subjects. which were divided into a control group (n = 30) and an experimental group (n = 30) according to a randomized block design. The control group are treated with standard nursing care, which included health education, counseling, and psychological support from nurses. The experimental group, in addition, was provided with a tripartite collaborative nursing intervention for 3 months. *Results:* The family resilience level, social support, and family function scores of the experimental group were higher than those of the control group, and the differences were statistically significant ($P \leq 0.05$). *Conclusion:* The implementation of tripartite collaborative nursing intervention improves the resilience of families of children suffered from leukemia.

Keywords: Caregivers; Collaborative nursing; Family coping capacity; Family resilience; Leukemia

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1. Introduction

The National Pediatric Oncology Surveillance Annual Report (2022) indicates that leukemia accounted for the highest proportion (48.07%) of all cancer discharges among children aged 0–19 years in China from 2019 to 2020. Among the incidence rates, leukemia in boys (41.85/million) and leukemia in girls (33.65/million) both rank first

among cancers, and have become a major disease threatening children's health ^[1,2].

Advances in medical technology have increased the five-year overall survival rate for children with leukemia to approximately 90%. Nonetheless, challenges such as managing complications, post-remission relapse, and diminished survival rates following recurrence continue to significantly impact the quality of life for affected families. Families universally experience multi-dimensional physical and psychological pressures related to taking care of the children. The family resilience, as a crucial capacity within the family system to cope with crises, has gained increasing research prominence.

Current domestic studies on family resilience primarily focus on building theory locally, analysis of influencing factors, and exploration of mediating effects, There are few intervention studies on family resilience ^[3]. Based on Walsh's Family Resilience Theory and Collaborative Care Theory, this study constructed a tripartite collaborative nursing intervention approach that led by the nursing team, coordinated by medical social workers, and supported by volunteers, aiming to systematically improve the resilience of families of children with leukemia ^[4,5].

2. Materials and methods

2.1. General data

60 primary caregivers of pediatric leukemia patients admitted to a Grade-A tertiary hospital between October 2024 and March 2025 were enrolled. The participants were randomized into control and experimental groups by a randomized block design. This study has been approved by the Research Ethics Committee of the hospital research department (Approval No.: 2025KS88).

Patient inclusion criteria:

- (1) The diagnosis must adhere to the pediatric leukemia standards outlined in the Chinese Guidelines for the Diagnosis and Treatment of Chronic Myeloid Leukemia, (2016 Edition) ^[6];
- (2) First onset.

Patient exclusion criteria: Presence of other severe neurological disorders.

Caregiver inclusion criteria:

- (1) Primary caregiver (e.g, parent);
- (2) Undertaking the main care of the child for a long time, ≥ 3 days a week ;
- (3) Informed consent and voluntary participation in this study are required.

Caregiver exclusion criteria:

- (1) Difficulty communicating;
- (2) Significant physical or psychological illness in the caregiver.;
- (3) Received other psychological interventions before;
- (4) Experiencing other traumatic events in the past month.

Sample size estimation formula for two-sample mean comparison:

$$n_1 = n_2 = 2 [(t_\alpha + t_\beta) \sigma / \delta]^2$$

“ σ ” represents the estimated standard deviation of the two samples, and “ δ ” denotes the difference between the two samples means. For a two-tailed test: α takes the value 0.05, β takes the value 0.10.

Calculation: $n_1 = n_2 = 27$.

Accounting for a 20% attrition rate, the final sample size was determined to be 30 participants for every group.

The comparative general characteristics of patients and caregivers in both groups are presented in **Table 1** and **Table 2**.

Table 1. Comparison of general characteristics between pediatric groups

Aspects	Control group	Observation group	Statistical value	P value
n	30	30		
Gender				
Male	17	13	$\chi^2 = 0.067$	0.795
Female	13	14		
Age	6.23 ± 1.501	6.87 ± 1.697	t = -1.531	0.131
Continue of education				
Yes	27	26	$\chi^2 = 0.165$	0.688
No	3	4		
Type of medical insurance				
Residential medical insurance	18	21	Fisher	0.487
Commercial insurance	5	4		
Both	4	3		
None	3	1		

Table 2. Comparison of general characteristics of caregivers in two groups of pediatric patients

Aspects	Control group	Observation group	Statistical value	P value
n	30	30		
Gender				
Male	13	11	$\chi^2 = 0.278$	0.598
Female	17	19		
Age	33.63 ± 3.211	32.00 ± 3.353	t = 1.927	0.059
Marital status				
Marries	27	28	Fisher	1.000
None	3	2		
Educational attainment				
Junior high	0	0	$\chi^2 = 0.720$	0.698
Secondary school or vocational college	5	5		
College	11	14		
Bachelor's degree or higher	14	11		
Monthly household income level in the past year				
< 3000	6	4	$\chi^2 = 1.680$	0.432
3000–5000	13	18		
> 5000	11	8		
Number of children				
1	20	19	Fisher	0.830
2	8	10		
3	2	1		

Table 2 (Continued)

Aspects	Control group	Observation group	Statistical value	P value
Place of residence				
City	5	8	$\chi^2 = 1.874$	0.392
County town	10	12		
Rural	15	10		

2.2. Intervention method

The control group were treated with conventional nursing care, which primarily involved health education, counseling, and psychological support provided by nurses to patients' families. The content included:

- (1) Upon admission, nurses will provide patients and their caregivers with an introduction to the hospital environment, medical insurance reimbursement policies, application procedures, precautions, etc.;
- (2) During hospitalization, nurses explain the progression of the disease, treatment protocols, and prognosis to parents, thereby alleviating psychological burdens on the patients' families. At different stage of treatment, they provide guidance on how to assist with taking care of children, including skin management, minimizing bleeding, promptly reporting fever, dietary plans, and managing appearance;
- (3) Nurses perform ward rounds more frequently, engaging with patients and their parents to evaluate psychological needs and offer timely emotional support;
- (4) Nurses can offer comfort, reassurance, and practical help to foster confidence and resilience in families to overcome the illness from the perspective of the parents of sick children by the mindset of empathy and compassion;
- (5) Considering the extended treatment period for pediatric leukemia, which typically lasts 2–3 years, and the fact that most maintenance therapy takes place at home following the hospital induction and consolidation phases, nurses are supposed to carry out biweekly telephone follow-ups, conduct home follow-up after discharge. This post-discharge home follow-up improves the compliance of children and their families and ensures the effective implementation of therapeutic measures.

For the experimental group, building upon the control group's nursing interventions and referencing the 2018 Pediatric Leukemia Diagnosis and Treatment Guidelines, Since the disease treatment mainly consists of 7 stages, the degree of risk and the length of treatment after each course of treatment are slightly different ^[7]. This group implemented a nurse-led tripartite collaborative care model involving nurses, medical social workers, and volunteers. The specific approach is detailed below.

2.2.1. Establishment of the tripartite collaborative working group

The group comprised one Head Nurse of Pediatric Hematology, four charge nurses, two medical social workers, four volunteers, two nursing postgraduates, two physicians, and two psychotherapists.

Prior to the formal implementation, group members underwent two rounds of standardized training, and then a preliminary experiment is conducted after passing the training, The formal experiment will be carried out after the preliminary experiment is feasible. Appoint the head nurse as the team leader, who responsible for overall planning, coordination, intervention quality control, and supervision. Physicians provided consultation and guidance during the implementation phase. Nurses, psychotherapists, medical social workers, and volunteers carried out specific intervention components. Nursing postgraduates assisted with completing literature reviews, data processing, and statistical analysis.

2.2.2. Developing the intervention protocol

A literature search was conducted across databases including PubMed, Web of Science, Embase, CINAHL, PsycINFO, China National Knowledge Infrastructure (CNKI), Wanfang Database, VIP, and the Chinese Biomedical Literature Database. Keywords such as “family resilience,” “collaborative nursing,” “psychological problems,” and “psychological intervention” were used to search and analyze relevant studies, based on the family resilience theoretical model proposed by Dr. Froma Walsh of the University of Chicago in the 1990s and further refined version in 2016, a preliminary intervention plan was formulated ^[8,9].

The research team leader convened a meeting with medical and nursing specialists from Pediatrics, Hematology, and the Mental Health Center to thoroughly discuss the rationality and feasibility of the proposed intervention measures in the draft plan, thereby the final implementation protocol was developed. Concurrently, the responsible nursing team leader conducted homogenization and standardized training on the intervention plan and methods. Nurses, medical social workers, and volunteers were permitted to participate only after passing assessments, ensuring the effective implementation of the intervention. The specific intervention plan is detailed in **Table 3**.

Table 3. Intervention protocol for enhancing resilience in families of pediatric hemophilia patients, grounded in Walsh’s Family Resilience Theory

Key Process	Intervention Timing	Intervention Content	Implementing Personnel	Purpose
Needs Assessment	Within 2 days of admission	Nurses used psychological assessment scales to evaluate the psychological status of parents	Nurses	Understanding of current psychological state
Belief Framework	Twice weekly during hospitalization, each session lasts 30 minutes until discharge	Nurses systematically and comprehensively explained leukemia-related knowledge to family members, guiding them towards an objective and rational understanding of the disease while dispelling irrational or incorrect perceptions, provided parents with as much information as possible regarding access to positive care and effective treatment. Additionally, they employed positive, constructive approaches to frame the meaning of disease management	Nurse	Assisting families in cultivating a sense of hope and control over the illness
		Psychotherapists and medical social workers led parents in mindfulness-based stress reduction and meditation training, guiding them to temporarily detach from life pressures and savor the present tranquility; for children with terminal illnesses, they provided spiritual or religious support	Psychotherapists and Medical Social Workers	Assist in reducing psychological stress
		Volunteers assisted parents in recognizing the positive changes they have noticed in their child or family throughout treatment, encouraging them to apply the knowledge they have gained to their daily lives	Volunteers	Cultivating positive psychological beliefs among family members
Organizational Model	Twice weekly during hospitalization, 30 minutes per session, until discharge.	Psychotherapists and medical social workers assisted parents in creating family structure diagrams and family ecosystem diagrams	Psychotherapists and medical social workers	Assist parents in recognizing the significance of the family and each family member
		Medical social workers and volunteers assisted the family members of children with leukemia by disseminating knowledge and providing case support. They helped these families understand the changes and pressures brought by the illness, encouraging them to gradually adapt to the life changes caused by the disease. They guided the reorganization of family roles with increased flexibility and facilitate joint life goal setting among family members. Additionally, they promoted mutual understanding between parents and between parents and children	Medical social workers and volunteers	Promote maintaining a positive outlook on life, foster mutual respect among family members, and establish connections and collaborative interactions within the family
		Through online platforms, policy education, and the Medical Social Work Department, they assisted families in identifying accessible socio-economic resources. Volunteers provided one-to-one guidance to parents, helping them explore their local support networks and reinforcing the understanding that “we are not fighting this battle alone”	Medical social workers and volunteers	Enhance parents’ confidence in managing illness together

Table 3 (Continued)

Key Process	Intervention Timing	Intervention Content	Implementing Personnel	Purpose
Effective Communication	Twice weekly during hospitalization, 30 minutes per session until discharge.	Led by nurses, psychotherapists, and medical social workers, parents were facilitated in their interactions through icebreaker activities. Group agreements and rules are established, and short-term, achievable goals are collaboratively set with family members	Nurses, psychotherapists, and medical social workers	Facilitating effective communication among family members, expressing love and care, and sharing positive emotions
		Nurses instructed family members in additional communication methods and skills, guiding them to maintain positive and effective communication with gratitude and tolerance	Nurses	
		Psychotherapists, medical social workers, and volunteers conducted communication sessions twice weekly, providing individual counseling when necessary. They encouraged family members to express their thoughts and difficulties, assist parents in managing emotions, and guided members in transforming negative feelings into positive energy while learning self-regulation and healing techniques. Conflicts are addressed promptly to clarify and resolve issues. Enhanced information and emotional exchange fosters reconnection with family members	Psychotherapists, medical social workers, and volunteers	
		Share personal experiences and treatment insights with other families facing similar circumstances, within this supportive peer group, participants expressed themselves, sought love and care, strengthened confidence in treatment, and alleviated anxiety	Medical social workers and volunteers	
Charitable Support	During hospitalization	Nurses performed initial assessments of the family's financial situation, income sources, and medical insurance coverage. Should the family be deemed rural impoverished, failed within the purview of major illness treatment assistance, or involved children with disabilities, this information is promptly communicated to the medical social work and volunteer service team	Nurses	Secure appropriate social support for families; foster a more inclusive social environment and a supportive atmosphere
		Medical social workers conducted in-depth interviews with parents to gain a thorough understanding of the family's financial circumstances. Simultaneously, based on policy eligibility and the severity of the child's condition, they assisted families in selecting suitable assistance programs or charitable funds to alleviate financial burdens for impoverished households wherever possible.	Medical Social Workers	
		Volunteers worked directly in clinical settings, guiding families through the completion of forms, refining application materials, explaining key considerations, and outlining subsequent claim procedures to ensure timely access to assistance for affected families	Volunteers	
		Medical social workers and volunteers actively identified and consolidated social resources, including crowdfunding platforms like Qingsongchou and the Red Cross Foundation, while also seeking policy support. This involves coordinating with community or sub-district civil affairs departments to facilitate applications for minimum living allowances	Medical Social Workers and Volunteers	

2.2.3. Implementing the intervention program

During the child's hospitalization, nurses lead bi-weekly interventions that last for approximately 30 minutes each, which are conducted in collaboration with medical social workers and volunteers. Depending on the content of the intervention, sessions are conducted by one-to-one or in small group. Locations include the child's bedside or patient-doctor consultation rooms, which utilize tools such as videos, case studies, PowerPoint presentations, and reference materials.

Prior to each session, parents are contacted to schedule the time and location. Interventions are strictly conducted according to the plan. parents' feedback including family experiences and feelings are supposed to actively sought to be understand after each session, with timely assistance provided as required. After discharge, biweekly telephone follow-ups are supplemented by a dedicated WeChat communication group, and this group regularly disseminates information on leukemia-related knowledge and stress management techniques. One-to-one follow-up discussions are arranged as needed.

2.2.4. Quality assurance

Before implementation, all team members undergo standardized training. During hospitalization, paper-based assessment questionnaires are administered. Two nursing graduate students use unified, standardized, and homogeneous standards to guide the family members of the children to fill in the form on site, which will be collected immediately to ensure its completeness. Data collection was scheduled from parents at 1 and 3 months' post-intervention in advance, and was conducted during follow-up hospital visits or chemotherapy sessions via on-site surveys. When on-site collection proved unfeasible, telephone follow-ups will be instead. The collected data underwent standardized numbering and organization, with dual data entry and cross-verification.

2.3. Evaluation methods

The Family Resilience Scale, Social Support Scale, and Family Functioning Scale were used to evaluate family resilience levels at the child's admission, one month post-intervention, and three months post-intervention.

2.3.1 Family resilience level

The Chinese version of the Family Resilience Assessment Scale (FRAS-C), revised in 2016 by Chinese scholars including Li, was utilized to evaluate family resilience levels ^[10]. This scale is based on the original FRAS developed by Sixbey ^[11]. This assessment consists of 32 items across three dimensions: Utilization of Social Resources (3 items), Maintaining Positive Perspectives (6 items), and Family Communication and Problem Solving (23 items).

The scale utilizes a four-point Likert scale, scoring items from 'Strongly Disagree' to 'Strongly Agree' as 1 to 4 points, respectively. The total score spans from 32 to 128 points, with higher scores indicating greater family resilience. The Cronbach's alpha coefficient for this scale in the present study ranged from 0.787 to 0.960.

2.3.2 Social support

The Social Support Rating Scale (SSRS), developed by Chinese scholar Xiao Shuiyuan, was utilized ^[12]. This scale is widely used both domestically and internationally ^[13,14]. It comprises three dimensions: objective support, subjective support, and utilization of social support, with a total of 10 items. The scale uses a 1–4 rating system, where higher scores across dimensions and the total score indicate greater social support received. Generally, a total score less than 20 indicates low social support, 20–30 denotes moderate support, and a score of 30 or above signifies satisfactory social support. The scale exhibits good reliability, with an internal consistency coefficient of 0.79 and a test-retest reliability of 0.920 ^[15].

2.3.3 Family functioning assessment

The Family Assessment Device (FAD), developed by Epstein et al. in 1983, was utilized ^[16]. This 60-item scale comprises seven subscales: Problem Solving, Communication, Roles, Emotional Reaction, Emotional Involvement, Behavioral Control, and Overall Functioning. Scores range from 1 to 4, corresponding to Strongly Agree, Agree, Disagree, and Strongly Disagree, respectively. Higher total scores suggest more negative assessment outcomes and poorer family functioning.

Scores between 60–120 indicate good family functioning, 121–180 indicate average functioning, and scores above 181 indicate poor family functioning. This scale needs to be completed by each family member aged 12 years or older.

2.4. Statistical methods

Data were entered by two operators using Epidata software and analyzed statistically with SPSS 23.0. Normally distributed quantitative data were described using means and standard deviations (SD). Intergroup comparisons employed independent samples t-tests at a significance level of $\alpha = 0.05$.

3. Results

Comparisons of family resilience, social support, and family functioning scores between the two groups before and after intervention are presented in **Table 4**, **5**, and **6**. At admission, differences in family resilience, social support, and family functioning scores between the control and experimental groups were not statistically significant ($P > 0.05$). 1 month and 3 months after intervention, the experimental group demonstrated significantly higher scores than the control group in family resilience, social support, and family functioning ($P \leq 0.05$).

Table 4. Comparison of family resilience scores before and after intervention in both groups (points, $\bar{x} \pm s$)

Group	n	Family Resilience Scale (FRAS)		
		Pre-intervention	1 month post-intervention	3 months post-intervention
Control group	30	90.367 \pm 3.68	94.367 \pm 1.712	97.267 \pm 2.099
Observation group	30	91.167 \pm 3.55	98.467 \pm 2.609	105.0 \pm 2.853
t-value		- 0.856	- 7.196	- 11.958
P-value		0.395	0.000	0.000

Table 5. Comparison of social support scores before and after the intervention in both groups of children (points, $\bar{x} \pm s$)

Group	n	Social support		
		Pre-intervention	1 month post-intervention	3 months post-intervention
Control group	30	21.900 \pm 1.605	24.700 \pm 1.803	28.200 \pm 2.107
Observation group	30	22.533 \pm 1.852	28.867 \pm 3.137	34.400 \pm 3.233
t-value		- 1.415	- 6.307	- 8.799
P-value		0.162	0.000	0.000

Table 6. Comparison of family functioning scores before and after intervention in both groups of children (points, $\bar{x} \pm s$)

Group	n	Family function score		
		Pre-intervention	1 month post-intervention	3 months post-intervention
Control group	30	147.167 \pm 7.553	141.000 \pm 8.094	131.933 \pm 4.667
Observation group	30	145.867 \pm 4.904	126.633 \pm 5.986	101.033 \pm 9.884
t-value		0.791	7.925	15.484
P-value		0.432	0.000	0.000

4. Discussion

4.1. Tripartite collaborative care enhances the level of social support for families of pediatric leukemia patients

Pediatric leukemia patients typically undergo multiple courses of chemotherapy within 1 month to 2 years of hospital admission, each causing varying degrees of psychological distress for both the child and their caregivers. Throughout this process, the level of family support plays a crucial role in combating the disease^[17].

Family social support involves multidimensional mutual assistance and protection among family members, encompassing emotional, material, informational, behavioral, and social resources. This support aids families in managing life's pressures and challenges, enhancing individual mental health, coping abilities, and life satisfaction^[18]. It also includes stress reduction, improved depressive symptoms, and increased well-being^[19].

Table 5 illustrates that at both 1 month and 3 months post-intervention, the social support levels within families of children with leukemia in the observation group were significantly higher than those in the control group ($P \leq 0.05$). Research indicates that increased levels of familial, community, and societal support, along with relationship quality and life satisfaction, contribute to enhanced family resilience^[20]. Following a child's diagnosis with leukemia, family members especially parents often experience a "sense of existential crisis", characterized by shock, fear, and feelings of powerlessness, along with significant physical distress such as insomnia and loss of appetite.

Despite their profound distress, parents frequently display remarkable resilience and love. During this challenging time, coordinated scientific interventions by nurses, medical social workers, and volunteers can help families adjust their mindset and transition roles by providing effective resources, implementing support measures, and actively seeking societal backing. Furthermore, heightened family resilience alleviates the patient's symptom burden, caregiver burden, psychological distress, and perceived stress, while also enhancing emotional and social support and quality of life for family members^[21,22]. Scholars advocate that healthcare professionals prioritize the crucial role of social and familial resources in delivering appropriate support and interventions to foster psychological resilience and mental health development^[23].

4.2. Tripartite collaborative care enhances family functioning in pediatric leukemia households

Family functioning refers to the dynamic capacity of the family system to achieve internal stability and external adaptation through processes such as normative interaction, emotional bonding, effective communication, and role coordination^[24,25].

As indicated in **Table 6**, the experimental group displayed significantly higher levels of family functioning than the control group at both 1 month and 3 months post-intervention ($P \leq 0.05$). Strong family functioning enhances psychological coping abilities among patients and caregivers, mitigates the impact of adverse events, and fosters positive familial relationships, which aligning with the findings from Huang's research^[26]. Families with a higher overall functional capacity demonstrate greater resilience in maintaining and improving family cohesion when facing adverse events^[27]. The tripartite collaborative care approach addresses not only the child's physical and mental health but also focuses on the psychological needs and well-being of the parents. It provides a platform for parents to communicate and share, and encourage family members to raise issues, engage in open dialogue, express feelings, and convey affection. This enhances role recognition among parents and relatives, utilizes familial bonds for intervention, strengthens family relationships, and increases confidence in overcoming

the illness.

Consequently, family functioning is improved, fully harnessing the family's proactive capacity to elevate its resilience, which aligns with existing scholarly conclusions that healthcare professionals should strive to enhance family resilience and communication skills to foster optimal family functioning^[28,29].

4.3. Tripartite collaborative care enhances the resilience of families with children diagnosed with leukemia

Upon the diagnosis of acute leukemia, the uncertainty surrounding treatment, the protracted duration of therapy, and the substantial financial burden often led to anxiety, depression, or acute post-traumatic stress syndrome in parents during the initial phase. Concurrent physical symptoms, such as dizziness, nausea, and abdominal pain, may further diminish the family's overall resilience.

Family resilience refers to the core characteristic where household members, through continuous adaptation and resource integration within stressful contexts, stimulate coping capacities. This facilitates the family's elastic recovery from adversity and achieves optimized functioning of both the family unit and its institutional relationships^[30]. It constitutes a dynamic process that enables families to undergo systemic restructuring during crises, achieving functional leaps post-adversity through effective adaptation^[31,32].

Table 4 demonstrates that at both 1 month and 3 months post-intervention, the experimental group exhibited significantly higher family resilience levels than the control group ($P \leq 0.05$), which aligns with findings from Lei regarding family resilience in pediatric leukemia patients^[33]. This study employed a multidisciplinary team-based collaborative nursing approach, utilizing family resilience process information to provide guidance on behavioral, physical, psychological, and social growth care services. This approach promoted family harmony and enhanced resilience levels, consistent with findings by Zhang^[34,35].

5. Conclusion

The nurse-led collaborative care intervention, which includes nurses, medical social workers, and volunteers, effectively enhances the overall resilience of families with children undergoing leukemia treatment. However, this study has its limitations, when considering the prolonged treatment cycle for leukemia and the constraints on time, manpower, resources, and the intervention lasted only 3 months. Moreover, family resilience is a dynamic process, Further research could adopt a longitudinal approach to explore this topic in greater depth and detail.

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Approaches to Achieving Effective Pre-Study for Systematic Anatomy

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Abstract: In the vast field of medical education, systematic anatomy serves as a solid cornerstone, firmly supporting medical students in their journey towards clinical professional knowledge. It is not just a course but also a key to unlocking the mysteries of medicine. This course is as rich as a vast treasure trove of knowledge, covering the fine structures and functions of various human body systems. Each knowledge point is like a bright pearl in the treasure trove. It is the foundation of clinical professional courses. Many subsequent clinical courses, such as diagnostics and surgery, rely on the basic understanding provided by systematic anatomy. Its professional vocabulary is also an important source of medical field terminologies, acting as the root of medical language and constructing the entire edifice of medical communication. Although the vocabulary of this course is rich, it is not complex. It is like a set of orderly-arranged jigsaw puzzles. As long as the correct methods are mastered, it is easy to piece them together. However, in the current teaching environment, the traditional cramming-style teaching method is like an old-fashioned carriage, showing obvious disadvantages on the road of the times. The pre-study link is like a rehearsal for a wonderful performance, having a direct and crucial impact on students' listening efficiency in class. Nevertheless, such an important teaching link is often overlooked, like a precious treasure forgotten in the corner. High-quality pre-study, for lecturers, is like giving wings to classroom teaching, which can greatly improve the efficiency of classroom teaching and make the teaching process smoother and more efficient. For students, it is like a magnifying glass that can deepen their understanding of knowledge points and their impression of the text, making the knowledge more clearly engraved in their minds. This article will focus on exploring the methods to achieve effective pre-study for systematic anatomy, hoping to contribute to the development of medical education.

Keywords: Effectiveness; Systematic anatomy; Teaching efficiency

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1. Introduction

As a foundational pillar of medical education, systematic anatomy is essential for understanding clinical disciplines. However, traditional teaching methods often overlook the critical role of pre-study, which serves as a vital rehearsal to enhance both teaching efficiency and student comprehension. This article therefore focuses

on strategies to achieve effective pre-study in systematic anatomy, aiming to improve learning outcomes and contribute to the advancement of medical education ^[1].

2. Teaching status quo of systematic anatomy and pre-study problems

In the long river of education, full-time undergraduate human anatomy lecturers are like navigators, leading one class of students after another to explore the ocean of medical knowledge. However, the current teaching still mainly adopts the traditional lecture-based model. It is like an old-fashioned projector. Lecturers deliver their lesson on the podium, while students passively listen below. This model makes both lecturers and students lack vitality.

For students, they are like containers being filled with knowledge, lacking the opportunities for active participation and thinking, so their learning interest is naturally not high. In class, their eyes often reveal confusion and fatigue, as if they have lost their way in the maze of knowledge ^[2]. For lecturers, each round of repetitive teaching is like a long-distance marathon, making them feel extremely tired. Although lecturers try their best to explain, hoping to accurately convey knowledge to students, this single teaching model is difficult to stimulate students' learning enthusiasm.

There is a sharp contradiction in current classroom teaching: classroom time is like the sand in an hourglass, limited and precious, while the teaching content is complex and extensive, like a dense forest that students need to explore deeply. The teaching progress is like an invisible thread that cannot be delayed, otherwise it will affect the evaluation and the teaching progress of other subjects. So, lecturers can only complete the required class hours within a limited time. Many students report that they can't keep up with the lecturer's teaching speed in class. It's like a car driving on the highway. They try their best to catch up but always fall short. Lecturers, on the other hand, think that their teaching speed is in line with the teaching progress and that the knowledge points are comprehensive. They are unable to understand why students can't keep up with their rhythm ^[2].

Although the importance of pre-study has always been emphasized, it's like repeatedly reminding travelers to bring essential luggage. However, very few students can actually preview before class. The contradiction between the lecturer's teaching speed and the students' acceptance level has never been effectively resolved. It's like a difficult puzzle that plagues both sides of teaching. Pre-study directly affects the listening efficiency in class, especially for medical students. Pre-study is like the first step in climbing the peak of medicine, which is essential. However, lecturers can't judge the students' pre-study situation and can't check it in class to avoid affecting the teaching progress ^[3]. It's like groping in the dark, not knowing whether students are ready to learn. To make students attach importance to pre-study, it needs to be transformed into a task that must be completed, just like giving students a clear instruction so that they can learn with goals and directions.

3. Pre-study methods and strategies for systematic anatomy

3.1. Course characteristics and pre-study content design

The course systematic anatomy is designed for freshmen majoring in clinical medicine, stomatology, and other medical specialties. They are like novices who have just stepped into the palace of medicine, with limited knowledge of human anatomy. In their perception, the human body is like a mysterious universe, full of unknowns and curiosities. At the same time, due to the professionalism and complexity of the course content, many students

have a fear of learning. It's like facing a towering mountain, feeling daunted.

Therefore, the design of pre-study content should fully consider the actual situation of students, be simple and easy to understand, and not take too much time. It's like preparing an easy-to-follow guide for students, allowing them to take the first step easily. At the same time, it should stimulate students' desire for exploration, like lighting a fire of curiosity in their hearts.

3.2. Methods to achieve active pre-study

First of all, it is necessary to establish students' awareness of pre-study and stimulate their interest in pre-study. In the new learning environment of the university, many students have not adapted to the rhythm of autonomous learning and need the guidance and supervision of lecturers. Lecturers should let students understand that the main task in university is to learn, and they must develop the habit of pre-study. It's like telling travelers to plan their itinerary in advance ^[3].

Lecturers should emphasize the importance of pre-study in the first class. It's like planting a seed in students' hearts. Inform students that the lack of pre-study will lead to difficulties in class and unsatisfactory grades, while effective pre-study can get twice the result with half the effort and enhance self-confidence. Some practical cases can be combined to let students more intuitively feel the benefits of pre-study. For example, there was once a student who, due to not developing the habit of pre-study, always couldn't keep up with the lecturer's rhythm in class and had unsatisfactory grades. Later, he realized the importance of pre-study and started to preview seriously. As a result, his grades improved significantly, and his self-confidence also increased.

The pre-study results can be scored and evaluated in combination with the total score. Pre-study should be included in the homework, and students should be required to complete it compulsorily. It's like setting a clear rule for students, letting them know that pre-study is an indispensable part of the learning process. After the lecture, assign pre-study homework, and randomly ask questions in the next class to examine the effectiveness of pre-study. Praise and give bonus points to students with good pre-study performance. This reward mechanism is like a catalyst that can stimulate students' enthusiasm and competitive spirit. For example, in class, lecturers can publicly praise students with excellent pre-study performance and let other students learn from them. At the same time, give bonus points, which are reflected in the final total score, so that students can feel the practical value of pre-study.

At the same time, lecturers should clearly guide students on pre-study methods and help them conduct effective pre-study. It's like giving students a key to open the door of knowledge. Pre-study can be arranged in class, and requirements can be gradually put forward to build a learning ladder. Offer pre-study guidance courses to teach students the skills to solve pre-study problems, integrate into the course, and assist in learning. For example, lecturers can teach students how to use textbooks, how to search for relevant materials, and how to take notes. In the pre-study guidance course, lecturers can demonstrate the application methods of these skills through practical operations, so that students can master them better.

The pre-study content should be set by lecturers in the form of courseware, with a large number of pictures and animations inserted, reducing text narration. It should combine regular and key content and highlight the key and difficult points. Pictures and animations are like vivid pictures that can enable students to more intuitively understand the structure and function of the human body. For example, when explaining the human skeletal system, animations can be used to show the movement and connection methods of bones, allowing students to see the shape and structure of bones more clearly ^[4]. Clinical cases or typical cases can also be inserted to guide students to ask questions during pre-study and find answers in class. Clinical cases are like real-life stories that can help students combine theoretical

knowledge with practical applications, improving the fun and practicality of learning.

3.3. Guidance on regular and key pre-study

Once pre-study becomes a norm, it is necessary to do a good job in guiding regular and key pre-study. Regular pre-study requires students to solve basic knowledge problems, just like laying a solid foundation when building a house. Students need to master the basic concepts, basic structures, and basic functions in the textbook to lay a solid foundation for subsequent learning. Key pre-study, on the other hand, requires lecturers to raise more difficult questions and guide students to search for information to broaden their knowledge. It's like building a tall building on the foundation, making students' knowledge more extensive and in-depth.

The accumulation of clinical knowledge is of great importance to medical students. It's like a weapon in the hands of doctors, which can help them better diagnose and treat diseases ^[4]. The pre-study courseware should be continuously improved, designed to be refined and beautiful, and incorporate internet buzzwords to highlight the key points. Internet buzzwords are like fashionable elements that can attract students' attention and increase the fun of learning.

3.4. Inspection of pre-study effectiveness

It is necessary to judge the effectiveness of pre-study through inspection and also check the pre-study courseware of lecturers ^[1]. Lecturers should pay attention to supervision and motivation to cultivate students' pre-study habits. At the beginning, lecturers can conduct supervision in person, like a strict supervisor, to ensure that students seriously complete the pre-study tasks. Lecturers can understand students' pre-study situations by checking their pre-study notes and communicating with them. Later, it can be adjusted to group mutual inspection. It's like a team-cooperation game, allowing students to supervise and learn from each other. Members within the group can check each other's pre-study assignments, exchange pre-study experiences, and improve together. Finally, let the group leader check.

In class, problems can be solved through questions, discussions, and answering doubts. The group leader is like the leader of the group, responsible for organizing and managing the pre-study work of the group. In class, lecturers can check the pre-study effects of students by asking questions and guide students to discuss to solve the problems encountered in pre-study.

The power of the group can also be exerted for mutual inspection and assistance. Group members can share their learning experiences and methods with each other and jointly solve the problems they encounter. For example, group members can discuss a clinical case together, analyze the human body structures and functions involved in the case, thereby deepening their understanding of knowledge. Through group mutual assistance, students can not only improve their learning ability but also cultivate team-cooperation spirit and communication skills.

3.5. Clarifying the purpose of pre-study and strengthening awareness

By achieving the above points, students can clarify the purpose of pre-study and enhance their awareness of active pre-study. When students clearly understand the importance and goals of pre-study, they are like a ship with a rudder, moving forward in the ocean of knowledge in the right direction ^[5]. Lecturers can help students gradually develop the habit of active pre-study by guiding them to establish pre-study awareness, providing effective pre-study methods, and conducting inspections of pre-study effectiveness. This habit is like a precious asset that can accompany students throughout their lives and benefit them in learning and work.

4. Positive impacts of pre-study on classroom learning

Having a good pre-study habit gets the course learning off to a good start and prepares students for classroom learning. Students are like well-equipped soldiers, confidently facing the challenges of classroom learning. Students understand that pre-study is a prerequisite for classroom teaching. It allows them to have a preliminary understanding of new lesson content, and they can get better results when listening to the class with preparation. It's like a wonderful performance; Only when the actors have fully rehearsed before the performance can they perform more confidently and outstandingly on the stage.

5. Conclusion

In summary, systematic anatomy constitutes the indispensable foundation of medical education, yet its mastery is often challenged by traditional, passive teaching methods. This article underscores the critical but frequently overlooked role of pre-class study as a powerful lever to enhance both teaching and learning efficacy. By shifting the focus towards developing and implementing effective pre-class preparation strategies, we can transform the learning experience of systematic anatomy. Such an approach promises to deepen students' understanding, improve classroom efficiency, and ultimately build a more robust knowledge base for their future clinical pursuits. Therefore, prioritizing and innovating pre-study methodologies is not merely beneficial but essential for advancing the quality of medical education ^[5].

Disclosure statement

The authors declare no conflict of interest.

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A Study on the Effect of Multimodal Nursing Intervention for Postoperative Pain in Gastrointestinal Surgery

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Abstract: *Objective:* To explore the clinical effect of multimodal nursing intervention on postoperative pain management in patients undergoing gastrointestinal surgery. *Methods:* A total of 120 patients who underwent gastrointestinal surgery in our hospital from January 2023 to January 2024 were selected as the research subjects. They were randomly divided into the intervention group and the control group, with 60 cases in each group. The control group received routine postoperative care, while the intervention group received multimodal pain care intervention. The postoperative pain scores, the rate of using analgesic drugs, postoperative recovery indicators, and nursing satisfaction were compared between the two groups. *Results:* At 24 hours, 48 hours, and 72 hours after surgery, the VAS pain scores of the intervention group were significantly lower than those of the control group ($p < 0.05$); the rate of using analgesic drugs in the intervention group (25.0%) was significantly lower than that in the control group (48.3%) ($p < 0.05$); the first defecation time, first ambulation time, and hospital stay of the intervention group were shorter than those of the control group ($p < 0.05$); the nursing satisfaction of the intervention group (96.7%) was significantly higher than that of the control group (80.0%) ($p < 0.05$). *Conclusion:* Multimodal pain care intervention can effectively relieve postoperative pain in patients undergoing gastrointestinal surgery, reduce the use of analgesic drugs, promote postoperative recovery, and improve nursing satisfaction.

Keywords: Gastrointestinal surgery; Postoperative pain; Multimodal care; Pain management; Rapid recovery

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1. Introduction

With the development of minimally invasive surgical techniques, gastrointestinal surgery has made significant progress. However, postoperative pain remains an important factor affecting patients' recovery. According to statistics, in 2023, the number of gastrointestinal surgery cases in China reached 2.8 million, and approximately 65% of the patients experienced moderate to severe pain after surgery^[1].

Postoperative pain not only increases patients' suffering but also may lead to respiratory depression, delayed recovery of gastrointestinal function, and prolong hospital stay^[2]. The traditional pain management model is mainly passive, which is difficult to meet the needs of modern rapid rehabilitation surgery. In recent years, the multi-modal analgesia concept has shown significant advantages in postoperative pain management. This concept emphasizes the synergistic effect of multiple approaches and methods to achieve better analgesic effects^[3]. Studies have shown that multi-modal analgesia can effectively reduce the dosage of opioid drugs, lower the postoperative pain score, and promote early recovery of patients^[4].

Based on the concept of rapid rehabilitation surgery (ERAS), the multi-modal analgesia plan has been widely applied to patients undergoing gastrointestinal surgery, and it has clear advantages in reducing postoperative pain, accelerating the recovery of gastrointestinal function, and shortening hospital stay^[5].

This study, based on the ERAS concept, has constructed a multi-modal pain care plan including preoperative education, intraoperative cooperation, and postoperative intervention, aiming to provide better pain management services for patients undergoing gastrointestinal surgery and verify its clinical effect.

2. Materials and methods

2.1. Study subjects

A total of 120 patients who underwent surgical treatment in the Gastrointestinal Surgery Department of our hospital from January 2023 to January 2024 were selected as the study subjects.

2.1.1. Inclusion criteria

- (1) Age ranging from 18 to 75 years
- (2) Scheduled for gastrointestinal surgery
- (3) ASA classification of grade I to II

2.1.2. Exclusion criteria

- (1) Chronic pain history
- (2) Long-term use of analgesic drugs
- (3) Mental illness or cognitive impairment
- (4) Severe dysfunction of heart, lung, liver, or kidney.

The patients were divided into the intervention group and the control group with 60 cases each using the random number table method. There was no statistically significant difference in baseline data between the two groups ($p > 0.05$), and they were comparable (**Table 1**).

Table 1. Comparison of baseline data between the two groups of patients

Project	Intervention group (n = 60)	Control group (n = 60)	t/χ^2	p
Age	52.3 ± 10.7	51.8 ± 11.2	0.251	0.802
Gender	32/28	34/26	0.136	0.712
BMI (kg/m ²)	23.5 ± 3.1	23.8 ± 3.4	0.502	0.617
Type of surgery / (Open surgery / Laparoscopic surgery)	18/42	20/40	0.136	0.712
Time of operation (min)	142.5 ± 35.6	138.7 ± 32.8	0.603	0.548

2.2. Intervention methods

2.2.1. Control group

- (1) Received routine postoperative care

Monitoring of vital signs after surgery, administration of analgesic drugs as needed, guidance on regular diet, and basic rehabilitation guidance

2.2.2. Intervention group

The multi-modal pain care intervention was implemented in the study design.

2.2.3. Preoperative intervention

- (1) Pain knowledge education

Use multimedia to explain the mechanism of postoperative pain, assessment methods, and coping strategies

- (2) Psychological counseling

Assess the patient's anxiety level and conduct targeted psychological intervention

- (3) Breathing training

Guide abdominal breathing and effective coughing methods

2.2.4. Intraoperative intervention

- (1) Position management

Use gel pads to protect the pressured areas

- (2) Temperature maintenance

Use heated blankets to maintain normal body temperature

- (3) Intervention

Cooperate with the anesthesiologist to implement multi-modal analgesia.

2.2.5. Postoperative intervention

- (1) Pain assessment

Use the VAS scoring method to assess pain severity every 4 hours and dynamically adjust intervention measures.

2.2.6. Non-pharmacological intervention

- (1) Cold/hot compress

Cold compress around the incision within 24 hours after surgery, and change to hot compress after 48 hours

- (2) Position adjustment

Assist the patient to take a comfortable position to reduce incision tension

- (3) Music therapy

Select soothing music according to the patient's preference, 2 times a day, 30 minutes each time

- (4) Relaxation training

Guide progressive muscle relaxation techniques

2.2.7. Pharmacological intervention

(1) Implement a stepped analgesic plan

Mild pain (VAS 1–3 points) uses non-steroidal anti-inflammatory drugs; moderate pain (VAS 4–6 points) adds weak opioids; severe pain (VAS 7–10 points) uses strong opioids

(2) Time interval

Combine timed administration with on-demand administration

(3) Contraindication

Preventive use of antiemetic drugs to reduce side effects of opioids.

2.2.8. Early activity

Start Moving around on the bed 6 hours after surgery, assist with getting out of bed 24 hours after surgery, then formulate individualized activity plans and gradually increase activity volume.

2.2.9. Nutritional support

Start drinking small amounts of water 6 hours after surgery; gradually transition to a diet based on gastrointestinal function recovery, then supplement with protein and vitamins to promote wound healing.

2.3. Observation indicators

2.3.1. Pain severity

Use the VAS scoring method (0–10 points) to record the pain scores at rest and during activity at 24 h, 48 h, and 72 h after surgery.

2.3.2. Use of analgesic drugs

Record the usage rate of analgesic drugs within 72 hours after surgery and calculate the equivalent dose of morphine.

2.3.3. Postoperative recovery indicators

The time of first exhaust, the time of first getting out of bed for activity, and the length of hospital stay.

2.3.4. Nursing satisfaction

Use a self-made Likert 5-level scoring questionnaire, including dimensions such as pain control, nursing attitude, and health education.

A total score of ≥ 90 is considered very satisfactory, 75–89 is satisfactory, and < 75 is unsatisfactory.

2.4. Statistical methods

Data analysis was conducted using SPSS 22.0 software.

Measurement data were expressed as mean \pm standard deviation ($\bar{x} \pm s$), and inter-group comparisons were performed using *t*-tests; count data were expressed as the number of cases (percentage), and inter-group comparisons were performed using χ^2 tests. $p < 0.05$ was considered statistically significant.

3. Result

3.1. Comparison of pain scores between the two groups

At each time point after the operation, the VAS scores of the intervention group during rest and activity were significantly lower than those of the control group ($p < 0.05$). The details are shown in **Table 2**.

Table 2. Comparison of VAS scores between the two groups after the operation ($\bar{x} \pm s$, points)

Time	Resting pain score				Activity pain score			
	Intervention group	Control group	<i>t</i>	<i>p</i>	Intervention group	Control group	<i>t</i>	<i>p</i>
24 h	3.2 ± 1.1	5.8 ± 1.3	11.72	< 0.001	4.5 ± 1.2	7.2 ± 1.4	10.56	< 0.001
48 h	2.6 ± 0.9	4.3 ± 1.1	9.43	< 0.001	3.8 ± 1.0	6.1 ± 1.2	8.92	< 0.001
72 h	1.8 ± 0.7	3.2 ± 0.9	9.25	< 0.001	2.9 ± 0.8	4.7 ± 1.0	7.84	< 0.001

3.2. Comparison of analgesic drug usage between the two groups

The usage rate of analgesic drugs within 72 hours after surgery in the intervention group (25.0%) was significantly lower than that in the control group (48.3%) ($\chi^2 = 6.78$, $p = 0.009$). The equivalent dose of morphine in the intervention group was (12.5 ± 4.2) mg, which was significantly lower than that in the control group (18.6 ± 5.8) mg ($t = 6.52$, $p < 0.001$).

3.3. Comparison of postoperative recovery indicators between the two groups

The time for the first defecation, the time for the first ambulation, and the hospital stay of the intervention group were significantly shorter than those of the control group ($p < 0.05$) (**Table 3**).

Table 3. Comparison of postoperative recovery indicators between the two groups ($\bar{x} \pm s$)

Index	Intervention group	Control group	<i>t</i>	<i>p</i>
First exhaust time (h)	24.5 ± 6.8	36.2 ± 8.9	8.24	< 0.001
The time of first getting out of bed (h)	28.3 ± 7.5	42.6 ± 9.8	9.12	< 0.001
Hospital stays (d)	7.2 ± 1.8	9.8 ± 2.5	6.87	< 0.001

3.4. Comparison of nursing satisfaction between the two groups

The nursing satisfaction rate of the intervention group (96.7%) was significantly higher than that of the control group (80.0%) ($\chi^2 = 8.45$, $p = 0.004$).

4. Discussion

The results of this study indicate that the implementation of multimodal pain care intervention can significantly improve the postoperative recovery process of patients undergoing gastrointestinal surgery. The pain scores of patients who received this intervention were significantly lower at all time points after surgery. This analgesic effect may be attributed to the synergistic effect of both pharmacological and non-pharmacological intervention measures^[6]. Through the combination of non-pharmacological methods such as cold and hot compresses, music therapy, and a stepwise pharmacological analgesic regimen, pain sensitivity and central sensitization were

effectively reduced. This multimodal intervention approach not only provides more comprehensive pain control but also enhances patients' understanding and participation in pain management through psychological counseling and health education^[7]. In terms of the use of analgesic drugs, the intervention scheme significantly reduced the usage rate of opioid drugs and the equivalent dose of morphine. This finding is of great significance because reducing the use of opioid drugs can effectively lower the risk of related side effects such as nausea, vomiting, and intestinal paralysis, thereby further promoting patient recovery.

Multimodal analgesia reduces dependence on opioid drugs through non-pharmacological means^[8]. It is worth noting that the intervention scheme also significantly improved postoperative recovery indicators. The time to first defecation, the time to get out of bed, and the length of hospital stay were significantly shortened, which reflects the comprehensive benefits of multimodal nursing intervention in promoting postoperative recovery.

Early activity and nutritional support, as the core content of the ERAS concept, provide strong support for shortening the hospital stay by reducing postoperative complications and promoting gastrointestinal function recovery. In particular, early ambulation not only helps promote blood circulation, reduce deep vein thrombosis, but also significantly promotes gastrointestinal function recovery, thereby accelerating the postoperative recovery process^[9].

The significant improvement in nursing satisfaction reflects the advantages of multimodal nursing intervention in providing personalized and comprehensive pain management. By combining psychological counseling, health education, and pain control, this approach enhances patients' trust and satisfaction. This patient-centered management model not only focuses on the physiological aspect of pain but also takes into account the influence of psychological and social factors on the pain experience, thus providing more comprehensive nursing services^[10].

5. Conclusion

Multimodal pain care intervention can effectively alleviate postoperative pain in patients undergoing gastrointestinal surgery, reduce the use of analgesic drugs, promote postoperative recovery, and improve nursing satisfaction. This plan is based on the ERAS concept and integrates multiple measures before, during, and after the surgery. Through the combination of drug and non-drug interventions, it achieves the optimization and individualization of pain management. Its clinical application and promotion can help improve patients' surgical experience, accelerate the recovery process, and reduce medical resource consumption, and has significant clinical value and practical significance.

Disclosure statement

The authors declare no conflict of interest.

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Study on the Effects of Respiratory Exercise Rehabilitation Nursing on Self-care Ability, Lung Function, and Quality of Life in Patients with COPD

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Abstract: *Objective:* To explore the effects of respiratory exercise rehabilitation nursing on self-care ability, lung function, and quality of life in patients with chronic obstructive pulmonary disease (COPD). *Methods:* A total of 88 patients with COPD admitted from February 2024 to February 2025 were selected and randomly divided into an experimental group and a control group, with 44 patients in each group. The control group received routine nursing, while the experimental group received respiratory exercise rehabilitation nursing on the basis of routine nursing. After 12 weeks of intervention, the self-care ability, lung function, and quality of life of the two groups were compared. *Results:* After the intervention, the scores of each dimension and the total score of self-care ability in the experimental group were significantly higher than those in the control group ($p < 0.001$). The improvement of lung function indicators such as FEV₁, FVC, and FEV₁/FVC in the experimental group was better than that in the control group ($p < 0.001$). The scores of each dimension and the total score of quality of life in the experimental group were significantly lower than those in the control group ($p < 0.001$). *Conclusion:* Respiratory exercise rehabilitation nursing can effectively improve the self-care ability, lung function, and quality of life of patients with COPD, which is worthy of clinical promotion and application.

Keywords: Chronic obstructive pulmonary disease; Respiratory exercise rehabilitation nursing; Self-care ability; Lung function; Quality of life

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1. Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disease characterized by persistent airflow limitation, featuring high incidence, high disability rate, and high recurrence. The emergence of the disease not only causes severe damage to patients' lung function but also leads to repeated acute exacerbations, reducing patients' self-protection ability and severely affecting their quality of life, thus imposing a heavy economic burden

on families and society^[1,2]. In recent years, with the development of rehabilitation medicine, the therapeutic value of respiratory exercise rehabilitation nursing for chronic respiratory diseases has gradually attracted people's attention. Simultaneously, systematic rehabilitation intervention can improve patients' understanding of the disease, promote the formation of active self-protection behaviors, relieve clinical symptoms, and enhance the quality of life. Based on this, this article analyzes the effects of respiratory exercise rehabilitation nursing on self-care ability, lung function, and quality of life of COPD patients, as follows.

2. Materials and methods

2.1. Baseline information

Eighty-eight COPD patients admitted to the respiratory medicine department of our hospital from February 2024 to February 2025 were selected as the research subjects. The patients were divided into an experimental group and a control group using a random number table method, with 44 patients in each group.

In the experimental group, there were 26 males and 18 females, with an age range of 45 to 78 years and an average age of (62.35 ± 8.42) years. The disease duration ranged from 3 to 15 years, with an average duration of (8.65 ± 3.24) years. In the control group, there were 24 males and 20 females, aged between 48 and 75 years, with an average age of (60.87 ± 7.91) years. The disease duration ranged from 2 to 14 years, with an average of (8.23 ± 2.97) years.

2.1.1. Inclusion criteria

Meet the diagnostic criteria for COPD in the "Guidelines for the Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease (2023 Revision)" developed by the Chinese Medical Association Respiratory Disease Branch, and be in a stable phase of the disease.

- (1) Aged between 40 and 80, able to understand and cooperate with various assessments and rehabilitation training.
- (2) Patients are willing to participate in this study and sign an informed consent form voluntarily.

2.1.2. Exclusion criteria

Combined with severe dysfunction of important organs such as heart, liver, and kidney, or the presence of malignant tumors, autoimmune diseases, and other diseases that seriously affect the study results.

- (1) Acute exacerbation of COPD has occurred in the past 3 months, or there is uncontrolled severe lung infection.
- (2) Presence of cognitive impairment, mental illness, unable to cooperate with respiratory exercise rehabilitation training.
- (3) Participation in other clinical trials that affect the results of this study in the near future.
- (4) There was no statistically significant difference in general information such as gender, age, and disease duration between the two groups ($p > 0.05$), and they were comparable.

2.2. Methods

Patients in the control group received routine nursing intervention for 12 weeks. The nursing content includes: Condition monitoring, regular measurement of body temperature, pulse, respiratory rate, and blood pressure

every day, recording 24-hour sputum volume and sputum properties; providing oxygen inhalation guidance, controlling oxygen flow at 1–2 L/min, and daily oxygen inhalation time of not less than 15 hours; conducting health education, with 1 collective lecture per week covering the causes, precipitating factors, and medication precautions of COPD, each lecture lasting 40 minutes; guiding patients to have a reasonable diet, ensuring a daily protein intake of 1.2–1.5 g/kg body weight and a daily water intake of 1500–2000 mL; nurses assisting patients in positional sputum excretion, twice a day (morning and evening), 15 minutes each time, assisting patients to lie on their sides, gently tapping the back from bottom to top and from outside to inside ^[3].

The observation group received respiratory rehabilitation nursing care based on routine nursing for 12 weeks.

2.2.1. Abdominal breathing training

The patient lies on their back with knees bent, placing one hand on the chest and the other on the abdomen. They slowly inhale through the nose, allowing the abdomen to rise for 4 seconds, then slowly exhale through the mouth with lips pursed as if blowing a whistle, allowing the abdomen to fall for 6 seconds. This exercise is performed 3 times a day, with each session lasting 15 minutes.

2.2.2. Pursed-lip breathing training

The patient sits in a relaxed position, inhales through the nose for 2 seconds, then purses their lips and exhales slowly for 4–6 seconds, trying to expel as much air from the lungs as possible. This training is done 3 times a day, with each session lasting 10 minutes.

2.2.3. Respiratory exercise training

This specifically includes chest expansion, bending, and turning movements. For chest expansion, the patient extends their arms to shoulder height, inhales while straightening their back, and exhales while bringing their arms back, repeating 10 times. For bending, the patient stands with feet shoulder-width apart, bends slowly at the waist with hands touching the ground and exhales, then inhales while returning to the upright position, repeating 8 times. For turning, the patient stands with feet shoulder-width apart, turns left and right while exhaling, and inhales while returning to the center, repeating 8 times on each side. This training is performed 2 times a day, with each session lasting 20 minutes.

2.2.4. Endurance training

The nurse develops a walking plan based on the patient's physical condition, starting with walking 300 meters at a pace of 60 steps/minute. The distance and pace are gradually increased by 100 meters and 5 steps per week, respectively, until reaching 1000 meters at a pace of 80 steps/minute. This training is performed once a day.

All respiratory rehabilitation training sessions are conducted under the guidance of a nurse. During the training, the nurse closely monitors the patient's breathing and heart rate to ensure that their blood oxygen saturation remains above 90% ^[4].

2.3. Observation indicators

2.3.1. Self-care ability

Evaluated using the Chronic Obstructive Pulmonary Disease Self-care Ability Scale, which includes four dimensions, includes the self-care knowledge, self-care skills, self-care responsibility, and self-care confidence.

The scale consists of 28 items, with each item scored from 1 to 5. The total score ranges from 28 to 140, and a higher score indicates stronger self-care ability.

2.3.2. Lung function

Patients forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio were measured using a lung function monitor. Before testing, patients were required to rest quietly for 15 minutes in a seated position. The test was repeated three times, and the maximum value was taken as the final result.

2.3.3. Quality of life

Evaluated using the St. George's Respiratory Questionnaire (SGRQ), which includes three dimensions, includes the symptoms, activity level, and impact of disease. The questionnaire consists of 50 items, with each item scored from 0 to 4 based on severity. A higher score indicates poorer quality of life for the patient. The total score and scores for each dimension were calculated using a formula, with the total score ranging from 0 to 100.

2.4. Statistical analysis

Data analysis was performed using SPSS 25.0 statistical software. Measurement data were expressed as mean \pm standard deviation ($\bar{x} \pm s$) and analyzed using the *t*-test. Count data were expressed as percentages (%) and analyzed using the chi-square test. A *p*-value < 0.05 was considered statistically significant.

3. Results

3.1. Self-care ability indicators for both groups of patients

Post-intervention, the experimental group demonstrated significantly greater improvement in all domains of self-care ability compared to the control group (all between-group *p*-values < 0.001). While both groups showed significant improvements from their own baselines, the increases in scores for self-care knowledge, skills, responsibility, confidence, and the total score were markedly higher in the experimental group. See **Table 1** for details.

Table 1. Comparison of self-care ability between the two groups of patients ($\bar{x} \pm s$)

Group	n	Time	Knowledge	Skills	Responsibility	Confidence	Total score
Experimental group	44	Pre	18.25 \pm 3.12	16.89 \pm 2.78	15.63 \pm 2.45	14.92 \pm 2.31	65.69 \pm 8.24
		Post	25.68 \pm 3.56	23.45 \pm 3.02	21.87 \pm 2.89	20.76 \pm 2.65	91.76 \pm 9.32
		<i>t</i> -value	10.256	11.362	9.875	10.543	12.689
		<i>p</i> -value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Control group	44	Pre	17.98 \pm 3.05	17.02 \pm 2.81	15.87 \pm 2.51	15.13 \pm 2.28	66.00 \pm 8.17
		Post	20.32 \pm 3.21	19.23 \pm 2.95	18.12 \pm 2.67	17.54 \pm 2.43	75.21 \pm 8.56
		<i>t</i> -value	3.872	3.561	3.214	3.678	4.125
		<i>p</i> -value	< 0.001	0.001	0.002	< 0.001	< 0.001
Comparison between groups after intervention		<i>t</i> -value	6.892	5.987	5.231	6.542	8.251
		<i>p</i> -value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

3.2. Lung function indicators of two patient groups

Post-intervention comparisons revealed statistically significant differences between the experimental and control groups across all measured lung function parameters, including FEV₁, FVC, and FEV₁/FVC ratio (all $p < 0.001$), favoring the experimental group. Intragroup analysis indicated that both groups experienced significant improvements from baseline (all $p < 0.05$ for the control group; all $p < 0.001$ for the experimental group). However, the magnitude of improvement was markedly superior in the experimental group. See **Table 2** for details.

Table 2. Comparison of lung function indicators between two patient groups ($\bar{x} \pm s$)

Group	n	Time	FEV ₁ (L)	FVC (L)	FEV ₁ /FVC (%)
Experimental group	44	Pre	1.42 ± 0.35	2.35 ± 0.42	58.63 ± 4.25
		Post	1.86 ± 0.41	2.89 ± 0.48	65.32 ± 4.68
		<i>t</i> -value	5.632	5.987	6.215
		<i>p</i> -value	< 0.001	< 0.001	< 0.001
Control group	44	Pre	1.39 ± 0.32	2.31 ± 0.39	57.98 ± 4.12
		Post	1.53 ± 0.36	2.52 ± 0.43	60.15 ± 4.32
		<i>t</i> -value	2.156	2.321	2.563
		<i>p</i> -value	0.035	0.023	0.012
Comparison between groups after intervention		<i>t</i> -value	4.021	3.876	4.521
		<i>p</i> -value	< 0.001	< 0.001	< 0.001

3.3. Quality of life indicators of two patient groups

Both the experimental and control groups exhibited statistically significant improvements from baseline to post-intervention in all quality-of-life domains, symptoms, activity, impact, and total score, with all p -values < 0.001. Following the intervention, the experimental group showed markedly lower, indicating better outcomes scores than the control group in all corresponding measures. These between-group differences were all statistically significant (all $p < 0.001$). See **Table 3** for details.

Table 3. Comparison of quality-of-life indicators between two patient groups ($\bar{x} \pm s$)

Group	n	Time	Symptom domain	Activity domain	Disease impact	Total score
Experimental group	44	Pre	28.65 ± 4.32	32.18 ± 5.16	26.43 ± 3.87	87.26 ± 10.53
		Post	16.23 ± 3.15	20.56 ± 4.21	15.87 ± 2.96	52.66 ± 7.82
		<i>t</i> -value	15.326	13.875	14.652	16.893
		<i>p</i> -value	< 0.001	< 0.001	< 0.001	< 0.001
Control group	44	Pre	27.98 ± 4.15	31.87 ± 4.98	25.96 ± 3.72	85.81 ± 10.25
		Post	23.56 ± 3.87	27.65 ± 4.53	21.34 ± 3.25	72.55 ± 9.36
		<i>t</i> -value	5.632	4.987	5.214	6.325
		<i>p</i> -value	< 0.001	< 0.001	< 0.001	< 0.001
Comparison		<i>t</i> -value	9.215	7.863	8.542	10.652
		<i>p</i> -value	<0.001	<0.001	<0.001	<0.001

4. Discussion

4.1. Positive impact of respiratory rehabilitation nursing on self-care ability of COPD patients

This study indicates that after intervention, the scores and total scores of various dimensions of self-protection ability in the experimental group were higher than those in the control group, and the evaluation results before and after intervention within the group were also statistically significant ($p < 0.05$). This confirms the important value of respiratory rehabilitation in enhancing the self-protection ability of COPD patients. Although the traditional nursing model can transmit basic disease knowledge to patients, it lacks specialized skill training and behavior supervision, making it difficult to translate theoretical knowledge into daily self-protection behaviors ^[5]. Respiratory rehabilitation nursing, based on a systematic training plan, allows patients to gradually master key disease management skills and deepen their control and cognition of their own physical health status through repeated practice of abdominal breathing, pursed-lip breathing, and other movements.

Nurses continuously provide guidance and timely feedback during the training process, which can enhance patients' self-protection awareness and prompt them to shift from passively cooperating with nursing to actively participating in disease management, ultimately achieving a comprehensive improvement in self-protection ability. Relevant studies have confirmed that enhancing self-protection ability can significantly reduce the probability of acute exacerbations in patients with chronic obstructive pulmonary disease.

4.2. Improvement effect of respiratory rehabilitation nursing on lung function of COPD patients

In this study, after intervention, the improvement of FEV1, FVC, and FEV1/FVC in the experimental group was significantly greater than that in the control group ($p < 0.05$), indicating a strong correlation with the physiological effect mechanism inherent in respiratory rehabilitation therapy. Due to long-term airway obstruction, the respiratory muscles of COPD patients are chronically loaded, leading to changes in muscle fiber structure and decreased function, which ultimately results in decreased lung ventilation function. Performing abdominal breathing training on patients can enhance the contractility of their diaphragm and other respiratory muscles, improve respiratory efficiency, and increase tidal volume. Pursed-lip breathing can prolong exhalation time, reduce intra-airway pressure, decrease airway obstruction, and improve gas exchange in the lungs. Endurance training can also enhance patients' cardiopulmonary reserve, improve their tolerance to hypoxic environments, and actively promote the recovery of lung function ^[6].

Although traditional nursing can alleviate hypoxic symptoms through methods such as oxygen inhalation, it cannot fundamentally improve respiratory muscle function and airway dynamic characteristics, thus its effect on improving lung function is limited. Long-term adherence to respiratory rehabilitation training by patients can delay the progressive decline in lung function associated with COPD.

4.3. Enhancing effect of respiratory rehabilitation nursing on the quality of life of COPD patients

The results of this study demonstrate that respiratory rehabilitation is of great significance in improving the quality of life of COPD patients. Implementing this intervention can enhance patients' quality of life. The reason for such results lies in the fact that respiratory rehabilitation can improve patients' self-protection abilities and lung function. Improving lung function can alleviate core symptoms such as dyspnea, reduce the constraints of

symptoms on daily life, enhance patients' self-care abilities in daily life, and improve symptoms and activity levels. Simultaneously, enhancing self-protection abilities can improve patients' coping effectiveness against the disease, reduce the psychological burden caused by disease recurrence, decrease limitations on social participation, and enhance their performance in various dimensions. Although routine nursing can alleviate patients' discomfort symptoms, it cannot fundamentally address the issue of decreased quality of life, thus the efficacy of the control group is not as good as that of the experimental group.

5. Conclusion

In summary, respiratory exercise rehabilitation nursing can effectively improve the self-care ability, lung function, and quality of life of patients with COPD, and is worthy of clinical promotion and application.

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Disclosure statement

The authors declare no conflict of interest.

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A Scoping Review on the Application of FAS in Postoperative Active Pain Management Among Surgical Patients in China

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Abstract: *Objective:* To conduct a scoping review on the application status of the Functional Activity Score (FAS) in postoperative active pain management in China, providing a reference for its standardized and normative promotion. *Methods:* Computerized searches of Chinese and English databases were performed to collect studies published by Chinese scholars from 2005 to July 2025 on the application of FAS in postoperative active pain management. After strict screening, the basic characteristics, application fields, assessment models, evaluation timing, types of functional activities, and clinical outcomes of the included literature were systematically analyzed. *Results:* A total of 18 studies were included, involving surgical types such as thoracic surgery, general surgery, and orthopedics. All studies adopted FAS combined with the Numeric Rating Scale (NRS) for assessment, with evaluation timing mostly concentrated within 72 hours postoperatively. The selected functional activities primarily included respiration-related and limb movements. Evaluation indicators covered pain control, functional recovery, complications, adverse events, patient experience, and tool assessment, with most studies reporting positive outcomes. *Conclusion:* FAS can effectively enhance pain control and promote functional recovery in postoperative active pain management in China, demonstrating high clinical value. However, existing studies exhibit inconsistencies in assessment criteria, selection of activity types, and research quality.

Keywords: Activity pain; Functional activity score; Pain management; Scoping review; Surgical nursing;

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1. Introduction

Postoperative active pain is pain that occurs when the patient performs functional activities after surgery (such as deep breathing, coughing, turning over, walking down, etc.)^[1]. Compared with rest pain, it has the characteristics of clear situation, high intensity and significant influence on rehabilitation compliance^[2]. Traditional pain assessments, such as numerical rating scale (NRS), are based on subjective perception and do not reflect objective limitations of pain on functional activity^[3].

Functional Activity Score (FAS) is an objective assessment conducted by medical personnel according to the actual activity performance of patients, which directly reveals whether pain restricts activities and its degree, and provides a basis for individualized analgesia and optimization of rehabilitation plan ^[4]. FAS has been introduced into the domestic nursing field since 2015, and has undergone three or four levels version development ^[5,6]. In 2024, FAS was adopted and promoted by the group standard of Adult Postoperative Pain Assessment and Nursing of Chinese Nursing Association, providing authoritative guidance for the standardized application of FAS ^[7].

Studies have shown that multi-dimensional assessment combining NRS (pain intensity) with FAS (functional limitation) can more comprehensively capture patient pain experience, improve the targeting of analgesic strategies, and improve rehabilitation compliance and clinical outcomes ^[8–10]. However, the application status, specific evaluation mode (different activity types and grade standards), effect evaluation indicators and clinical value of FAS in different specialties/operations (such as impact on pain control, functional recovery, complication prevention and patient experience) in postoperative pain management in China lack systematic arrangement and comprehensive evaluation.

Therefore, guided by the PRISMA extended version list applicable to the scope review report published by Tricco et al., this study systematically combs the research evidence of FAS in the management of postoperative active pain in China from 2005 to 2025, analyzes its application characteristics, evaluation mode and effect evaluation indicators, and discusses its clinical value and limitations ^[11]. The aim is to provide a reference for standardized and standardized application of FAS, and lay a foundation for future high-quality research and development of digital tools.

2. Materials and methods

2.1. Establish research questions

The research questions were as follows:

- (1) What are the characteristics of FAS in active pain management among Chinese postoperative patients?
- (2) In clinical practice, what evaluation modes and effect evaluation indicators are used for active pain management based on FAS?
- (3) What clinical value does FAS reflect in the management of postoperative active pain in China?

2.2. Inclusion and exclusion criteria

Inclusion criteria are as follows:

- (1) Adult patients aged ≥ 18 years who have undergone surgical procedures (orthopedics, general surgery, thoracic surgery, etc.);
- (2) FAS is clearly used for assessment or management of active pain in the study;
- (3) Clear description of the assessment method and/or management strategy of active pain (including assessment tools, timing and operation details);
- (4) Chinese and English literatures written and published by China scholars;
- (5) Published from 2005 to 2025.

Exclusion criteria are as follows:

- (1) Full text unavailable or incomplete or incorrect information;
- (2) Studies focusing only on resting pain without involvement of active pain;

(3) Literatures with chronic pain as the main study object.

2.3. Search strategy

Computerized search of China Knowledge Net, Wanfang Data Knowledge Service Platform, VIP, Web of Science, PubMed, Cochrane Library, Springer link, Embase was performed.

A combination of subject words and free words was used for retrieval. Taking Zhiwang as an example, the Chinese search formula is as follows: (SU='Activity Pain' OR SU='Activity Pain' OR SU='Functional Activity Pain' OR SU='Functional Activity Pain Score' OR SU='FAS') AND (SU='Postoperative Pain Management' OR SU='Postoperative Pain Care' OR SU='Postoperative Pain Assessment' OR SU='Accelerated Rehabilitation Surgery') AND (SU='Patient' OR SU='Adult' OR SU='postoperative patient') NOT (SU='child' OR SU='infant' OR SU='adolescent'); Take Cochrane library as an example, the English search formula is as follows:

#1 (pain NEAR/3 management):ti,ab,kw OR "pain control":ti,ab,kw OR analgesia:ti,ab,kw

#2 (postoperative NEXT pain):ti,ab,kw OR (post NEXT surgical NEXT pain):ti,ab,kw OR (post NEXT procedural NEXT pain):ti,ab,kw #3 #1 AND #2 #4 ("activities of daily living":ti,ab,kw OR "mobility limitation":ti,ab,kw OR "recovery of function":ti,ab,kw OR (functional NEXT activit*):ti,ab,kw OR (physical NEXT activit*):ti,ab,kw OR mobil*:ti,ab,kw OR ambulat*:ti,ab,kw)

#5 #3 AND #4

2.4 Literature screening and data extraction

Two investigators independently screened the literature. According to the search formula and reference tracking, the bibliography of the literature obtained from the search results was imported into Note Express. Duplicate articles were eliminated by using the duplicate check function. Obviously irrelevant articles were excluded by reading the title and abstract, and then the literature was screened by reading the full text. For the articles that were difficult to determine or had differences, consensus was reached through joint discussion. When the opinions were inconsistent, the third investigator made a judgment. Information on the included articles was collated using uniform tables, including title, author, publication date, study type, sample size, adult patients undergoing surgical procedures, duration of intervention, intervention method, control method, pain assessment tool, functional activity on which FAS assessment was based, outcome measures/evaluation indicators, main findings and conclusions of the study.

3. Results

3.1. Retrieved result

4395 articles were obtained in the initial search, 587 articles were obtained after removing duplicate articles, 322 articles were obtained after reading titles and abstracts one by one, and 19 articles were obtained after reading full texts. Since the sample size was small (only 15 cases), there was controversy, and 18 articles were included after discussion by the research group [5, 6, 8-10, 12-24].

3.2. Basic characteristics of included literature

Among the 18 articles, 17 articles were Chinese, 1 article was English, 7 articles were randomized controlled trials, 10 articles were quasi-experimental studies, and 1 article was methodological study. See **Table 1** for basic characteristics of included literatures.