

## Disclosure statement

The authors declare no conflict of interest.

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# Study on Synergistic Effect of Eye Care and Drug Therapy in Patients with Dry Eye

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**Abstract:** *Objective:* The aim of this study was to evaluate the synergistic effect of eye care and drug therapy in patients with dry eye. *Methods:* A total of 59 patients with dry eye diagnosed and treated in our hospital were randomly divided into the reference group (29 cases) and the experimental group (30 cases). Patients in the reference group received only the usual medication, while the experimental group received additional eye care. The treatment response and the improvement of quality of life were evaluated by comparing the treatment excellence rate, quality of life score, and nursing satisfaction score of the two groups. *Results:* The rate of excellent treatment in the experimental group was 93.33%, which was significantly higher than that in the reference group (68.97%) ( $P = 0.013$ ). The quality of life scores in social function, psychological function and physiological function of the experimental group were significantly higher than those of the reference group ( $P < 0.003$ ), the nursing satisfaction score and symptom score were also improved more significantly ( $P < 0.003$ ), and the SAS score was decreased more ( $P < 0.003$ ). *Conclusion:* The synergistic effect of comprehensive eye care and drug therapy on patients with dry eye can significantly improve the rate of good treatment and quality of life score, increase the nursing satisfaction of patients, and have potential benefits to improve psychological status, providing an effective way for the management of dry eye.

**Keywords:** Dry eye; Eye care; Medication; Quality of life score; Excellent and good rate of treatment

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## 1. Introduction

People with dry eyes often suffer from a burning sensation around the pupils and discomfort in the eyes, and these symptoms are a pain they cannot ignore. This disease not only impairs visual function but also leads to a significant decrease in quality of life. With electronic screens becoming an integral part of daily life and the continuing effects of environmental pollution, dry eye is becoming a growing public health problem. Globally, the prevalence of dry eye is between 5% and 30%, and this figure increases as people age. Ocular surface damage

and visual impairment caused by dry eye disease have become a health threat that cannot be ignored, and it can also trigger a chain reaction of mental health issues, causing profound negative effects on the career and personal life of patients. At present, the treatment of dry eye mainly relies on drug therapy, such as artificial tears, anti-inflammatory drugs, etc., but single drug treatment is often difficult to meet the comprehensive needs of patients. In recent years, eye care, as an auxiliary treatment, has been widely used in the management of dry eye. By improving the eye environment, promoting tear secretion, and reducing eye pressure, eye care can effectively relieve patients' symptoms and improve treatment results. Studies have shown that drug therapy combined with eye care may have a synergistic effect that can significantly improve patients' symptoms and quality of life. However, current systematic studies on the synergistic effect of eye care and drug therapy in patients with dry eye are still limited. Therefore, this study aims to evaluate the synergistic effect of combining eye care and drug therapy for patients with dry eye through clinical trials, to provide new ideas and evidence support for the clinical treatment of dry eye.

## **2. Data and methods**

### **2.1. General information**

The study was conducted in our hospital from June to December 2022, and a total of 59 patients diagnosed with dry eye were selected for the study. Using a computer-generated randomization table, the 59 patients were evenly divided into two groups, with 29 in the control group and 30 in the test group. In the reference group, 12 men and 17 women ranged in age from 30 to 59 years, with an average age of about 44.07 years. In the trial group, 13 men and 17 women ranged in age from 28 to 60 years, with an average age of about 45.03 years. No significant statistical difference was found in gender, age, course of disease, and severity of dry eye between the two groups, indicating a good comparability between the two groups.

All patients in the control group received routine eye care instructions, including eye cleaning, use of tear substitutes, hot eye compresses, and use of anti-inflammatory and lubricating eye drops as prescribed by the doctor. Patients in the experimental group received the same eye care measures as the control group, but also added a specially designed care plan, including personalized eye massage, lifestyle adjustment guidance, and regular follow-up and feedback mechanisms.

During treatment, none of the patients received other drugs or treatments that could have affected the study results. This study has been approved by the ethics committee of the hospital and the informed consent signed by the patients, and the personal information of the patients is kept confidential. The collection and collation of the study data was undertaken by the members of the research team and evaluated in a double-blind manner to ensure the accuracy and objectivity of the data.

### **2.2. Methods**

This is a prospective, randomized controlled clinical study to evaluate the synergistic effect of eye care and medication in patients with dry eye. The subjects were hospitalized patients diagnosed with dry eye syndrome. According to the patients' wishes and the principle of random allocation, the patients were divided into a reference group and an experimental group.

Patients in the control group received conventional dry eye treatment, including medication and regular eye care. In terms of medication, all patients were treated with artificial tear drops, and the dosage was individually

adjusted according to clinical needs. The care regimen includes regular eye cleansing, use of moisturizing creams and perieye massages aimed at improving blood circulation. All care measures are carried out by professional nursing staff and strictly follow standardized operating procedures.

In the experimental group, comprehensive eye care intervention was added on the basis of conventional treatment. The nurse first makes a comprehensive assessment of the patient's eye condition and then develops a personalized care plan, including eye hygiene instructions, eyelid cleaning, eye moisturizing, etc. In addition, the patient received regular eye massage and topical hot compress treatment to promote microcirculation in the eye and reduce dry eye symptoms. Caregivers also communicate with patients, pay attention to their care needs, and conduct psychological counseling to help patients adjust their emotions and reduce the impact of dry eye symptoms on daily life.

The intervention period for dry eye patients was 8 weeks. During the intervention period, patients in the control group and the experimental group received eye care once a week for about 30 minutes. The care process includes eye cleansing, moisturizing, hot compresses, and recommendations for personalized care tailored to the patient's symptoms. Patients in the test group also received regular eye massages and mood management instructions, which were flexibly adjusted according to the patient's specific symptoms.

### **2.3. Evaluation indicators and criteria**

The evaluation of curative effect was mainly based on three criteria: excellent rate of treatment, quality of life score, and evaluation of intervention effect.

According to the improvement of patients' disease, the rate of excellent treatment was divided into three stages: "good", "acceptable", and "no significant improvement". Among them, "better" means that the disease is significantly improved; "Acceptable" means partial remission of the disease; "No significant improvement" means that the disease has not significantly reduced or even worsened. The treatment excellence rate is calculated by adding the number of patients who are "good" and "acceptable" and then dividing by the total number of people in the study.

The quality of life score was scored using a standardized scale covering three main dimensions: social ability, mental state, and physical function. The score for each dimension is assessed according to the corresponding item on the scale, and the higher the score, the higher the quality of life in that dimension. The three dimensions of the score are combined into an overall quality of life indicator.

The effect of the intervention was measured by comparing multiple scores before and after treatment. Among them, patients' satisfaction with nursing work is reflected on a scale through specific terms, and scored according to the 1100 score scale. The self-rating Anxiety Scale (SAS) score was used to assess the difference in the anxiety status of dry eye patients before and after treatment, and the increase in the score indicated an increase in the anxiety level. Symptom scores use a standard scale to track the extent to which a patient's symptoms are alleviated, with lower scores indicating remission.

Each score is assessed using a double-blind method and is conducted by a professionally competent assessment team. The evaluation team does not need to know the patient's group during the scoring process to ensure the fairness and accuracy of the assessment results. By comparing the key indicators of the reference group and the experimental group, the aim of this study was to investigate the effect of the synergistic effect of eye care and drug therapy on treatment outcomes and quality of daily life in patients with dry eye disease.

## 2.4. Statistical analysis

Once the data were accurate, a normal distribution test was performed. The measured quantized data are presented in terms of the mean and standard deviation ( $\bar{x} \pm s$ ) after verification of normality. The independent sample t-test was used to control and analyze the treatment effect and the change between the treatment group and the control group. When calculating the frequency, such as comparing the response to a treatment, the Chi-square test enters the stage and is converted into a more intuitive percentage form.

In order to get absolutely reliable statistical results, SPSS22.0, a powerful statistical analysis software, was used. In the process of analysis, the *P*-value is like a compass to guide us to determine whether statistical significance is achieved. In general, when the *P*-value is less than 0.05, then it is believed that there is a statistical difference between the two groups; that is, the observed effect is not due to chance factors, but has a certain repeatability and universality.

## 3. Results

### 3.1. Comparison of good rates of treatment

In the study of eye care and drug therapy in patients with dry eye, the rate of good treatment in the experimental group was compared with that in the reference group. The results showed that the rate of excellent treatment in the experimental group was significantly higher than that in the reference group, the difference was statistically significant ( $P = 0.013$ ), indicating that the synergistic treatment was more effective in improving the therapeutic effect. See **Table 1** for details.

**Table 1.** Treatment excellence rate (n/%) compared between the reference group and the experimental group after treatment

Group	Optimal(n)	Good(n)	Poor(n)	Excellent and good rate of treatment
Reference group (29)	8(27.59)	12(41.38)	9(31.03)	20(68.97)
Experimental group (30)	13(43.33)	15(50.00)	2(6.67)	28(93.33)
$\chi^2$ value	-	-	-	5.773
<i>P</i> value	-	-	-	0.013

### 3.2. Analysis of quality of life score

After treatment and intervention for dry eye, the quality of life scores of social function, psychological function and physiological function of experimental group were significantly higher than those of the reference group, indicating that the synergistic effect of eye care and drug therapy could effectively improve the overall quality of life of patients with dry eye disease, and the difference was statistically significant ( $P < 0.003$ ). See **Table 2** for details.

**Table 2.** Quality of life scores of patients in the reference group and experimental group after intervention

Group	Social function	Mental function	Physiological function	Quality of life score
Reference group (29)	62.23 $\pm$ 3.23	61.15 $\pm$ 3.45	60.50 $\pm$ 3.69	61.50 $\pm$ 3.78
Experimental group (30)	68.5 $\pm$ 3.31	67.89 $\pm$ 4.10	68.52 $\pm$ 4.55	67.95 $\pm$ 4.20
<i>T</i> -value	-	-	-	4.573
<i>P</i> -value	-	-	-	< 0.003

### 3.3. Evaluation of intervention effect

In terms of the evaluation of intervention effect, the nursing satisfaction score and SAS score of the experimental group were significantly improved, and the symptom score was reduced more than that of the reference group, and the difference between the two groups was statistically significant ( $P < 0.003$  for all), indicating that the synergistic effect of eye care and drug therapy was more significant in the experimental group. See **Table 3** for details.

**Table 3.** Nursing satisfaction scores, SAS scores, and symptom scores of the two groups before and after intervention

Group	Nursing satisfaction score	Symptom score		SAS score	
		Pre-care	After care	Pre-care	After care
Reference group (29)	85.60 ± 4.11	15.45 ± 5.26	12.02 ± 3.29	52.25 ± 3.46	47.79 ± 2.10
Experimental group (30)	92.36 ± 3.27	15.50 ± 5.30	9.89 ± 2.50	52.20 ± 3.55	43.38 ± 1.89
<i>T</i> -value	7.783	0.153	6.633	1.123	8.593
<i>P</i> -value	< 0.003	0.893	< 0.003	0.553	< 0.003

## 4. Discussion

Treating dry eye disease has always been a major challenge in the field of ophthalmology, which not only affects patients' vision but also seriously reduces their quality of life and can cause other complications. Therefore, it is important for patients to explore more effective treatment strategies. The patients with dry eye are divided into the reference group and the experimental group, and received different courses of treatment respectively. The results showed that the synergistic effect of eye care measures and drug combination therapy cannot be ignored. In terms of the excellent and good rate of treatment, the reference group had an excellent and good rate of 68.97%, while the experimental group had a better treatment response, with an excellent and good rate of 93.33%. There was a significant difference between the two groups ( $P = 0.013$ ), which was statistically significant. This indicates that the treatment received by patients in the experimental group significantly improves the therapeutic effect and should receive more attention in medical practice. This result proves that the comprehensive intervention measures combining eye care and drug therapy can significantly improve the treatment effect of dry eye disease, and provides strong evidence for clinical treatment.

The combined interventions also had a positive impact on patients' quality of life. The quality of life is assessed through three dimensions: social function, psychological function, and physiological function. The quality of life score of the experimental group was significantly higher than that of the control group in all dimensions after intervention ( $t = 4.573$ ,  $P < 0.003$ ), indicating that the comprehensive treatment program had a better effect on improving the quality of life of patients.

The significant benefits demonstrated by the trial group also demonstrate the importance of combining eye care with medication. After intervention, the score of nursing satisfaction of the experimental group was significantly improved, which was higher than that of the control group. Not only did the symptoms improve, but the SAS score was also better. The error is controlled within 3 parts per thousand, clearly verifying the important role of comprehensive treatment in improving patients' mood and quality of life.

Patients responded positively to the comprehensive intervention in the trial group, clearly demonstrating the criticality of combining eye care with medication. This combined effect is not only reflected in the treatment efficiency, but also expands the psychological, physiological, and even social functions of patients, providing a



more comprehensive treatment method for patients with dry eye.

Future research areas should further explore the integration of various forms of eye care and drug therapy, aiming to create a more effective treatment path that is more tailored to each unique case, in order to alleviate the daily discomfort of dry eye patients and improve their living standards.

Dry eye is an eye disease caused by multiple causes, which not only damages the vision of patients, but also reduces their quality of life. In the treatment of dry eyes, medication is not the only means, eye care is also crucial. By implementing a combination of eye care and medication in patients with dry eye, the multifaceted impact of this combination on patients' quality of life is evaluated <sup>[1]</sup>.

In the conventional drug treatment group, the average quality of life score of patients with dry eye after treatment was 61.50, with a margin of error of  $\pm 3.78$ . For patients who included eye care in their treatment regimen, the same score rose to 67.95 on average, with a margin of error of  $\pm 4.20$  points. Whether it was daily work ability, mental state, or physical health, the treatment regimen that included eye care outperformed the condition with medication alone after the intervention, and the improvement was statistically significant. It is clear that nursing interventions play an important role in improving the overall quality of life of people with dry eye. Nursing interventions, such as regular eye cleaning, drying protection, and the use of wet dressings, not only help to slow the exacerbation of symptoms, but also improve the efficacy of drugs by improving the quality and quantity of tears and optimizing the ocular microenvironment, thereby improving the overall satisfaction of patients with treatment <sup>[2]</sup>.

Further analysis showed that dry eye syndrome, as a chronic disease, has a long-term impact on the psychological and physiological state of patients, which may lead to increased mental stress, decreased sleep quality, and even affect daily work and interpersonal communication <sup>[3]</sup>.

Through professional nursing technology to effectively alleviate the trouble of dry eye, not only optimizing the eye environment, but also helping patients to restore the function of daily life, reshaping the social active image. Especially for the special groups with severe course of dry eye disease and special sensitivity to life satisfaction, the combination of eye care and medicine has achieved remarkable results. According to the quality of life and nursing satisfaction as evaluation indicators, patients with dry eye disease significantly feel an improvement in their life after receiving eye care and drug treatment, which proves the effectiveness of comprehensive therapy. Therefore, in order to improve the health level and quality of daily life of patients with dry eye, it is recommended to combine drug treatment with eye care, and apply various nursing interventions, which is the link that clinicians need to pay special attention to <sup>[4]</sup>.

Future research could go further and examine how the combination of care and medication may affect long-term outcomes and living standards for patients with dry eye. People with dry eyes often complain of dry eyes, foreign body sensation, and fatigue, which seriously affect their quality of life and mental state. The researchers divided the patients into a test group and a control group, looking carefully at the advantages of nursing combined with medication and their substantial improvements in patients' quality of life and mental health.

In the course of treatment, nursing satisfaction has become an important criterion to evaluate patients' overall satisfaction with treatment. After receiving special care and drug combination therapy, the satisfaction of the experimental group on nursing was significantly improved from the original  $92.36 \pm 3.27$  points, even higher than the  $85.60 \pm 4.11$  points of the reference group ( $P < 0.003$ ), which proved that patients in the experimental group had higher satisfaction with the treatment plan.

After receiving comprehensive nursing measures combined with drug therapy, the treatment satisfaction of



dry eye patients will be significantly improved. Depression, anxiety and other psychological aspects of the impact on the treatment of disease and quality of life is indeed significant. Anxiety state assessment criteria (SAS score) can directly reflect the psychological state of patients [5]. According to the study, the SAS score of the experimental group decreased from  $52.20 \pm 3.55$  points before treatment to  $43.38 \pm 1.89$  points after treatment. In contrast, SAS scores in the control group declined less, from  $52.25 \pm 3.46$  to  $47.79 \pm 2.10$ . There was a significant difference in SAS score decline between the experimental group and the reference group ( $P < 0.003$ ), which indicated that the comprehensive treatment strategy could significantly reduce the anxiety level of patients.

Symptom score directly reflects the improvement of the patient's condition and is one of the important indicators to evaluate the treatment effect. The symptom score of the experimental group decreased from  $15.50 \pm 5.30$  before intervention to  $9.89 \pm 2.50$  after intervention, while the symptom score of the control group decreased from  $15.45 \pm 5.26$  before intervention to  $12.02 \pm 3.29$ . There was a significant difference in symptom score between the two groups ( $P < 0.003$ ). This result further confirmed that drug therapy combined with comprehensive eye care measures can more effectively relieve the clinical symptoms of dry eye patients.

## 5. Conclusion

In conclusion, the combination of drug therapy and comprehensive eye care measures has a significant promoting effect on improving the treatment rate, quality of life and mental health of patients with dry eye. Careful and thoughtful care can enhance patients' confidence in the treatment plan, relieve their mental stress, and thus enhance the treatment effect, improve dry eye symptoms, and enhance their quality of life. It should be paid attention to and promoted in clinical practice.

## Disclosure statement

The authors declare no conflict of interest.

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# Exploring the Relationship between Obesity, Body Fat Percentage, Abnormal Blood Lipid Levels, and Prediabetes

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**Abstract:** *Objective:* To explore the relationship between obesity, body fat percentage (BF%), blood lipid levels, and prediabetes. *Methods:* A total of 91 patients with prediabetes who visited the hospital from February 2024 to February 2025 were included in the observation group, and 90 healthy individuals with normal blood glucose levels during the same period were included in the control group. Physical examination, body fat percentage, and biochemical indicators were checked, and the relationship between these indicators and prediabetes was analyzed. *Results:* The observation group had higher body weight (BW), waist circumference (WC), body mass index (BMI), fat mass (FM), total cholesterol (TC), low-density lipoprotein (LDL), triglycerides (TG), fasting blood glucose (FBG), and 2-hour postprandial blood glucose (2hPG) compared to the control group, with  $P < 0.05$ . The detection rates of obesity, abnormal WC, abnormal body fat percentage (BF%), abnormal TC, abnormal TG, and abnormal LDL were higher in the observation group than in the control group, with  $P < 0.05$ . Multivariate logistic regression analysis showed that WC, TC, TG, BF%, and BMI were independent high-risk factors for prediabetes, with  $P < 0.05$ . *Conclusion:* Obesity and dyslipidemia are high-risk factors for prediabetes. Scientific dietary planning and weight management should be implemented to reduce the incidence of diabetes.

**Keywords:** Prediabetes; Blood lipids; Body fat percentage; Obesity

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## 1. Introduction

Diabetes mellitus is characterized by defects in insulin function and inadequate secretion, which are related to reduced daily activity, changes in dietary structure, and variations in material living standards. It is a common chronic disease. Diabetes is a high-risk factor for cardiovascular and cerebrovascular diseases, and its incidence is closely associated with obesity. Obesity leads to excessive body fat, which in turn induces insulin resistance<sup>[1]</sup>. Additionally, the accumulation of excessive fat in the body can affect the body's metabolic function and increase

the risk of metabolic diseases. Therefore, there is a correlation between changes in body fat percentage, blood lipid levels, and metabolic disorders <sup>[2]</sup>. Based on this, this article explores the relationship between obesity, body fat percentage, blood lipid levels, and prediabetes using a sample of 91 prediabetes patients and 90 healthy individuals who visited the hospital from February 2024 to February 2025.

## 2. Materials and methods

### 2.1. Materials

A total of 91 patients with prediabetes who visited the hospital from February 2024 to February 2025 were included in the observation group, including 46 males and 45 females, aged between 40–70 years, with a mean age of  $(54.19 \pm 3.28)$  years. During the same period, ninety healthy individuals with normal blood glucose levels were included in the control group, consisting of 45 males and 45 females, aged between 41–69 years, with a mean age of  $(54.25 \pm 3.36)$  years. The baseline data of the observation group were compared with those of the control group, with  $P > 0.05$ .

### 2.2. Inclusion and exclusion criteria

The inclusion criteria were: (1) The observation group met the criteria for prediabetes in the “Chinese Diabetes Prevention and Treatment Guidelines” <sup>[3]</sup>; (2) The control group had normal blood glucose levels; (3) Subjects provided informed consent.

The exclusion criteria included: (1) Abnormal liver or kidney function; (2) Urinary system diseases; (3) Cardiovascular diseases.

### 2.3. Methods

- (1) Human body indicators: Ultrasonic physical examination machine was used to measure BW, WC, BMI (obesity defined as  $\geq 24\text{kg/m}^2$ ), and height (H). Body composition analyzer was used to determine BF% (abnormal defined as  $\geq 35\%$ ) and FM.
- (2) Serological indicators: Fully automated biochemical analyzer was used to detect TC (abnormal defined as  $> 5.72\text{mmol/L}$ ), TG (abnormal defined as  $> 1.70\text{mmol/L}$ ), LDL (abnormal defined as  $> 3.64\text{mmol/L}$ ), high-density lipoprotein (HDL, abnormal defined as  $\leq 0.91\text{mmol/L}$ ), fasting blood glucose (FBG, normal range  $3.9\text{--}6.1\text{mmol/L}$ ), and 2-hour postprandial blood glucose (2hPG, normal defined as  $< 7.8\text{mmol/L}$ ).

### 2.4. Statistical analysis

Data were processed using SPSS 21.0. Count data were tested using  $\chi^2$  and recorded as percentages (%), while measurement data were tested using t-test and recorded as mean  $\pm$  standard deviation ( $\pm s$ ). Multi-factor logistic regression analysis was performed to explore the relationship between various indicators and prediabetes. Statistical significance was set at  $P < 0.05$ .

## 3. Results

### 3.1. Analysis of indicators in both groups

The observation group had higher BW, WC, BMI, FM, TC, LDL, TG, FBG, and 2hPG compared to the control group, with  $P < 0.05$ . See **Table 1** for details.

**Table 1.** Analysis of relevant indicators in both groups ( $\pm$ s,%)

Item	Observation group ( $n = 91$ )	Control group ( $n = 90$ )	$t$	$P$
BW(kg)	69.39 $\pm$ 1.28	63.82 $\pm$ 1.04	32.1100	0.0000
H(cm)	165.25 $\pm$ 3.26	164.87 $\pm$ 3.21	0.7901	0.4305
WC(cm)	86.29 $\pm$ 1.82	83.16 $\pm$ 1.21	13.6094	0.0000
BMI(kg/m <sup>2</sup> )	25.31 $\pm$ 1.26	23.68 $\pm$ 1.01	9.5965	0.0000
FM(kg)	18.69 $\pm$ 2.11	16.08 $\pm$ 1.26	10.0896	0.0000
TC(mmol/L)	5.39 $\pm$ 0.26	5.25 $\pm$ 0.21	3.9826	0.0001
LDL(mmol/L)	3.15 $\pm$ 0.16	3.05 $\pm$ 0.13	4.6118	0.0000
TG(mmol/L)	1.69 $\pm$ 0.11	1.51 $\pm$ 0.10	11.5154	0.0000
HDL(mmol/L)	1.37 $\pm$ 0.32	1.41 $\pm$ 0.35	0.8026	0.4233
FBG(mmol/L)	6.35 $\pm$ 0.59	5.11 $\pm$ 0.57	14.3777	0.0000
2hPG(mmol/L)	8.24 $\pm$ 0.61	6.51 $\pm$ 0.58	19.5494	0.0000

### 3.2. Analysis of detection rates of obesity, body fat percentage, and dyslipidemia

The detection rates of obesity, abnormal WC, abnormal BF%, abnormal TC, abnormal TG, and abnormal LDL in the observation group were higher than those in the control group, with  $P < 0.05$ . See **Table 2** for details.

**Table 2.** Analysis table of detection rates of obesity, body fat percentage, and dyslipidemia(n, %)

Item	Observation group ( $n = 91$ )	Control group ( $n = 90$ )	$\chi^2$	$P$
Detection rate of obesity	62(68.13)	34(37.78)	16.7381	0.0000
Detection rate of abnormal WC	64(70.33)	32(35.56)	21.9677	0.0000
Detection rate of abnormal BF%	38(41.76)	6(6.67)	6.4950	0.0108
Detection rate of abnormal TC	42(46.15)	5(5.56)	30.2827	0.0000
Detection rate of abnormal TG	34(37.36)	4(4.44)	29.5607	0.0000
Detection rate of abnormal LDL	29(31.87)	3(3.33)	25.3149	0.0000
Detection rate of abnormal HDL	3(3.30)	2(2.22)	0.1945	0.6592

### 3.3. Multi-factor logistic regression analysis

Based on multi-factor logistic regression analysis, WC (waist circumference), TC (total cholesterol), TG (triglycerides), BF% (body fat percentage), and BMI (body mass index) were identified as independent high-risk factors for prediabetes, with a significance level of  $P < 0.05$ . The details are presented in **Table 3**.

**Table 3.** Multi-factor logistic regression analysis table

Indicator	$\beta$	SE	Wald $\chi^2$ value	OR value	95%CI	P value
WC	0.685	0.292	5.531	1.905	0.801-0.897	0.038
TC	0.627	0.294	4.602	1.858	1.053-3.284	0.033
TG	0.670	0.293	5.418	1.953	1.102-3.462	0.018
BF%	0.701	0.288	5.231	1.868	0.823-0.936	0.025
HDL	0.919	0.821	1.258	2.528	0.505-12.112	0.263
LDL	0.301	0.337	0.775	1.359	0.701-2.605	0.376
BMI	0.611	0.281	5.318	1.861	1.093-2.504	0.008

## 4. Discussion

Prediabetes refers to a condition where blood glucose levels are elevated but do not meet the diagnostic criteria for diabetes. However, at this stage, the body's blood glucose balance mechanism is disordered and unable to regulate blood glucose independently. Entering the prediabetes state, if FBG (fasting blood glucose) is between 6.1–7.0 mmol/L, it suggests impaired fasting glucose; if 2hPG (2-hour postprandial glucose) is between 7.8–11.1 mmol/L, it indicates abnormal glucose tolerance, which can increase the risk of developing diabetes. Clinically, lifestyle modifications can reduce the risk of prediabetes patients progressing to diabetes, making early identification of prediabetes extremely important.

Based on the data analysis presented in this article, the observation group had higher levels of BW, WC, BMI, FM, TC, LDL, TG, FBG, and 2hPG compared to the control group. Additionally, the detection rates of obesity, body fat percentage, and dyslipidemia were higher in the observation group ( $P < 0.05$ ). These findings suggest that the obesity rate is higher among individuals with prediabetes compared to healthy individuals undergoing routine check-ups, indicating a close relationship between obesity and blood glucose fluctuations. Historically, BMI has been used as a basis for evaluating obesity in clinical settings, without fully considering the distribution of body fat and muscle content, which limits its ability to objectively reflect the obesity index.

Furthermore, while CT and MRI techniques can accurately assess obesity by scanning the area of visceral fat at the L4–L5 intervertebral disc, their high cost prevents them from being widely used as routine screening tools<sup>[4]</sup>. As research on obese populations continues to deepen, the BF% index has gradually been incorporated into obesity assessments. This index utilizes bioelectrical impedance technology to measure body fat content, addressing the limitations of BMI and providing precise feedback on the distribution of body fat, the extent of fat accumulation, and metabolic disorders. An increase in BF% may be associated with excessive fat content in obese individuals or a normal BMI but low muscle mass, leading to an increased proportion of fat content<sup>[5]</sup>.

According to another set of data, multivariate logistic regression analysis identified WC, TC, TG, BF%, and BMI as independent high-risk factors for prediabetes ( $P < 0.05$ ). The analysis suggests that WC is an important indicator for assessing obesity, particularly in individuals with central obesity who have excessive abdominal fat accumulation. This not only affects body aesthetics but also increases the release of toxic substances in the body, affecting insulin sensitivity and potentially leading to insulin resistance and increased diabetes risk. Additionally, long-term consumption of high-calorie and high-sugar foods in some individuals can contribute to continuous fat accumulation in the abdomen, further affecting blood glucose fluctuations<sup>[6]</sup>. Elevated TC levels can increase the

risk of cardiovascular and cerebrovascular diseases, and since diabetes is a high-risk factor for these conditions, regulating TC levels can indirectly prevent diabetes. TG is closely related to the visceral fat index and provides feedback on the amount of fat stored in the body. If the lipid content exceeds the body's fat storage capacity, fat can be stored ectopically in other organs and cells, such as pancreatic beta cells, leading to impaired pancreatic cell function and potentially inducing diabetes<sup>[7]</sup>.

BF% objectively reflects the proportion of body fat content. High BF% values suggest the presence of metabolic disorders and insulin resistance, thereby increasing the risk of diabetes. It is recommended that individuals with slightly elevated blood glucose levels maintain moderate exercise and follow a scientific diet to regulate body fat percentage and reduce insulin sensitivity, ultimately reducing the risk of diabetes<sup>[8]</sup>. BMI is a clinically important indicator for evaluating the degree of obesity. Higher BMI levels are associated with increased diabetes risk, which is related to insulin resistance commonly observed in obese individuals, leading to abnormal blood glucose levels. Obesity also increases the risk of metabolic disorders, further elevating the incidence of diabetes<sup>[9]</sup>. Therefore, scientific management and control of BMI are crucial for effective diabetes prevention.

## 5. Conclusion

In summary, individuals with prediabetes exhibit differences in obesity, body fat percentage, and lipid profiles compared to healthy individuals undergoing routine check-ups. Multivariate logistic regression analysis identified WC, TC, TG, BF%, and BMI as independent high-risk factors for prediabetes. Therefore, it is important for individuals with prediabetes to actively manage their weight, reduce BMI and BF%, and regulate their lipid profiles to lower the risk of developing diabetes.

## Disclosure statement

The authors declare no conflict of interest.

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# Advances in Research on the Use of ICU Diaries in Post-ICU Syndrome

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**Abstract:** This article reviews the concept of ICU diary and the related contents of post-ICU syndrome, focuses on the current application status of ICU diary in post-ICU syndrome, problems faced, and suggestions for improvement, aiming to provide a reference basis for improving the physical and mental health of ICU patients and their families.

**Keywords:** ICU diary; Post-ICU syndrome; Psychological well-being; Family support

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## 1. Introduction

Intensive Care Unit (ICU) is designed to provide comprehensive and high-quality care to critically ill patients and plays a vital role in improving cure and survival rates <sup>[1, 2]</sup>. Its significant reduction in mortality in critically ill patients has led to a growing population of transferred patients, with millions of patients being transferred from ICU each year in the United States alone <sup>[3]</sup>. However, an increasing number of patients and their families face mental health problems such as fatigue, sleep disturbances, and anxiety <sup>[4]</sup>. As many as 50% of ICU patients may develop post-ICU syndrome, which manifests itself as a multitude of physical, cognitive, psychological, and social problems, and approximately 50% fail to return to their previous work or school status one year after discharge, and many do not return to their initial level of health <sup>[5, 6]</sup>. ICU patients often experience memory gaps or unpleasant memories after discharge from the hospital, which are often closely associated with the onset of symptoms such as anxiety, depression, and post-traumatic stress disorder (PTSD), which in turn negatively impacts health-related quality of life <sup>[7-9]</sup>.

Studies have shown the value of ICU diaries in processing emotions, gaining insight, reducing stress, documenting important information, and facilitating communication between medical staff and patients <sup>[10]</sup>. Diary

writing enables ICU medical staff to reflect on their daily work and care for each patient. The use of diaries has spread across Europe and North America and is gradually expanding to other continents <sup>[11, 12]</sup>. In regions where this tool is offered, patients and families usually initiate the use of diaries from the beginning of the hospitalization period <sup>[13]</sup>. Thus, the ICU diary serves as an effective intervention aimed at preventing long-term mental health problems and significantly improving the physical and mental health status of patients and their families.

## **2. Overview**

### **2.1. Concept of post-ICU syndrome**

The concept of post-intensive care syndrome (PICS) was first introduced by the American College of Critical Care at the Global Conference on Acute and Critical Care in 2010, aiming to describe new or worsened physical, cognitive, or mental health problems in critically ill patients after ICU treatment, which can appear within 24 hours after ICU admission and can persist for 5–15 years after discharge <sup>[14, 15]</sup>. At the same time, the process of patients receiving treatment and post-care in the ICU also brings significant stress and burden to their families, leading to psychological and physical disorders, a phenomenon known as Post-Intensive Care Syndrome-Family (PICS-F), which is collectively referred to as Post-ICU Syndrome (PICS) <sup>[14, 16]</sup>. In 2012, at the second global conference, a commitment was made to comprehensively improve the understanding, management, and intervention of PICS to improve the prognosis of critically ill patients and their families <sup>[17]</sup>.

### **2.2. Concept of ICU diary**

Bäckman *et al.* defined an ICU diary as a daily record written by ICU healthcare staff and the patient's family <sup>[18]</sup>. This record is a patient-centered account of the patient's experiences, daily life, and behaviors during hospitalization using an empathetic and reflective language style. As a nurse-led therapeutic tool, the ICU diary has gained wide acceptance among patients, families, and medical staff. Its use not only promotes recovery and reduces post-traumatic stress for both family members and patients, but also helps to strengthen communication and emotional connection between nurses, family members, and patients, and facilitates the expression of emotions and feelings <sup>[19]</sup>.

## **3. Forms of ICU diary in post-ICU syndrome**

### **3.1. Original paper ICU diary**

ICU diaries were first introduced by Backman and Walther in 1999 as a method of documenting a patient's experience of care in the ICU, with the aim of helping patients to review events that occurred during their hospitalization <sup>[20]</sup>. ICU diaries not only fill in the gaps in patients' memories but also help to reduce the risk of psychiatric disorders for both patients and their relatives after discharge from the hospital. Currently, ICU diaries are widely used in hospitals in several countries, including Norway, Denmark, and the United Kingdom <sup>[21]</sup>.

Typically, diaries begin with a short introduction stating their purpose, followed by a summary of the patient's experience to date, including daily care, disease progression, and patient improvement or deterioration. During writing, it is necessary to use plain language to explain specialized medical terms, avoid abbreviations, and sign the text. In the Netherlands, about 87% of ICUs offer this diary service, which is mainly written by the patient's family and may contain content in the form of photographs, drawings, or poems, while protecting patient privacy <sup>[22]</sup>. Most ICU diaries are in paper form, sometimes accompanied by pamphlets and other informational materials <sup>[23]</sup>.

Studies have shown that reading an ICU diary has a positive impact on the patient's ability to cope with the trauma experienced during their stay in the ICU <sup>[24]</sup>.

In addition, relatives who participated in diary writing improved their own mental health in terms of emotional support <sup>[25]</sup>. ICU diaries written by nurses help patients and families to understand the ICU environment, which reduces fear <sup>[26]</sup>. ICU diaries also provide caregivers with the opportunity to reflect on and process their experiences, supporting their emotional and psychological well-being <sup>[27]</sup>. This process not only enhances caregivers' self-awareness but also helps to promote professional growth and increase job satisfaction.

### **3.2. Digital ICU diary**

During COVID-19, family members' access to ICU diaries was also limited due to visitation restrictions and infection control concerns <sup>[25]</sup>. With the advancement of "Internet Plus" and information technology, mobile health (mHealth) has emerged and is widely used in medical practice. Researchers can utilize mHealth technology to develop an electronic ICU diary platform that provides families with the opportunity to stay in touch with their patients from a safe distance, through which they are able to easily upload photos, videos, and audio clips and collaborate with other family members to compose content.

In addition, the digital platform helps nurses to provide timely updates about the patient. Haakma *et al.* developed "Post-ICU" a web-based application designed to allow family members to collaborate on writing in a digital diary and interact with the patient remotely <sup>[28]</sup>. The app can be used on any connected device with a display (e.g., smartphone or tablet) and allows families to not only send text messages, but also to elaborate on the patient's personal situation. Hart *et al.* investigated the introduction of video calls to facilitate family-patient contact and communication with healthcare professionals <sup>[29]</sup>.

With the accelerated progress in the digitization of patient self-care, the transition to technology and scientific methodology is becoming more urgent. Li *et al.* investigated an ICU e-diary platform built on a co-design approach and validated its applicability <sup>[30]</sup>. The platform was designed to facilitate the seamless transmission of video, audio recordings, and images, thereby saving time, simplifying information storage, and gaining acceptance among healthcare professionals, patients, and their families. This innovation not only contributes to improving patients' mental health and quality of life, but also significantly improves the efficiency of medical staff. Thus, digital diaries play a crucial role in improving the quality of care in ICU <sup>[31]</sup>.

## **4. Effectiveness of ICU diary in post-ICU syndrome**

### **4.1. Reducing anxiety and depression in ICU patients and their families**

Psychological factors have a direct impact on the quality of life of ICU patients, especially anxiety, depression, and post-traumatic stress disorder (PTSD), all of which are important factors in the recovery of ICU patients <sup>[32]</sup>. The ICU environment often leads to a variety of complications, such as polyneuropathy, dysphagia, organ damage, and muscle weakness due to chronic pain, all of which have a serious impact on a patient's overall health <sup>[32]</sup>. Villa *et al.* found that ICU diaries can help patients better understand their experiences during their stay in the ICU <sup>[33]</sup>. By filling in memory gaps and rationalizing the sequence of events, ICU diaries give new meaning to difficult experiences for patients <sup>[34]</sup>. In addition, ICU diaries have been shown to improve personal emotional resilience and provide emotional support to patients <sup>[35]</sup>.

Recording the patient's feelings and experiences facilitates communication between healthcare professionals

and family members, and helps the patient adapt to daily life more quickly after discharge. This record makes patients feel cared for by healthcare professionals and valued by their families, which in turn increases confidence and hope in treatment <sup>[36]</sup>. Haines *et al.* showed that family members often develop negative emotions such as anxiety, depression, and PTSD due to the severity and uncertainty of the disease during treatment in the ICU, and that family members can read the words and pictures in the ICU diary to better grasp and understand the patient's situation, thus reducing the psychological burden <sup>[37]</sup>. In addition, Jones *et al.* found that ICU diaries helped to improve ICU-related PTSD outcomes <sup>[38]</sup>. Gazzato *et al.* showed that ICU diaries significantly reduced the incidence of PTSD, anxiety, and depression in ICU patients <sup>[39]</sup>. Studies have shown that uncertainty is an important factor contributing to anxiety in family members, and the provision of information is key to reducing uncertainty and anxiety <sup>[40, 41]</sup>. Therefore, ICU diaries significantly reduce negative emotions such as depression and anxiety by providing basic information to ICU patients and their families.

## **4.2. Giving emotional support to ICU families**

ICU diaries have played an active role in giving emotional support to families, helping them to keep track of time and better understand the progress of critical illnesses <sup>[42]</sup>. The diary not only broadened the perspective of ICU care, but also became an important source of information for families <sup>[43]</sup>. Many families expressed appreciation for the diary as a reflection of the support and care of the medical staff. Through the diary, families felt the joint efforts of the medical team and were convinced that the patient was well cared for and valued <sup>[44]</sup>. The diary can improve the family's experience and give hope to ICU patients and their families. Mickelson *et al.* found that ICU diaries became an important tool to support emotional coping, information management, and communication, thus reducing distress among family members <sup>[44]</sup>. In addition, Liu *et al.* found that recording ICU diaries not only conveyed nurses' and family members' concern for the patient, but also increased communication between healthcare professionals and family members, alleviated the patient's delusional memories, and enhanced emotional interactions among family members <sup>[45]</sup>. In summary, ICU diary has significant effects in supporting families' emotions, promoting information sharing, and enhancing healthcare communication. It not only improves the family's understanding of the patient's condition, but also helps to reduce the psychological distress of family members. Through the diary, medical staff can better demonstrate their concern for patients and provide emotional support for patients and families, thus effectively enhancing the quality of ICU care.

## **4.3. Enhance healthcare team communication**

ICU diaries are seen as an important tool to promote patient recovery and family-centered care. While ICU diaries have been proposed as a means of preventing psychiatric symptoms in critically ill patients, families and healthcare professionals can benefit from them as well. Studies have shown that families report unquantifiable benefits from ICU diaries, including improved communication about critical illness, provision of emotional support, and demonstration of ICU staff's humanity. Together, these factors helped families better tolerate the discomforts of an ICU stay <sup>[46]</sup>. In the pediatric setting, diary writing has been identified as potentially beneficial in increasing parent satisfaction, coping skills, and improving communication between parents and healthcare professionals <sup>[47]</sup>. As a communication tool, ICU diaries are effective in improving the exchange of information between the healthcare team and patients and their families.

By recording key information and treatment progress, diaries help to minimize misunderstandings and enhance patients' and families' understanding of and cooperation with treatment plans <sup>[48]</sup>. In addition, diary writing



helps healthcare providers better perceive the human element of their work and serves as a verbal communication aid to improve communication with families <sup>[49]</sup>. In summary, ICU diaries excel in enhancing healthcare team communication and provide effective support for patients and families. By improving information exchange and emotional connection, ICU diaries not only contribute to patient recovery but also enhance family satisfaction and coping skills. For healthcare providers, diary writing improves their professional satisfaction, reduces work stress, and further contributes to the quality of care.

## 5. Shortcomings and prospects

Up to now, ICU diaries have not been standardized in terms of structure and content, and there is a lack of clear definitions of diary format, record content, storage methods, and ethical standards <sup>[50]</sup>. In addition, domestic policy support for ICU diaries is still insufficient, so it is recommended that hospitals in China accelerate the development of relevant policies to alleviate healthcare workers' concerns about medical disputes. Healthcare professionals generally believe that the heavy workload of intensive care and the shortage of human resources are important factors restricting the promotion of ICU diaries <sup>[45]</sup>. A German study showed that nurses spent less than 6 minutes per day recording ICU diaries for patients, suggesting that there may be a discrepancy between healthcare professionals' perceptions of diaries and their actual time-consumption, partly due to their lack of adequate knowledge about ICU diaries <sup>[51]</sup>. Therefore, recommendations to promote the implementation of ICU diaries need to be approached at multiple levels.

Hospitals should conduct relevant training to reduce the actual workload and issue supportive policies to encourage pilot studies of ICU diaries; departments should increase nurse manpower allocation, flexible scheduling, and set up dedicated positions to realize returning nurse time to patients; and medical staff need to enhance training to change their perceptions. In addition, we should learn from the advanced experience of foreign countries, such as the United States has developed the application of ICU diary, using technology to reduce the workload of handwritten diary <sup>[52]</sup>. Through the above measures, the implementation of ICU diary can be promoted, thus better supporting patients and families and improving the effectiveness of diary application.

## 6. Summary

In summary, the ICU diary is gaining increasing attention as an important nursing tool, and its use in post-ICU syndrome has demonstrated significant positive effects. However, in order to better fulfill its role, there is an urgent need to address the current deficiencies and promote its standardization and policy support, so as to provide more comprehensive support and care for patients and their families.

## Disclosure statement

The authors declare no conflict of interest.

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# Investigation and Analysis of Professional Identity and Research on Influencing Factors of Nursing Students before and after Clinical Practice

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**Abstract:** *Objective:* To analyze the related factors affecting the professional identity of nursing students before and after clinical practice, hoping to provide reference for the career development and education of nursing students. *Methods:* A total of 393 undergraduate nursing students of grade 2020 from the Department of Nursing of a university in Shanxi Province were selected. The professional choice motivation, educational attainment expectation, future career planning, professional practice, and employment prospect expectation of nursing students before clinical practice, and the willingness to upgrade educational attainment, professional experience, career development expectation, and employment planning of nursing students after clinical practice were investigated. Through statistical analysis of the survey data, the related influencing factors affecting the professional identity of nursing students before and after clinical practice were explored. *Results:* The observation of general data showed that the proportion of female students in the survey sample was higher than that of male students, and the proportion of those whose family residence was in rural areas was slightly higher than that in urban areas. The analysis of students' own situation showed that nursing students chose the nursing major because of the high expected employment rate, but they were generally anxious about the employment prospect before the internship, showing a contradictory mentality. The analysis of students' professional ability showed that nursing students believed that their professional ability was mainly reflected in the vocational adaptability. The analysis of the social environment showed that the educational attainment expectations of nursing students were mainly undergraduate and master's degrees, and they preferred to engage in clinical nursing work rather than nursing research. The analysis on the selection of internship hospitals shows that nursing students' choice of internship hospitals is mainly influenced by the duration of the internship, and they consider the correlation between the selection of internship hospitals and future employment decisions to be low. The analysis on the surrounding environment such as family and school shows that the professional identity of nursing students is mainly influenced by the opinions of school teachers and parents, but the occupations of most of the family members of nursing students are not related to medicine. *Conclusion:* Targeted intervention strategies should be formulated based on the relevant influencing factors that affect the professional identity of nursing students before and after clinical internship, to enhance the professional identity and employment confidence of nursing students, and promote the healthy and sustainable development of nursing education and the medical service industry.

**Keywords:** Nursing major; Clinical practice; Professional identity; Influencing factors

**Online publication:** April 29, 2025

# 1. Introduction

In the process of the gradual intensification of the aging population phenomenon in China and the gradual deepening of the “Healthy China” strategy, the demand for nursing staff shows an obvious growth trend, and the role of nursing professionals has become more prominent <sup>[1]</sup>. However, the shortage of nursing human resources and the crisis of nurses’ professional identity have become realities that cannot be ignored <sup>[2]</sup>. A survey of nursing students, especially undergraduate nursing interns, found that low professional identity among nursing students has become a relatively common problem. In the development of China’s nursing cause, nursing students are very important reserve human resources. Nursing students should not only have good professional qualities, but also have a firm professional belief, fully identify with the value of nursing work, and fully love the profession they will engage in. This is very crucial for building an efficient and stable nursing team <sup>[3]</sup>. This article mainly analyzes the professional identity of undergraduate students majoring in nursing before and after clinical practice and explores related influencing factors, thereby providing suggestions for the career development education and talent training optimization of undergraduate nursing students.

## 2. General information and methods

### 2.1. General information

According to the standard, a total of 393 undergraduate nursing students of grade 2020 from the School of Nursing of a certain university in Shanxi were selected in a random sampling manner to participate in this investigation and research project. All the research participants were informed of the purpose and specific contents of this investigation and research, and signed the written consent form.

### 2.2. Questionnaire survey

A questionnaire survey was conducted to explore various factors, including nursing students’ gender, reasons and motivations for choosing the nursing major, family residence, preferred type of internship hospital, anticipated future employment in medical and health institutions, expected academic qualifications, career planning, expected salary range, and the potential impact of the nursing professional internship period on the choice of internship hospital. The survey also investigated whether the choice of internship hospital is linked to future employment decisions, students’ attitudes towards their career prospects before the internship, the perceived advantages of internship or employment, the influence of suggestions from university professional course instructors on decisions regarding future internships or employment, and whether family members’ occupations are related to healthcare.

### 2.3. Statistical analysis

The data were analyzed by SPSS 22.00 software. Quantitative data that conformed to the normal distribution were expressed as ( $\bar{x} \pm s$ ), and the t-test was used between groups; qualitative data were expressed as (n, %), and the  $\chi^2$  test was used between groups. Statistical significance was indicated by ( $P < 0.05$ ).

## 3. Results

### 3.1. General data observation

Among all 393 nursing students, the proportion of females was higher than that of males, and the number of those whose family residence was in rural areas was slightly higher than that in urban areas (**Table 1**).



**Table 1.** Observation of general information of nursing students (n = 393)

General information		Number	Percentage (%)
Gender	Male	51	12.98
	Female	342	87.02
Family residence	City	181	46.06
	Rural area	212	53.94

### 3.2. Analysis of students' own situations

From the analysis of the students' own situations, it was found that 266 students chose the nursing major because of the good career prospects. Most of the students expected to be employed in top-level general hospitals in the future, accounting for 81.93%; 92.88% of the students most wanted to do internships in general hospitals, and 66.92% of the students expected their future salary range to be above 6,000. Before the internship, the proportion of students who were anxious about the career prospects was 39.44%, while the proportion of students who were optimistic was only 13.49%, and 5.60% of the students were pessimistic about the career prospects (**Table 2**).

**Table 2.** Analysis of students' own reasons (n = 393)

Influencing factors		Number	Percentage (%)
Reasons for choosing the nursing major	Self-love	60	15.27
	Family expectation	157	39.95
	Good career prospects	266	67.68
	Affected by the epidemic	64	16.28
	Forced to be adjusted	96	24.43
Future expected medical institutions to be employed	Tertiary general hospital	322	81.93
	Hospitals of grade two and below	14	3.56
	Community health service center	17	4.33
	Private clinic	6	1.53
	Others	34	8.65
Most desired type of hospital for internship	General hospital	365	92.88
	Local specialized hospital	28	7.12
Expected future salary range	2000–3000	1	0.25
	3000–4000	12	3.05
	4000–5000	56	14.25
	5000–6000	61	15.52
	More than 6000	263	66.92
Attitude towards career prospects before internship	Optimistic	53	13.49
	General	163	41.48
	Relatively anxious	155	39.44
	Pessimistic	22	5.60



### 3.3. Analysis of professional ability reasons

The analysis of professional ability revealed that 85.24% of the students felt their strengths in internship or employment were most evident in adaptability. Additionally, 64.63% of the students believed their advantages were reflected in teamwork skills, while 50.13% identified nursing operation ability as a key strength. In contrast, only 29.26% of students felt their strengths in internship or employment were related to management skills (**Table 3**).

**Table 3.** Analysis of reasons for technical capability (n = 393)

In what aspects are the advantages of internship or employment reflected	Expressive and communication skills	240	61.07
	Teamwork ability	254	64.63
	Adaptability	335	85.24
	Management ability	115	29.26
	Appearance	188	47.84
	Nursing operation ability	197	50.13

### 3.4. Analysis of social environment reasons

From the analysis of the social environment, it was found that most students expected their educational attainment to be a master's degree, accounting for 53.69%, and 41.48% of the students chose clinical nursing work for their future career planning (**Table 4**).

**Table 4.** Analysis of social environmental causes (n = 393)

Influencing factors		Number	Percentage (%)
Expectation of one's own academic qualifications	Undergraduate	170	43.26
	Master	211	53.69
	Doctor	12	3.05
Direction of one's own future career planning	Nursing clinical	163	41.48
	Nursing research	17	4.33
	Postgraduate entrance examination	127	32.32
	Teacher	41	10.43
	Choose other industries	45	11.45

### 3.5 Analysis of the reasons for the internship

From the aspect of internship analysis, it was found that 56.74% of the students believed that the length of the internship period would affect the choice of the internship hospital, while 76.08% of the students thought that the choice of the internship hospital had no correlation with the choice of career intention (**Table 5**).

**Table 5.** Analysis of the reasons for internship (n = 393)

Influencing factors		Number	Percentage (%)
Whether the length of the internship period affects the choice of the internship hospital	Yes	223	56.74
	No	170	43.26
Whether there is a correlation between the choice of the internship hospital and the choice of the intention to work	Yes	94	23.92
	No	299	76.08

### 3.6 Analysis of reasons from school, classmates, and family

The analysis from the perspectives of school, classmates, and family revealed that 30.53% of students' career intentions are influenced by the opinions of their family members, while 3.82% are influenced by the views of friends and classmates. Additionally, 78.63% of students stated that suggestions from professional course teachers would impact their decisions regarding internships or careers. Furthermore, 81.93% of students reported that their parents' or family members' occupations are not related to the medical field (**Table 6**).

**Table 6.** Analysis of reasons from schools, classmates, and families (n = 393)

Influencing factors		Number	Percentage (%)
Which item mainly influences the career intention	Family members' opinions	120	30.53
	Teacher's opinions	8	2.04
	Friends and classmates' opinions	15	3.82
	Self-determination	237	60.31
	National and social demands	13	3.31
Whether the teacher's suggestions will affect the internship or career decision	Yes	309	78.63
	No	84	21.37
Whether the parents or family members' occupations are related to medical care	Yes	71	18.07
	No	322	81.93

## 4. Discussion

During the process of the gradual intensification of the aging population and the gradual improvement of the medical service level in our country, the demand for both the quantity and quality of nursing staff is increasing <sup>[4]</sup>. The nursing major not only has a relatively broad employment prospect, but also has a relatively stable career development path, and has become a "hot" major that attracts wide attention in society. However, in the process of employment, there are still certain individual differences in the professional identity of nursing students, and it is comprehensively affected by various factors. Professional identity will have a direct impact on the future employment willingness and career development of nursing students, and it will also affect the service level of nursing and even the entire medical industry in our country <sup>[5]</sup>. Therefore, it is very important to analyze the related factors that affect the professional identity of nursing students, guide them to build a correct employment concept and career development concept, and thus make rational career development decisions.

An analysis from the aspect of the students majoring in nursing found that 266 students chose the nursing major because of the expected good employment prospects. The majority of the students expected to be employed in Grade-A tertiary general hospitals in the future, accounting for 81.93%, while 92.88% of the students most wanted to do internships in general hospitals, and 66.92% of the students expected their future salary to be above 6,000 yuan. Before the internship, only 13.49% of the students were optimistic about the career prospects, and 5.60% were pessimistic. The analysis results revealed that society generally believes that the development prospects of the nursing major and the career prospects of nurses are relatively good. Therefore, most of the nursing students chose to study the undergraduate program of nursing based on the expected good employment prospects. Most of them hoped to engage in clinical nursing work in Grade-A tertiary general hospitals in the

future, and for the choice of internship hospitals, most students hoped to go to general hospitals. However, the choice of internship hospitals is also influenced by many factors, such as the length of the internship period, accommodation conditions, internship expenses, and whether it is conducive to future career development <sup>[6]</sup>. Most students have high expectations and requirements for their salary after entering the profession.

From the analysis of professional ability, it was found that 85.24% of the students believed that their advantages in internship or employment were reflected in the aspect of adaptability, 64.63% of the students thought that their advantages in internship or employment were reflected in the aspect of teamwork ability, while only 29.26% of the students considered that their advantages in internship or employment were reflected in the aspect of management ability. The results indicated that most students believed that nursing internship or employment required various abilities, such as teamwork, expression and communication, and environmental adaptability. The talent training program for the nursing major should strengthen the cultivation of students' nursing management ability. From the analysis of the social environment, it was found that the majority of students expected to have a master's degree for themselves, accounting for 53.69%. For future career planning, 41.48% of the students chose clinical nursing work. For current college students, the employment pressure they are facing is increasing, and the role of academic qualifications in employment competition is becoming more and more important. To better cope with the employment pressure, it is necessary to comprehensively improve their professional identity and comprehensive ability.

The process of pursuing academic qualifications is also a process of cultivating one's own professional identity and comprehensive ability <sup>[7]</sup>. At the same time, it is also necessary to actively change the concept of employment. On the basis of considering the hospital environment and salary, more attention can also be paid to grassroots medical institutions to have a comprehensive understanding of the nursing employment positions. Actively learn various knowledge and skills during the internship and continuously improve their practical operation skill level, thereby enhancing their employment competitiveness <sup>[8]</sup>.

From the analysis of the surrounding environment such as schools, classmates, families, etc., it is found that the career intentions of 30.53% of students are influenced by the opinions of their families, and the career intentions of 3.82% of students are influenced by the opinions of their friends and classmates; for 78.63% of students, the suggestions of professional course teachers will affect their internship or career decisions; in 81.93% of students' families, the occupations of parents or family members are not related to healthcare. The results show that the opinions of family members, friends, and classmates will affect students' professional identity and employment decisions to a certain extent. The high cost of nursing internships and living costs will increase the burden on students' families, thereby affecting their internship choices and career intentions <sup>[9]</sup>.

Therefore, efforts should be made to provide academic assistance and living subsidies during the internship period to effectively reduce their economic pressure and learning burden. When conditions permit in the school, it can help students solve the accommodation problem during the internship. In addition, the school should also do a good job in employment guidance, guiding nursing students to choose the appropriate internship hospital based on their own actual situation and make wise career decisions to avoid following the trend <sup>[10]</sup>. The suggestions of university professional course teachers will have a continuous impact on students' professional identity and future career development. Therefore, the teaching level of teachers during the school period and the coaching level of instructors during the internship period should be strictly controlled. Students should be guided to learn the professional knowledge and nursing skills of various departments, and have a deeper understanding of the nursing profession imperceptibly, improve professional identity and confidence in practice, so that nursing students can have a rational and specific plan for their own career development <sup>[11]</sup>.

## 5. Conclusion

In conclusion, there are many factors influencing the professional identity of nursing students before and after clinical practice. Targeted intervention strategies should be formulated based on the relevant influencing factors to enhance the professional identity of nursing students, stimulate their enthusiasm for the profession, and enable the cultivation of nursing talents and medical and health services to achieve healthy and sustainable development.

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## Disclosure statement

The authors declare no conflict of interest.

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# Visual Analysis of Postoperative Nursing Research of Ureterocutaneostomy based on CiteSpace

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**Abstract:** *Objective:* To conduct a visual analysis of the current status and hotspots in the postoperative nursing of ureterocutaneostomy based on CiteSpace, in order to provide an evidence-based basis for the research direction and thinking in this field. *Methods:* In this study, the subject words and free words were used to search the China National Knowledge Infrastructure (CNKI), Wanfang Database, VIP Database, and Web of Science Core Database as the literature sources. The search time limit was from January 1, 1999 to December 31, 2024. CiteSpace 6.3. R2 software was used to conduct a visual analysis of the publication volume, authors, and keyword clusters of the literature related to ureterocutaneostomy nursing. *Results:* A total of 129 Chinese literary works were finally included. The results showed that 2019 was the peak year of publication volume (20 domestic articles); the First Affiliated Hospital of Nanchang University was the institution with the highest publication volume (13 articles); the high-frequency keywords included “bladder cancer” (42 times), “nursing” (29 times), and “quality of life” (16 times); the keyword cluster analysis showed that the research hotspots were concentrated in complication management, continuous nursing, and the application of intelligent technology. *Conclusion:* The nursing of ureterocutaneostomy has developed from a single technical operation to a multi-dimensional comprehensive intervention system, and the nursing shows a trend of multidisciplinary integration. In the future, it is necessary to strengthen the research and development of intelligent technology, the promotion of standardized nursing processes, and the balanced allocation of regional resources.

**Keywords:** Bladder cancer; Ureterocutaneostomy; Evidence-based nursing; Visual analysis; Bibliometrics

**Online publication:** April 29, 2025

## 1. Introduction

Bladder cancer is one of the common malignant tumors of the urogenital system. The Global Cancer Statistics Report 2020 <sup>[1]</sup> shows that bladder cancer has ranked among the top ten in global incidence (440,000), and it



ranks seventh in new cancer cases among Chinese men (62,000, 2.7%). With the intensification of the aging trend of the population in China, there is an increasing number of elderly patients who have many underlying diseases and poor surgical tolerance. Among the three commonly used radical cystectomy methods for bladder cancer, ureterocutaneostomy is often suitable for elderly patients with cardiopulmonary insufficiency or obesity who cannot tolerate ileal or colonic cystoplasty<sup>[2]</sup>. Patients after ureterocutaneostomy need to wear a stoma urine collection bag on the lower abdominal wall and replace the ureteral stent placed in the body regularly, which brings certain inconvenience to the patients' lives<sup>[3,4]</sup>. Currently, the lack of patients' self-care knowledge and insufficient continuous nursing support remain clinical difficulties. This study systematically analyzed the research trends, collaboration networks, and hot spot evolution in the field of ureterocutaneostomy nursing in the past 25 years by integrating CiteSpace visualization technology and bibliometrics methods, aiming to provide a scientific basis for optimizing nursing strategies and promoting technological innovation.

## **2. Materials and methods**

### **2.1. Data sources**

The literature sources were retrieved from CNKI, Wanfang Database, and VIP Database by using the search method of subject words + free words. The retrieval time limit was from January 1, 1999 to December 31, 2024. The search subject words in the Chinese database were “Bladder Cancer,” “Ureterocutaneous Ostomy,” and “Evidence-Based Nursing.”

### **2.2. Inclusion and exclusion criteria for literature**

Inclusion criteria: (1) The literature type was primary literature, conference papers, or reviews related to ureterocutaneostomy. (2) The language of the literature was Chinese.

Exclusion criteria: (1) Duplicated reports. (2) Literature for which the full text could not be obtained. (3) Literature irrelevant to the content of this study. (4) News and popular science literature.

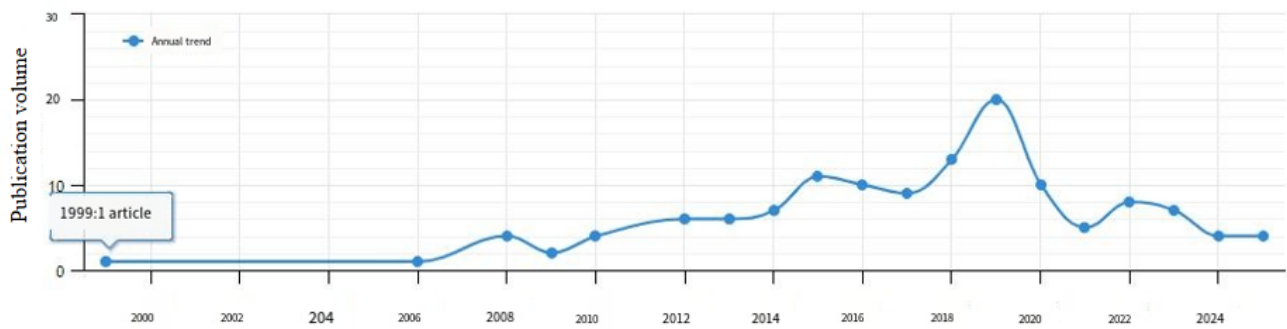
### **2.3. Data analysis**

Visual analysis was performed using CiteSpace 6.3. R2 software. The main analysis contents included authors, institutions, countries, keyword clustering, and visual analysis, and the analysis rules were further summarized. The time slice for literature analysis was one year, and the algorithm was set to extract the top 50 cited literatures in each time slice for analysis. The rest were default parameters. The author cooperation network, institutional distribution, and keyword clustering maps were drawn. The modularity value ( $Q$  value) and the average silhouette value ( $S$  value) were used to evaluate the rationality of clustering ( $Q > 0.3$  and  $S > 0.5$  were valid).

## **3. Results**

### **3.1. Publication volume**

From 1999 to 2024, the publication volume of domestic research on ureteral cutaneous stoma care showed a trend of rapid increase–peak–slow decline. The peak (20 articles) was reached in 2019, and it began to decline in 2021, indicating that the overall popularity of this research has decreased (see **Figure 1**).



**Figure 1.** Trend of the number of published papers on ureterocutaneous stoma care from 1999 to 2024

### 3.2. Publishing institutions

In the Chinese data platform, the top three publishing institutions are the Nursing Department of the First Affiliated Hospital of Nanchang University (13 articles), the School of Nursing of Nanchang University (6 articles), and Nanchang University (5 articles), as shown in **Figure 2**.



**Figure 2.** Knowledge graph of the cooperation of the publishing institutions on the Chinese data platform

### 3.3. Author of the post

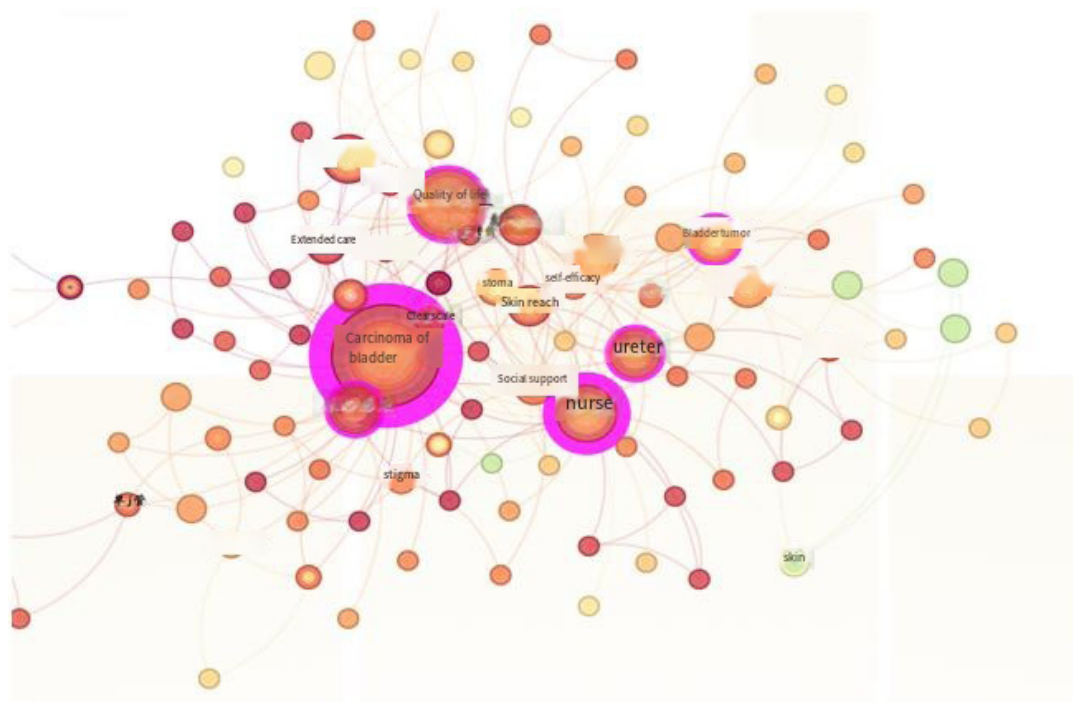
The author with the largest number of posts on the Chinese data platform is the Tang Liping team. They led 62.1% of the studies (14 articles), coming from the First Affiliated Hospital of Nanchang University, and mainly engaged in wound and stoma research. However, the cross-regional cooperation network is weak, and there are only limited cooperations with local institutions (such as the Medical College of Nanchang University). The top three authors in terms of the number of posts are shown in **Table 1**.

**Table 1.** The top three authors with the largest number of posts on the Chinese data platform

No.	CNKI			
	Author	Number of publications (articles)	Research direction	Institution
1	Tang Liping	14	Innovation of ostomy nursing technology	The First Affiliated Hospital of Nanchang University
2	Cao Ying	8	Construction of continuous nursing model	Nursing School of Nanchang University
3	Wang Jun	5	Complication risk prediction model	School of Medicine of Nanchang University

### 3.4. High-frequency keywords

In this study, the top 25 literature keywords ranked by citation frequency in the time slices on schedule were selected for contribution analysis, as shown in **Figure 3** and **Table 2**.



**Figure 3.** Knowledge graph of keywords contribution for ureterocutaneous stoma care in the Chinese data platform

**Table 2.** The top 10 high-frequency keywords in the research on ureteral cutaneous stoma care

No.	CNKI	
	Keyword	Frequency (times)
1	Carcinoma of bladder	42
2	nurse	29
3	Quality of life	16
4	Nursing Experience	8
5	Complete resection of bladder	8
6	Bladder tumor	8
7	Extended care	7
8	Nursing intervention	6
9	ureter	6
10	Urinary tract infection	6

### 3.5. Keyword clustering

Keyword clustering reflects the research focus in this field. Based on the co-occurrence analysis of keywords, clustering was conducted on the research of ureteral cutaneous stoma care. Eventually, a total of nine clusters were formed in CNKI. In the clustering results, the CiteSpace software provided two indicators, namely the modularity value ( $Q$  value) and the average silhouette value ( $S$  value), based on the network structure and the clarity of clustering. A  $Q$  value  $> 0.300$  indicates a reasonable structural division, and an  $S$  value  $> 0.500$  indicates a reasonable clustering, which are the basis for evaluating the mapping effect. The analysis results of this study showed that the  $Q$  value of the nine clusters in CNKI was 0.622, and the  $S$  value was 0.894, suggesting that the clustering results were meaningful, as shown in **Figure 4**. Based on the clustering results and combined with the specific content of the literature to extract keywords, the salience intensity of keywords is shown in **Figure 5**. The cluster analysis further revealed three major hotspots: (1) Complications management (Cluster #1, #3): covering urinary tract infections, skin and mucosa separation, etc.; (2) Continuity of care (Cluster #2, #5): emphasizing remote guidance and family participation; (3) Intelligent technology (Cluster #4, #6): focusing on the Internet of Things and AI applications.

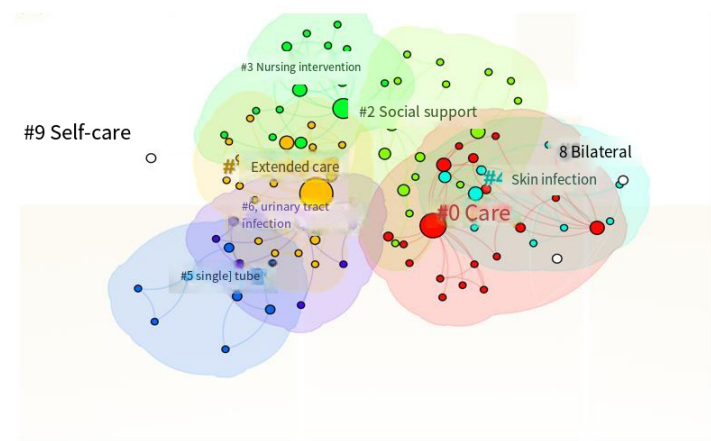


Figure 4. Keyword clustering map of research on ureterocutaneous stoma care in the Chinese data platform

### Top 13 Keywords with the Strongest Citation Bursts

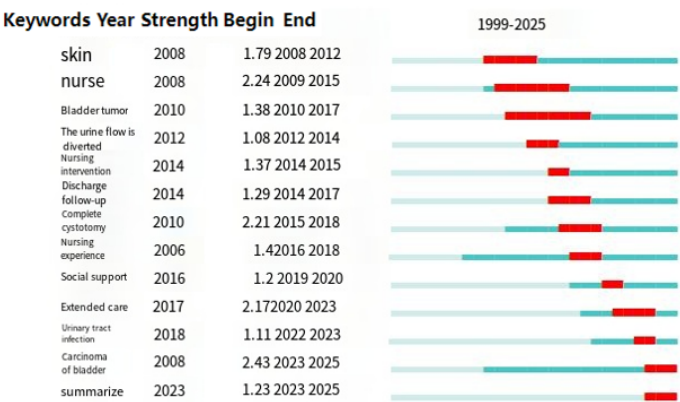


Figure 5. Keywords highlighting of ureteral cutaneous stoma care research

## 4. Discussion

### 4.1. Research status of ureterocutaneous stoma care

It can be seen from the distribution curve of the publication year that the research on ureterocutaneous stoma care has been on the rise since 2006 and reached its peak in 2019, which is closely related to the rising incidence of bladder cancer (with an average annual growth of 3.2%)<sup>[5]</sup> and the release of the “Expert Consensus on Stoma Care”<sup>[6]</sup>. However, the decline in the number of publications after 2021 may reflect the following issues: (1) Partial satisfaction of clinical needs: The popularization of standardized nursing procedures (such as the norms for changing ostomy bags) has reduced the demand for repetitive research; (2) Lagging technological innovation: The research and development of intelligent equipment is still in the laboratory stage and has not been put into clinical use on a large scale; (3) Unbalanced regional resources: 72.4% of the research is concentrated in tertiary hospitals, and data from primary medical institutions is scarce<sup>[7]</sup>. It is worth noting that this research direction shows obvious geographical concentration: The publication volume of the First Affiliated Hospital of Nanchang University and its affiliated institutions accounts for 62.1%; The research of the most published author, Tang Liping’s team, focuses on wound care technology innovation (such as 3M tape fixation technology)<sup>[8]</sup>. However, it can be seen that a cross-regional and multi-center cooperation network has not yet been formed<sup>[9]</sup>. This phenomenon may be limited by the uneven distribution of regional medical resources. It is suggested that academic alliances or database sharing mechanisms be used to promote national collaboration in the future to further advance the development of this research field.

### 4.2. Research hotspots in ureterocutaneous stoma care

#### 4.2.1. Complications and care of ureterocutaneous stoma

The incidence of complications in ureterocutaneous stoma care is significantly related to the patient’s age and nursing skills. For example, in elderly patients ( $\geq 65$  years old), due to decreased skin elasticity and cognitive impairment, the risk of urinary tract infection is 34% higher than that in younger patients<sup>[10]</sup>. Through technological innovation: local application of EGF gel can shorten the mucosal healing time from 14 days to 8.4 days ( $P < 0.01$ )<sup>[11]</sup>; in the future, it is necessary to construct a multi-dimensional risk assessment model and integrate physiological indicators (such as immune status) and environmental factors (such as family hygiene conditions) for dynamic early warning. This study shows that complication management is the core issue in the research of ureterocutaneous stoma care, and the high-frequency keywords include “urinary tract infection” (frequency 6), “skin and mucosa separation” (implied in cluster #3). The use of antibacterial dressings combined with dynamic adjustment of stoma size can reduce the incidence of skin irritant dermatitis from 28.3% to 12.1%. However, elderly patients still face a higher risk of complications due to poor skin elasticity and decreased perception ability (the infection rate of patients over 65 years old is 34% higher than that of the younger group). In recent years, research has begun to focus on molecular-level intervention, such as the local application of epidermal growth factor (EGF) gel to promote the repair of mucosa around the stoma. Clinical trials show that the healing time is shortened by 40%. In the future, it is necessary to further explore the complication risk prediction model and formulate a stratified nursing plan based on individual patient characteristics (such as BMI and immune status).

#### 4.2.2. Innovation and effect verification of the continuity nursing model

Continuity nursing, through regular follow-up after discharge, remote guidance, and family nursing training,



significantly reduces the incidence of complications. The keyword “continuity nursing” appears seven times, and cluster analysis shows that it is strongly associated with “quality of life.” A multi-center RCT study indicates that continuity nursing based on the WeChat platform (twice weekly remote guidance + once monthly home visit) reduces the incidence of complications within 3 months after discharge from 24.7% to 9.3%, and increases the social function score by 18.5 points (using the SF-36 scale). Its core lies in establishing a collaborative network of patients, family members, and medical staff to enhance self-care ability. The study emphasizes that psychological care needs to be carried out throughout the process. However, in rural areas, due to insufficient network coverage and scarce nursing resources, the intervention compliance is only 52.3%<sup>[12]</sup>, significantly lower than that in cities (81.6%). To solve this difference, it is necessary to integrate community medical resources, such as training rural doctors as “nursing coordinators,” or developing an offline version of the nursing guidance app. Some studies have shown that the Internet of Things (IoT) technology can realize real-time monitoring of stoma status (such as leakage alerts and infection indicator analysis), and provide personalized advice combined with AI algorithms<sup>[13,14]</sup>. The application of remote nursing platforms can expand the coverage of continuity nursing, especially for patients in rural areas or with limited mobility.

#### **4.2.3. The clinical application prospects of intelligent technology**

The keyword burst analysis in this study shows that “intelligent” (Burst = 4.32) has become an emerging hotspot in the past five years. The current applications are concentrated in two major directions: (1) Real-time monitoring system: For example, the intelligent ostomy bag equipped with a humidity sensor can automatically alarm for leakage<sup>[15]</sup>, reducing the nurse’s response time from an average of 2.1 hours to 0.5 hours; (2) AI decision support: Based on machine learning algorithms (such as random forest model) to predict the risk of complications, the accuracy rate reaches 89.7% (AUC = 0.91). In the future, it is necessary to break through technical barriers, such as developing flexible electronic skin patches to achieve non-invasive monitoring, or using natural language processing (NLP) technology to analyze patients’ self-reported symptoms to achieve dynamic adjustment of nursing plans.

## **5. Conclusion**

The nursing of complications after ureterocutaneostomy has developed from a single technical operation to a comprehensive system covering physiology, psychology, and social support. The practical effects of continuous nursing and predictive nursing are remarkable, and intelligent technology and multidisciplinary collaboration will become the core driving forces in the future. It is suggested that the standardized nursing process be further promoted in clinical practice, and at the same time, patient education be strengthened to achieve the transformation from “disease management” to “whole-person health.”

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# Application and Practice of Characteristic Traditional Chinese Medicine Nursing Techniques in the Colorectal Department

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**Abstract:** *Objective:* To explore the application effect and value of characteristic traditional Chinese medicine (TCM) nursing techniques in the colorectal department in clinical practice, in order to provide references for improving the nursing quality of patients and promoting their rehabilitation. *Method:* The colorectal department of Hospital A began to implement characteristic TCM nursing techniques in January 2023. Therefore, 100 patients admitted to the colorectal department from September 2022 to December 2022 were set as the control group, and 100 patients admitted from January 2023 to April 2023 were taken as the experimental group. The experimental group adopted characteristic TCM nursing techniques, including comprehensive measures such as herbal enema therapy, TCM hip bath, acupoint massage and application, and emotional care; the control group adopted conventional Western medicine nursing methods. The application effect and value of characteristic TCM nursing techniques in the clinical practice of the colorectal department were evaluated by comparing indicators such as the frequency of use, the proportion of treated patients, the number of types, and patient satisfaction between the two groups. *Result:* After using the characteristic TCM nursing techniques, the recovery speed of the patients in the experimental group was significantly accelerated, and the incidence of complications was significantly reduced. Specifically, the average hospital stay of the patients in the experimental group was shortened by approximately 20% compared with the control group. At the same time, the pain score of the patients in the experimental group was also significantly lower than that of the control group. In addition, the satisfaction rate of the patients in the experimental group with the nursing service was as high as 95%, significantly higher than 80% of the control group. *Conclusion:* The application and practice of the characteristic TCM nursing techniques in the colorectal department have shown significant advantages in improving the recovery speed of patients and the quality of nursing services, and can be further promoted in clinical practice.

**Keywords:** Colorectal department; Characteristic TCM nursing techniques; Herbal enema therapy

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## 1. Introduction

With the continuous progress of modern medical technology, the characteristic nursing techniques of traditional

Chinese medicine (TCM) have gradually demonstrated their unique advantages in the clinical practice of the colorectal department. The characteristic nursing techniques of TCM not only focus on the treatment of diseases, but also emphasize the overall rehabilitation and mental health of patients, which coincides with the “bio-psycho-social” medical model in the modern medical model <sup>[1]</sup>. In the colorectal department, patients often face a series of symptoms such as pain, constipation, and bleeding. These symptoms not only affect the daily life of patients, but also bring them a great psychological burden. Therefore, how to effectively relieve the symptoms of patients and improve their quality of life has become the focus of attention for medical staff in the colorectal department. The characteristic nursing techniques of TCM, with its unique theoretical system and practical experience, provide a brand-new nursing model for patients in the colorectal department.

## **2. Materials and methods**

### **2.1. General information**

The colorectal department of Hospital A has implemented characteristic TCM nursing techniques since January 2023. Patients in two time periods were selected as the control group and the experimental group for a comparative study. The control group included 100 patients admitted from September 2022 to December 2022. The experimental group covered another 100 patients admitted from January 2023 to April 2023. The patients in the control group were aged 27 to 39 years, with an average age of 33 years; there were 50 male patients and 50 female patients. The patients in the experimental group were aged 28 to 40 years, with an average age of 34 years; there were 52 male patients and 48 female patients. All patients were clinically diagnosed with colorectal diseases, and those with severe organic diseases such as heart, liver, and kidney diseases, as well as mental diseases, were excluded. This study was approved by the hospital ethics committee. Inclusion criteria for patients: (1) Aged between 18 and 65 years old; (2) Voluntarily participated in this study and signed the informed consent form; (3) Able to cooperate to complete the treatment and nursing process <sup>[2]</sup>. Exclusion criteria for patients: (1) Suffering from other severe diseases that may affect the research results; (2) Having obvious resistance or being unsuitable to receive such nursing for traditional Chinese medicine characteristic nursing techniques <sup>[3]</sup>. There were no significant differences in basic information such as gender, age, and condition between the two groups of patients, and they were comparable.

### **2.2. Methods**

For the patients in the control group, conventional Western medical nursing methods were applied, which mainly included condition monitoring, drug guidance, basic care, general health education, etc. Condition monitoring mainly involved regularly observing and recording the vital signs and condition changes of the patients to ensure that they were in a stable state; Drug guidance was to explain the name, dosage, usage, and possible side effects of the drugs to the patients in detail to ensure that they took the drugs correctly; Basic care covered the daily living, dietary nutrition, and cleanliness of the patients, aiming to provide a good rehabilitation environment; While general health education was to popularize the relevant knowledge of anorectal diseases to the patients and enhance their self-care awareness. For the patients in the experimental group, on the basis of conventional Western medical care, characteristic TCM nursing techniques were added, including enema therapy, TCM hip bath, acupoint massage and application, emotional care, etc. The specific methods are as follows.

### **2.2.1. Herbal enema therapy**

Herbal enema therapy is a commonly used method in the characteristic nursing techniques of TCM. It involves infusing Chinese herbal decoctions or specific liquid medicines into the rectum through the anus to achieve the purposes of clearing away heat and detoxifying, moistening the intestines and promoting defecation, promoting blood circulation, removing blood stasis, etc.<sup>[4]</sup>. In the treatment of colorectal diseases, enema therapy is particularly suitable for patients with constipation, proctitis, colitis, etc. Through an enema, it can directly act on the lesion site, promote local blood circulation, accelerate the regression of inflammation, relieve constipation symptoms, and reduce the pain of patients. The implementation of enema therapy requires strict control of indications and contraindications to ensure standardized operation and avoid unnecessary harm to patients<sup>[5]</sup>.

### **2.2.2. Chinese medicine hip bath**

Chinese medicine hip bath is to pour the prepared Chinese herbal liquid into the hip bath basin and add an appropriate amount of warm water to adjust to a suitable temperature. The patient sits in the hip bath basin, allowing the anal area to be completely immersed in the liquid. Through the warm effect of the liquid and the direct penetration of the medicinal components, it achieves the effects of clearing heat and detoxifying, reducing swelling and relieving pain, and promoting blood circulation and removing blood stasis<sup>[6]</sup>. Chinese herbal hip bath is particularly suitable for the treatment of colorectal diseases such as hemorrhoids, anal fissures, and perianal abscesses. It can effectively relieve symptoms such as pain, itching, and swelling in patients, promote local blood circulation, and accelerate the healing of the lesion. When implementing a Chinese herbal hip bath, it is necessary to closely monitor the patient's reaction to ensure that the temperature of the liquid is appropriate and to avoid the occurrence of adverse reactions such as burns or allergies<sup>[7]</sup>. At the same time, it is also necessary to pay attention to the specific condition and constitution of the patient, and flexibly adjust the prescription and course of treatment of the Chinese herbal hip bath to achieve the best therapeutic effect.

### **2.2.3. Acupoint massage and herbal plaster application**

Acupoint massage and herbal plaster application are important components of characteristic nursing techniques in traditional Chinese medicine. Acupoint massage mainly stimulates specific acupoints of the human body through manipulation techniques such as pressing and kneading to regulate the circulation of qi and blood in the human body, achieving the purposes of dredging the meridians, reconciling yin and yang, and enhancing physical fitness<sup>[8]</sup>. In the treatment of colorectal diseases, acupoint massage is particularly suitable for alleviating patients' pain and improving constipation and other symptoms. By massaging specific acupoints, such as Zusanli and Tianshu, it can promote intestinal peristalsis, increase fecal excretion, and relieve constipation symptoms in patients. Acupoint massage can also relieve the tense state of the muscles around the anus and reduce patients' pain. Acupoint herbal plaster application involves making traditional Chinese medicine with specific effects into ointments or medicinal cakes and applying them to specific acupoints of the human body. Through the direct penetration of the medicine and the stimulating effect of the acupoints, the purpose of treating diseases is achieved. In colorectal departments, acupoint herbal plaster application is often used to treat diseases such as hemorrhoids and anal fissures, which can effectively relieve patients' pain, bleeding, and other symptoms and promote the healing of the lesion<sup>[9]</sup>. When implementing acupoint massage and herbal plaster application, it is necessary to accurately select acupoints and master the appropriate stimulation intensity and frequency to ensure the therapeutic effect.



#### 2.2.4. Emotion-regulating nursing therapy

Emotion-regulating nursing therapy is an indispensable component of characteristic TCM nursing techniques. It is based on the understanding in TCM theory about the close relationship between emotions and internal organs, as well as the qi-blood system. Through psychological counseling, emotional regulation, and other methods, it helps patients relieve negative emotions such as anxiety, fear, and depression, thereby achieving the goal of regulating emotions and promoting recovery<sup>[10]</sup>. In the colorectal department, patients often have negative emotions such as anxiety and fear due to the pain and discomfort caused by the disease, as well as stress factors such as surgery and treatment. These emotions not only affect the patients' mental health but also may aggravate the patients' physical symptoms and delay the recovery process<sup>[11]</sup>.

### 2.3. Observation indicators

- (1) Comparing the frequency of the use of characteristic TCM nursing techniques in the colorectal department;
- (2) Comparing the proportion of treated patients before and after the implementation of characteristic TCM nursing techniques;
- (3) Comparing the number of types carried out before and after the implementation of characteristic TCM nursing techniques;
- (4) Comparing the satisfaction of patients before and after the implementation of characteristic TCM nursing techniques.

The satisfaction survey adopted the self-made questionnaire of Hospital A, which includes aspects such as the attitude of nursing service, technical level, treatment effect, and rehabilitation guidance. It was filled out by patients before discharge, with a full score of 100. The higher the score, the higher the satisfaction of patients with the nursing service<sup>[12]</sup>. Through the comparative analysis of the above observation indicators, the application effect and value of characteristic TCM nursing techniques in the clinical practice of the colorectal department were further evaluated.

### 2.4. Statistical methods

The data were processed using SPSS 22.0. The measurement data were expressed as mean  $\pm$  standard deviation (SD) and were analyzed by *t*-test. The count data were expressed as a percentage (%) and were analyzed by  $\chi^2$  test.  $P < 0.05$  indicated statistically significant differences.

## 3. Result

### 3.1. Comparison of the usage frequency of characteristic TCM nursing techniques in the colorectal department before and after the implementation

After the implementation of characteristic TCM nursing techniques in the colorectal department, the frequency of the use of characteristic TCM nursing techniques by patients in the experimental group increased significantly. Compared with the control group, the experimental group showed a higher frequency in the use of various techniques such as herbal enema therapy, Chinese medicine hip bath, acupoint massage and herbal plaster application, and emotion-regulating nursing therapy (**Table 1**).

**Table 1.** Comparison of usage frequency before and after implementation

Time	<i>n</i>	Frequency of use (times/week)
Before implementation	15	81.05 ± 1.12
After implementation	15	112.07 ± 5.39
<i>t</i>		21.82
<i>P</i>		0.00

### 3.2. Comparison of the proportion of patients treated with characteristic TCM nursing techniques in the colorectal department before and after implementation

After the experimental group adopted the characteristic TCM nursing techniques, the proportion of treated patients also significantly increased ( $P < 0.05$ ) (**Table 2**).

**Table 2.** Comparison of treated patients before and after the implementation of characteristic TCM nursing techniques

Time	<i>n</i>	Proportion of patients [ <i>n</i> (%)]
Before implementation	100	75 (75.00)
After implementation	100	90 (90.00)
$\chi^2$		14.56
<i>P</i>		0.00

### 3.3. Comparison of the number of types of characteristic TCM nursing techniques carried out in the colorectal department before and after implementation

The number of implemented characteristic TCM nursing techniques was higher after the implementation than before. This indicates that the application of characteristic TCM nursing techniques in the colorectal department not only broadens the nursing methods but also improves the diversity and pertinence of nursing services (**Table 3**).

**Table 3.** Comparison of the number of types of characteristic TCM nursing techniques before and after implementation

Time	<i>n</i>	Number of types of TCM techniques (types/month)
Before implementation	100	3.04 ± 0.24
After implementation	100	5.33 ± 1.33
<i>t</i>		12.29
<i>P</i>		0.00

### 3.4. Comparison of the scores of nursing management quality in the department before and after implementation

In order to comprehensively evaluate the quality of nursing management, the colorectal department adopted the evaluation system of nursing management quality formulated within the hospital, covering multiple dimensions such as the nursing service process, nursing operation norms, nursing document records, and patient satisfaction. By comparing the score data before and after the implementation, the experimental group made significant

progress in all evaluation indicators (**Table 4**).

**Table 4.** Comparison of the scores of nursing management quality in the department before and after implementation

Time	<i>n</i>	Nursing management quality scores (score, mean $\pm$ SD)
Before implementation	15	85.12 $\pm$ 2.07
After implementation	15	93.45 $\pm$ 4.11
<i>t</i>		7.01
<i>P</i>		0.00

### 3.5. Comparison of the satisfaction rate of nursing staff on the management of characteristic TCM nursing techniques before and after implementation

After the implementation of characteristic TCM nursing techniques, the satisfaction rate of nursing staff with the management of characteristic TCM nursing techniques has significantly increased, as shown in **Table 5**.

**Table 5.** Management satisfaction before and after implementation

Satisfaction	<i>n</i>	Proportion [ <i>n</i> (%)]
Very satisfied	15	7 (46.67)
Relatively satisfied	15	5 (33.33)
Satisfied	15	2 (13.33)
Dissatisfied	15	1 (6.67)

## 4. Discussion

Clinical research shows that the application of characteristic TCM nursing techniques in the colorectal department not only enriches clinical nursing methods but also provides patients with more comprehensive and meticulous nursing services. Through the implementation of comprehensive measures such as herbal enema therapy, Chinese medicine hip bath, acupoint massage and herbal plaster application, and emotion-regulating nursing therapy, patients in the experimental group have achieved significant improvements in terms of recovery speed, complication rate, and satisfaction with nursing services<sup>[13]</sup>. This not only reflects the unique advantages of characteristic TCM nursing techniques but also further validates their application value in clinical practice in the colorectal department.

It is worth noting that the implementation of characteristic TCM nursing techniques has put forward higher requirements for nursing staff. Nursing staff not only need to master solid theoretical knowledge of TCM, but also need to possess proficient operational skills and good communication and coordination abilities to ensure the effectiveness and safety of nursing services<sup>[14]</sup>. Therefore, while promoting characteristic TCM nursing techniques, training and education for nursing staff should also be strengthened to improve their professional quality and service level. In addition, the implementation of characteristic TCM nursing techniques is of great significance for improving the quality of nursing management in departments. Through measures such as optimizing the nursing service process, standardizing nursing operations, and improving the records of nursing documents, the

experimental group has made significant progress in the score of nursing management quality <sup>[15]</sup>. This not only improves the efficiency and quality of nursing work but also provides a safer and more comfortable rehabilitation environment for patients.

## 5. Conclusion

In conclusion, the application and practice of characteristic TCM nursing techniques in the colorectal department have shown significant advantages in improving the recovery speed of patients and the quality of nursing services. In the future, with the continuous development and improvement of characteristic TCM nursing techniques, it is believed that their application prospects in the colorectal department and even the entire medical field will be broader.

## Disclosure statement

The author declares no conflict of interest.

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# Practical Analysis of the Matrix Medical Administration Model to Improve Medical Safety Level

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**Abstract:** *Objective:* To analyze the effectiveness of the matrix medical administration model in enhancing medical safety management. *Method:* A total of 39 medical incidents in the hospital from September 2020 to September 2022 were selected as the reference group, implementing conventional medical administration. Another 39 medical incidents from October 2022 to October 2024 were chosen as the experimental group, adopting the matrix medical administration model. The practical indicators such as causes of medical disputes, dispute compensation, medical injury appraisal results, and diagnosis and treatment quality indicators were compared between the two groups. *Results:* In the experimental group, the primary reasons for medical disputes were patient-related, and most disputes resulted in no compensation. After medical injury appraisal, most cases were not considered medical injuries. The comparison between the two groups was statistically significant ( $P < 0.05$ ). The diagnosis and treatment quality indicators of the experimental group were superior to those of the reference group ( $P < 0.05$ ). *Conclusion:* The matrix medical administration model can reduce medical disputes caused by hospital factors, decrease the proportion of compensation and the incidence of medical injuries, and improve the quality of diagnosis and treatment, demonstrating high management effectiveness.

**Keywords:** Matrix medical administration model; Medical safety; Causes of disputes; Quality of diagnosis and treatment; Effectiveness

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## 1. Introduction

Medical safety level directly impacts the effectiveness of hospital management. To enhance medical safety and reduce medical disputes and injuries, China has actively introduced various laws and regulations to ensure orderly and standardized medical administration<sup>[1]</sup>. However, these measures cannot eliminate medical disputes from their root causes, necessitating more reliable and efficient medical administration strategies. The matrix management model optimizes both flat and vertical management approaches, balancing management scope and hierarchy to

maximally meet the needs of medical safety management. This highly flexible management can reduce medical incidents through a rapid response mechanism and optimize work efficiency, exhibiting strong scientific and practical management characteristics <sup>[2]</sup>. Therefore, this study selected 78 medical incidents to evaluate the implementation effects of matrix medical administration.

## **2. Materials and methods**

### **2.1. General information**

The reference group comprised 39 medical incidents that occurred in the hospital from September 2020 to September 2022, involving 39 patients. Among them, there were 23 medical disputes and 16 medical injuries. The patients included 24 males and 15 females, aged between 40 and 82 years, with a mean age of  $55.95 \pm 4.18$  years. The experimental group consisted of 39 medical incidents that occurred from October 2022 to October 2024, also involving 39 patients. There were 22 medical disputes and 17 medical injuries. The patients comprised 26 males and 13 females, aged between 38 and 84 years, with a mean age of  $55.82 \pm 4.27$  years. There were no significant differences in basic information between the two groups ( $P > 0.05$ ).

Inclusion criteria: Medical disputes or medical injuries occurring in the hospital; inpatients; patients aged over 18 years; complete basic information; normal communication ability; and high informed consent for the study. Exclusion criteria: Medical events occurring after discharge; patients in special periods such as pregnancy or lactation; patients with mental illnesses; and withdrawal from the study.

### **2.2. Methods**

The reference group implemented conventional medical administration: a vertical management model was selected, which was divided into multiple departments, such as the pharmacy department, medical department, and equipment department, based on functions. Each department was responsible for internal management, that is, systematic self-management.

The experimental group implemented matrix medical administration: (1) Vertical management: Optimize the internal management processes of various departments such as the medical department or pharmacy department, summarize the management effectiveness of each department once a week, evaluate the feasibility of management measures based on feedback, improve management content in a targeted manner, and strengthen internal supervision. Regularly conduct spot checks on the management quality of departments such as the pharmacy department or nursing department, evaluate their management issues occasionally, provide knowledge training for medical staff in various departments, and carry out professional ethics training activities to enhance their sense of responsibility. Clarify the management norms of each department and require medical staff to engage in relevant work according to relevant systems and norms to prevent medical incidents. (2) Horizontal management: Members of the management team come from the superior departments of the vertical management system, with the team leader being the head of the superior department, responsible for coordinating and arranging management issues and coordinating the management work among different groups. Medical staff from the pharmacy department, medical department, and nursing department form a safety assurance team, responsible for dynamically evaluating the existing problems of medical safety management, continuously providing feedback, and improving the current management process. The medical department, the dean's office, and the pharmacy department form a drug supervision team, responsible for evaluating the management of drug procurement, distribution, adverse

reaction monitoring, and other aspects. Each team organizes a collective meeting once a week, based on the research direction and management objectives of each team, deeply analyzes the current management deficiencies, uses brainstorming to uncover the essence of the problems, and develops problem-solving strategies for each department. Daily management should strengthen communication frequency among departments, mutually monitor the implementation of their management, and report management defects as improvement targets for subsequent management.

### 2.3. Observation indicators

(1) Causes of medical disputes: (a) Patient factors: weak legal awareness, poor cognition of medical knowledge; (b) Hospital factors: limited doctor-patient communication skills, inadequate management and supervision, insufficient skills of medical staff. (2) Dispute compensation: whether there was compensation. (3) Medical malpractice appraisal results: whether it was a medical malpractice incident. (4) Quality indicators of diagnosis and treatment: patient mortality rate, disease cure rate, disease recurrence rate, complication rate, referral rate, follow-up rate outside the hospital, number of visits, waiting time for visits, nursing satisfaction (self-made scale, total 100 points, positive scoring).

### 2.4. Statistical analysis

The data processing software used was SPSS 28.0. Measurement data were represented as mean  $\pm$  standard deviation (SD), and *t*-value comparison and test were implemented. Count data were represented as [*n* (%)], and chi-square value comparison and test were implemented. If the statistics were significant, then  $P < 0.05$ .

## 3. Results

### 3.1. Comparison of the causes of medical disputes between the two groups

Among the causes of medical disputes in the experimental group, the proportion of patient factors was lower than that in the reference group ( $P < 0.05$ ). See **Table 1**.

**Table 1.** Comparison of the causes of medical disputes between the two groups [*n* (%)]

Group	<i>n</i>	Patient reasons			Hospital reasons			Total
		Weak legal awareness	Poor cognition of medical knowledge	Total	Limited doctor-patient communication skills	Inadequate management and supervision	Insufficient skills of medical staff	
Experimental group	23	3 (13.04)	3 (13.04)	26.09 (6/23)	8 (34.78)	5 (21.74)	4 (17.39)	73.91 (17/23)
Reference group	22	7 (31.82)	6 (27.27)	59.09 (13/22)	4 (18.18)	3 (13.64)	2 (9.09)	40.91 (9/22)
$\chi^2$	-	2.293	1.423	5.021	1.585	0.505	0.670	5.021
<i>P</i>	-	0.130	0.233	0.025	0.208	0.477	0.413	0.025

### 3.2. Comparison of dispute compensation between the two groups

In the experimental group, the proportion of uncompensated events was higher than that in the reference group ( $P < 0.05$ ). See **Table 2**.

**Table 2.** Comparison of dispute compensation between the two groups [*n* (%)]

Group	<i>n</i>	No compensation	Compensation
Experimental group	23	18 (78.26)	5 (21.74)
Reference group	22	10 (45.45)	12 (54.55)
$\chi^2$	-	5.148	
<i>P</i>	-	0.023	

### 3.3. Comparison of medical malpractice appraisal results between the two groups

In the appraisal results of the experimental group, the proportion of events that were not considered medical malpractice was higher than that of the reference group ( $P < 0.05$ ). See **Table 3**.

**Table 3.** Comparison of medical malpractice appraisal results between the two groups [*n* (%)]

Group	<i>n</i>	It is not a medical malpractice incident	It is a medical malpractice incident
Experimental group	16	14 (87.50)	2 (12.50)
Reference group	17	9 (52.94)	8 (47.06)
$\chi^2$	-	4.661	
<i>P</i>	-	0.031	

### 3.4. Comparison of diagnosis and treatment quality indicators between the two groups

The diagnosis and treatment quality indicators of the experimental group were better than those of the reference group ( $P < 0.05$ ). See **Table 4**.

**Table 4.** Comparison of diagnosis and treatment quality indicators between the two groups [*n* (%), mean  $\pm$  SD]

Group	<i>n</i>	Patient mortality Rate	Disease cure rate	Disease recurrence rate	Complication rate	Referral rate	Follow-up rate outside hospital	Number of visits	Waiting time for visits (min)	Nursing satisfaction (score)
Experimental group	39	0	38 (97.44)	2 (5.13)	1 (2.56)	2 (5.13)	32 (82.05)	1.81 $\pm$ 0.42	15.85 $\pm$ 3.41	96.42 $\pm$ 2.85
Reference group	39	4 (10.26)	33 (84.62)	8 (20.51)	7 (17.95)	9 (23.08)	24 (61.54)	2.44 $\pm$ 0.59	25.43 $\pm$ 4.68	92.11 $\pm$ 2.73
$\chi^2$	-	4.216	3.924	4.129	5.014	5.186	4.052	5.433	10.332	6.820
<i>P</i>	-	0.040	0.048	0.042	0.025	0.023	0.044	0.000	0.000	0.000

## 4. Discussion

Medical administration refers to the government management of medical safety, health care, and other related issues implemented by hospitals. Its service subjects are medical workers, medical institutions, etc., constituting a comprehensive and multi-dimensional management service <sup>[3]</sup>. The effectiveness of medical administration plays a decisive role in the level of medical safety and affects the rational allocation of medical resources and the health status of patients. Its management content is complex and has special characteristics, including safety guarantees, disease treatment, prevention of complications, and other aspects, which are prone to medical disputes or damage events. To reduce conflicts between doctors and patients during medical administration and create a

harmonious and safe medical environment, most hospitals systematically implement management content based on relevant documents such as the “Tort Liability Law” or “Medical Accident Classification Standards” during the management period. However, institutional constraints cannot solve deep-seated problems, so their role in improving medical safety levels is limited <sup>[4]</sup>. Based on this, hospitals actively seek standardized, improved, and efficient medical administration models, introducing matrix management.

Matrix management is a new management model derived from organizational structure forms. It has strong flexibility, can simplify administrative command chains, improve coordination among medical staff, and highly integrate existing resources, thereby improving management effectiveness <sup>[5]</sup>. This nursing extends management thinking to “surface” or “volume” management, preventing many problems that arise during conventional management such as “point” or “line” management. Specifically, matrix management can expand the management scope under the horizontal management model and enrich the management levels under the vertical management model, bringing the two into a dynamic balance <sup>[6]</sup>. Moreover, this management can rationalize the allocation of human resources and management projects, keeping the upper-level departments and various management teams in a state of power balance, thereby sharing medical information and coordinating medical resources.

The results showed that among the causes of medical disputes, the proportion of patient factors in the experimental group was 26.09%, and the proportion in the reference group was 59.09%. Evidently, the experimental group was lower than the reference group ( $P < 0.05$ ). The reason is that matrix management focuses on aspects such as the frequency of doctor-patient communication and the professional skills of medical staff. It can clearly delineate management authority, avoid power overlaps, and thereby improve the overall level of hospital management. Horizontal management can establish rules for various departments, ensuring the orderly progress of vertical management. At the same time, it deeply analyzes the underlying causes of medical disputes, targets the improvement of the overall quality of medical staff, makes them focus on patients’ thoughts, explains medical knowledge in detail, and evaluates the precipitating factors of medical disputes from multiple perspectives. Then, it reasonably improves management measures to reduce disputes caused by hospital factors <sup>[7]</sup>. In terms of dispute compensation, the proportion of uncompensated events in the experimental group was 78.26%, and the proportion in the reference group was 45.45%. Apparently, the experimental group was higher than the reference group ( $P < 0.05$ ). The reason is that matrix management can achieve two-line management, simultaneously establishing two teams responsible for daily affairs management and drug management, respectively. The management team is responsible for supervising the implementation of management, which can significantly enhance the sense of responsibility of medical staff, ensure the efficient implementation of management projects, and thereby reduce compensation events <sup>[8]</sup>. Among the appraisal results of medical malpractice, the proportion of events not considered medical malpractice in the experimental group was 87.50%, and the proportion in the reference group was 52.94%. Evidently, the experimental group was higher than the reference group ( $P < 0.05$ ). The diagnosis and treatment quality indicators of the experimental group were better than those of the reference group ( $P < 0.05$ ). The reason is that matrix management can reduce communication costs among various departments, maximize the utilization of medical resources based on the principles of interaction, mutual assistance, and complementarity, strengthen the communication efficiency of medical staff regarding medical malpractice events, and develop feasible and comprehensive improvement plans to reduce medical malpractice events <sup>[9]</sup>. Additionally, this management has the advantages of being multi-dimensional and dynamic, enabling medical staff to quickly adapt to the management needs of medical safety and continuously improve their basic management skills and professional functions. Furthermore, during the management period, a horizontal system



can be utilized to carry out systematic management of specialized tasks, while integrating a vertical leadership system, enabling innovative multi-dimensional management, thereby significantly improving the quality of diagnosis and treatment<sup>[10]</sup>.

## 5. Conclusion

In summary, matrix management can enhance the effectiveness of medical safety management, reduce medical disputes or damage events, lower the compensation ratio for medical disputes, and maximize the improvement of diagnosis and treatment quality. It has a promoting significance for raising the level of medical safety.

## Disclosure statement

The author declares no conflict of interest.

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# Application of Full Disease Course Management via Internet Platform in Rehabilitation Management of Patients with Depression

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**Abstract:** *Objective:* To observe the application effect of full disease course management via an internet platform in the rehabilitation management of patients with depression. *Methods:* Eighty patients with depression meeting the inclusion criteria were selected as the study subjects and randomly divided into an experimental group and a control group, with 40 patients in each group. The control group was followed up every 4 weeks for 12 weeks after discharge. The experimental group underwent full disease course management via an internet platform for 12 weeks after discharge. The quality-of-life scores, depression scores, medication compliance, insight and treatment attitude questionnaire scores, and self-efficacy scores were compared between the two groups. *Results:* After 12 weeks of follow-up, the experimental group had higher quality-of-life scores, lower depression scores, higher medication compliance, higher insight and treatment attitude scores, and higher self-efficacy scores than the control group ( $P < 0.05$ ). *Conclusion:* Full disease course management via an internet platform has a positive impact on the quality of life, medication compliance, self-efficacy, and disease stability of discharged patients with depression.

**Keywords:** Internet; Full disease course management; Depression

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## 1. Introduction

Depression is a psychological disorder that is clinically characterized by persistent low mood and is prone to recurrent episodes. It is difficult to treat and can affect patients' thinking, behavior, and feelings, not only impacting their daily life and work but also potentially leading to self-harm and suicidal behavior in severe cases<sup>[1]</sup>. Clinically, to control the progression of the disease, patients generally need to take antidepressants for a long time. However, patient compliance is often poor, making it difficult to adhere to medication, which affects the recovery of the disease and imposes a serious burden on families and society. Improving patients' awareness of the disease, strengthening self-management, and improving compliance are beneficial to the prognosis of patients. Therefore, effective nursing

intervention and guidance outside the hospital are needed for these patients <sup>[2]</sup>. Full disease course management refers to the establishment of case files by medical staff, strengthened case tracking and guidance services after discharge, and the provision of individualized medical, psychological, and social services to patients <sup>[3,4]</sup>. Full disease course management originates from social work practices and is based on the long duration of depression. In daily life, patients need to face pressure from external environments such as family, work, or study, and the disease can lead to decreased cognitive and social functioning. Through full disease course management, patients' independence can be improved, helping them better cope with stress, improve compliance, and enhance social functioning. By implementing full disease course management, hospitals can provide continuous care and personalized treatment, thereby improving communication between doctors and patients, utilizing early intervention pathways to prevent recurrence, enhancing patients' treatment efficacy, and promoting recovery. Simultaneously, full disease course management is also significant in popularizing medical knowledge, saving medical, family, and social resources, and improving patients' quality of life. In this study, the effect of full disease course management via an internet platform in the rehabilitation management of discharged patients with depression was investigated, and the results are reported below.

## 2. Materials and methods

### 2.1. Study subjects

Eighty patients with depression who were hospitalized, treated, and discharged from our hospital from June 2023 to August 2024 were selected as the study subjects. All patients voluntarily participated in the study and signed informed consent forms. They were randomly divided into a control group and an experimental group using a random number table method, with 40 patients in each group. There were no statistically significant differences in general characteristics such as gender, age, ethnicity, and marital status between the two groups ( $P > 0.05$ ). See **Table 1**.

**Table 1.** General information of patients in the two groups

Variable		Experimental group ( $n = 40$ )	Control group ( $n = 40$ )	$t/\chi^2$	$P$
Age		$39.10 \pm 14.50$	$39.78 \pm 16.41$	0.196	0.960
Gender	Male	5	6	0.105	0.745
	Female	35	34		
Household registration	City	17	14	0.474	0.491
	Countryside	23	26		
Marital status	Unmarried	11	11	4.000	0.262
	Married	23	23		
	Divorced	3	6		
	Widowed	3	0		
Education level	Primary school and below	8	8	3.034	0.386
	Junior high school	13	16		
	High school/Secondary school	8	11		
	College and above	11	5		

**Table 1 (Continued)**

Variable		Experimental group ( <i>n</i> = 40)	Control group ( <i>n</i> = 40)	<i>t</i> / $\chi^2$	<i>P</i>
Occupation	Student	5	4	0.247	0.884
	Working	18	20		
	Others	17	16		
Source of medical payment	Self-pay	2	2	1.324	0.516
	Medical insurance for urban and rural residents	18	23		
	Employee medical insurance	20	15		
Monthly household income	Less than or equal to 3000	1	5	3.174	0.205
	3000–5000	9	10		
	Greater than or equal to 5000	30	25		
Number of depressive episodes	First time	8	9	0.850	0.654
	Twice	10	13		
	Three times and above	22	18		

Inclusion criteria: (1) Meet the diagnostic criteria for depression in the 10th edition of the International Classification of Diseases (ICD-10); (2) Obtain informed consent from the patient and guardian; (3) Have a smartphone and know how to use software such as WeChat and QQ. Exclusion criteria: (1) Patients with other mental illnesses; (2) History of drug abuse; (3) Mental retardation; (4) Accompanied by severe physical illness or organic brain disease. Dropout criteria: Patients who automatically request to withdraw from the study or are lost to follow-up during the study period.

## 2.2. Research methods

The control group received conventional drug treatment, physical therapy, psychological therapy, and related nursing health education, and was followed up every 4 weeks for 12 weeks after discharge.

The experimental group underwent full disease course management via an internet platform based on the control group and was followed up for 12 weeks after discharge. The implementation details are as follows: (1) During the follow-up period after discharge, patients were provided with relevant knowledge about depression, treatment measures (including drugs, physical therapy, psychotherapy, relaxation training, etc.), and recovery knowledge once a week, and regular assessments were conducted. (2) After admission, according to the specific situation of each patient, the staff formulated a precise treatment plan, established a health file, recorded the patient's basic information, each psychological scale evaluation situation, the current patient treatment plan, treatment effect, the next evaluation time, and other information. (3) A "Self-Management Manual" was established for patients, which mainly focuses on items that patients need to achieve and record, including emotion diaries, weekly emotion change tables, drug self-management tables, life schedules, etc., and feedback was provided every week. (4) Medical staff provided timely responses to relevant questions raised by patients during the study period through mobile internet social tools. (5) The staff regularly reminded discharged patients to return to the clinic for follow-up. (6) Mobile internet social tools were used to conduct brief follow-ups on patients every 4 weeks after discharge, summarize recent problems encountered by patients, and encourage patients to cultivate

interests and hobbies, participate in social activities, and guide patients to confide through social networks. Follow-up frequency was increased for those with fluctuating conditions, and if necessary, hospitalized again for treatment.

### 2.3. Observation indicators

- (1) Short Form 36 Health Survey (SF-36): Assessment was conducted through eight aspects, including physiological function, psychological role, and general health status, all with a score of 100, scored positively.
- (2) Self-Rating Depression Scale (SDS): Developed by Zung, the scale consists of 20 items, each with four rating levels. The standard score is 53, and depression is scored positively.
- (3) Morisky Medication Adherence Scale (MMAS-8): This consists of eight items, with a maximum score of eight. A score below six indicates low adherence, 6–7 indicates moderate adherence, and above seven indicates high adherence.
- (4) Insight and Treatment Attitude Questionnaire (ITAQ): This consists of 11 items, using a 0–2 three-level scoring system. The score range is 0–22, and the higher the score, the more complete the insight.
- (5) General Self-Efficacy Scale (GSES): It contains 10 items, using a 4-level scoring method. The sum of the item scores is the total score of the scale. The higher the total score, the better the self-efficacy.

### 2.4. Statistical analysis

Data were analyzed using SPSS 23.0 software. Measurement data were represented by and compared using two independent sample *t*-tests;  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Comparison of SF-36 scale scores between the two groups

There was no statistically significant difference in SF-36 scale scores between the two groups before intervention ( $P > 0.05$ ). After intervention, the experimental group scored higher than the control group ( $P < 0.05$ ). See **Table 2**.

**Table 2.** Comparison of SF-36 scale scores between the two groups of patients (mean  $\pm$  standard deviation [SD], scores)

Group	n	Before intervention	After intervention	<i>t</i> -value	<i>P</i> -value
Control group	40	403.17 $\pm$ 115.39	383.46 $\pm$ 122.88	5.365	0.000
Experimental group	40	399.07 $\pm$ 130.99	461.61 $\pm$ 108.40	-7.697	0.000
<i>t</i> -value		-0.148	3.016		
<i>P</i> -value		0.883	0.003		

### 3.2. Comparison of SDS scale scores between the two groups

There was no statistically significant difference in SDS scale scores between the two groups before intervention ( $P > 0.05$ ). After intervention, there was a statistically significant difference in SDS scale scores between the two groups ( $P < 0.05$ ). See **Table 3**.



**Table 3.** Comparison of SDS scale scores between the two groups (mean  $\pm$  SD, scores)

Group	<i>n</i>	Before intervention	After intervention	<i>t</i> -value	<i>P</i> -value
Control group	40	56.15 $\pm$ 11.42	61.35 $\pm$ 10.34	-2.713	0.01
Experimental group	40	55.13 $\pm$ 12.14	52.60 $\pm$ 7.87	1.109	0.274
<i>t</i> -value		-0.389	-4.259		
<i>P</i> -value		0.698	0.000		

### 3.3. Comparison of ITAQ scale scores between the two groups

There was no statistically significant difference in ITAQ scale scores between the two groups before intervention ( $P > 0.05$ ). However, after intervention, there was a statistically significant difference in ITAQ scale scores between the two groups ( $P < 0.05$ ). See **Table 4**.

**Table 4.** Comparison of ITAQ scale scores between the two groups (mean  $\pm$  SD, scores)

Group	<i>n</i>	Before intervention	After intervention	<i>t</i> -value	<i>P</i> -value
Control group	40	17.83 $\pm$ 3.23	17.53 $\pm$ 3.05	0.506	0.616
Experimental group	40	18.20 $\pm$ 3.44	19.68 $\pm$ 3.10	-3.375	0.002
<i>t</i> -value		0.503	3.124		
<i>P</i> -value		0.617	0.003		

### 3.4. Comparison of GSES scale scores between the two groups

Before intervention, there was no statistically significant difference in GSES scale scores between the two groups ( $P > 0.05$ ). However, after intervention, there was a statistically significant difference in GSES scale scores between the two groups ( $P < 0.05$ ). For the control group, there was no significant difference in GSES scale scores before and after intervention ( $P > 0.05$ ), while for the experimental group, there was a statistically significant difference in GSES scale scores before and after intervention ( $P < 0.05$ ). See **Table 5**.

**Table 5.** Comparison of GSES scale scores between the two groups (*n*, mean  $\pm$  SD)

Group	<i>n</i>	Before intervention	After intervention	<i>t</i> -value	<i>P</i> -value
Control group	40	26.13 $\pm$ 4.72	26.45 $\pm$ 4.95	-0.453	0.653
Experimental group	40	26.05 $\pm$ 5.51	32.55 $\pm$ 3.15	-8.286	0.000
<i>t</i> -value		-0.065	6.577		
<i>P</i> -value		0.948	0.000		

### 3.5. Comparison of MMAS-8 scale scores between the two groups

There was no statistically significant difference in MMAS-8 scale scores between the two groups before intervention ( $P > 0.05$ ). However, after intervention, a statistically significant difference in MMAS-8 scale scores was observed between the two groups ( $P < 0.05$ ). See **Table 6** for details.

**Table 6.** Comparison of MMAS-8 scale scores between the two groups (*n*, mean  $\pm$  SD)

Group	<i>n</i>	Before intervention	After intervention	<i>t</i> -value	<i>P</i> -value
Control group	40	4.73 $\pm$ 1.12	5.62 $\pm$ 0.85	-8.295	0.000
Experimental group	40	4.68 $\pm$ 1.35	6.58 $\pm$ 1.13	-11.888	0.000
<i>t</i> -value		-0.18	4.279		
<i>P</i> -value		0.857	0.000		

## 4. Discussion

Currently, the incidence of depression is increasing year by year, which may be related to various factors such as genetics, psychology, and environment <sup>[5]</sup>. Depression not only affects the psychological state and quality of life of the patients themselves, but also poses risks such as violence and aggression to their families. Moreover, depression has a long duration, is prone to recurrent episodes, and is difficult to completely cure. Therefore, it is very important to actively adopt corresponding drug, physical, and psychological treatments during hospitalization, as well as to provide treatment and care for patients after discharge <sup>[6,7]</sup>. After inpatient treatment, patients' depressive symptoms have improved significantly compared to before hospitalization. However, when they encounter stressful events again in life, work, or study, patients are still prone to develop depressive emotions, leading to worsened conditions and even requiring re-hospitalization. Additionally, some patients have poor treatment compliance due to a lack of disease knowledge, and they may reduce medication, stop medication, or fail to return for follow-up visits after symptomatic improvement, which increases the risk of disease recurrence <sup>[8]</sup>.

Full disease course management via an internet platform can provide continuous care for patients without being limited by time and location, enabling timely and effective delivery of disease treatment and recovery knowledge. It strengthens communication and exchange with patients, allows early detection of changes in patients' conditions, promptly reminds patients of follow-up visits, and provides timely answers to patients' questions about the treatment process <sup>[9]</sup>.

The results of this intervention showed that through full disease course management via an internet platform, the experimental group scored better on various scales compared to the control group. This indicates that full disease course management via an internet platform is beneficial for patients' rehabilitation management outside the hospital and has a positive impact on the quality of life, medication compliance, self-efficacy, and stability of depressive symptoms in patients with depression.

## 5. Conclusion

In summary, full disease course management via an internet platform plays a positive and effective role in the rehabilitation management of patients with depression.

## Disclosure statement

The authors declare no conflict of interest.

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# The Association between Cardiometabolic Multimorbidity and Frailty among Middle-Aged and Older Adults in China

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**Abstract:** *Objective:* To explore the association between cardiometabolic multimorbidity and frailty among middle-aged and older adults in China. *Methods:* Data were derived from the 2013 wave of the China Longitudinal Healthy Longevity Survey, including a total of 6,179 individuals aged 45 years and above with complete follow-up records. Basic demographic information was collected, and frailty status was assessed using a physical frailty scale. Generalized linear models were employed to analyze the association between the number and combinations of cardiometabolic conditions—such as hypertension, diabetes, heart disease, and stroke—and frailty. *Results:* The prevalence of cardiometabolic multimorbidity among middle-aged and older adults was 14.23%. After adjusting for sociodemographic covariates, individuals with cardiometabolic multimorbidity had a significantly increased risk of frailty compared to those without such conditions (OR = 1.78, 95% CI: 1.45–2.19), along with higher frailty scale scores ( $\beta$  = 0.26, 95% CI: 0.19–0.34). Compared to individuals without cardiometabolic diseases, those with both hypertension and stroke (OR = 1.18, 95% CI: 1.06–1.31) and those with hypertension, heart disease, and stroke (OR = 1.46, 95% CI: 1.24–1.73) exhibited notably higher frailty risks. *Conclusion:* There is a significant association between cardiometabolic multimorbidity and frailty in middle-aged and older adults in China, particularly for comorbidity patterns involving hypertension. These findings provide evidence for developing targeted health interventions for aging populations.

**Keywords:** Cardiometabolic multimorbidity; Frailty; Middle-aged and older adults; Nursing

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## 1. Introduction

China is currently facing a severe challenge of population aging, and the health issues of middle-aged and older adults have attracted increasing attention. With advancing age, the prevalence of chronic diseases rises steadily

in this population, and the phenomenon of individuals suffering from multiple chronic conditions simultaneously (known as multimorbidity) has become increasingly common. Previous studies have shown that 55.77% of middle-aged and older adults in China suffer from two or more chronic diseases simultaneously <sup>[1,2]</sup>. Among the various chronic disease patterns, cardiometabolic multimorbidity (CMM) is one of the most prevalent and relatively stable combinations <sup>[3]</sup>, referring to the co-occurrence of two or more cardiometabolic diseases (CMD) in an individual. Frailty is a common geriatric syndrome characterized by a decline in physiological reserves and multiple organ functions with aging <sup>[4]</sup>. The coexistence of multiple chronic diseases may lead to functional decline, reduced endurance, and immobility among middle-aged and older adults, ultimately resulting in frailty and increasing the risks of disability, hospitalization, and mortality. Previous studies have confirmed that cardiometabolic multimorbidity is a significant risk factor for frailty in middle-aged and older populations <sup>[5,6]</sup>.

Most existing studies have focused on single or a limited number of specific disease combinations, or have examined the relationship between the number of chronic conditions and frailty without fully considering the cumulative effects of different combinations of cardiometabolic diseases. Therefore, this study draws upon data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) to systematically examine the association between cardiometabolic multimorbidity and frailty from two perspectives: the number of diseases and their specific combinations. The aim is to provide scientific evidence for delaying frailty in China's middle-aged and older population.

## **2. Participants and methods**

### **2.1. Study population**

The data used in this study were obtained from the publicly available database of the Chinese Longitudinal Healthy Longevity Survey (CLHLS), which covers 28 provinces, municipalities, and autonomous regions across China and is highly representative. However, due to the incompleteness of physical examination data (such as height, weight, grip strength, and walking speed) in the 2015 and 2018 waves, frailty could not be assessed in those years. Therefore, this study used data from the 2013 wave. A total of 13,138 participants aged 45 years and above were initially included. After excluding 6,959 individuals with missing information on cardiometabolic diseases or the frailty scale, 6,179 participants remained in the final analysis. All participants had signed informed consent forms prior to the survey. The use of all data in this study was exempted from ethical review by the hospital ethics committee (Application number: 2025-L-007).

### **2.2. Research methods**

#### **2.2.1. Basic information**

In this study, cardiometabolic diseases included hypertension, diabetes, heart disease, and stroke. CMM was defined as the simultaneous presence of two or more of these conditions in an individual <sup>[7-9]</sup>. Information on whether participants had been diagnosed with hypertension, diabetes, heart disease, or stroke was obtained through a structured questionnaire. In addition, basic demographic and health-related variables were collected, including gender, age, type of residence, marital status, education level, smoking behavior, alcohol consumption, body mass index (BMI), history of falls, sleep duration at night, and self-rated health status.

#### **2.2.2. Physical Frailty Phenotype (PFP)**

This study used the Physical Frailty Phenotype (PFP), developed by Fried *et al.*, to assess frailty status <sup>[10]</sup>. The scale consists of five criteria: slowness, weakness, weight loss, low physical activity, and exhaustion. All data



were sourced from the CLHLS database, with reference to established criteria used in prior frailty studies based on CLHLS data <sup>[11,12]</sup>. Slowness: Assessed by measuring the time required to walk 2.5 meters. The average of two trials was used, and slowness was defined as being in the slowest 20% of walking speed based on gender and height. Weakness: Measured using grip strength of the dominant hand. The highest value from the two trials was recorded. If there was no dominant hand, the highest value of both hands was used. Weakness was defined as grip strength in the lowest 20%, adjusted for gender and BMI. Weight loss: Defined as a self-reported unintentional weight loss of more than 5 kg since the last survey or a BMI < 18.5. Low physical activity: Defined as the inability to walk or engage in physical activity for at least 10 minutes in a typical week, based on self-report. Exhaustion: Measured using two items from the 10-item Center for Epidemiologic Studies Depression Scale (CESD-10): “I felt that everything I did was an effort” and “I could not get going.” Participants were considered exhausted if they responded “sometimes or occasionally (3–4 days)” or “most of the time (5–7 days)” to either item. Each criterion that meets the standard is assigned 1 point, resulting in a total score ranging from 0 to 5. Based on the total score, participants are classified into three categories: 0 points: non-frail; 1–2 points: pre-frail; 3–5 points: frail.

## 2.3. Statistical analysis

In this study, data organization and analysis were performed using Stata 18.0 software. The sociodemographic characteristics of the participants were summarized using descriptive statistics, including median, interquartile range, frequency, and percentage (%). The main exposure variables were the number and combination patterns of cardiometabolic diseases in 2013, while the outcome variables included the presence of frailty and the PFP score. In the analysis, sociodemographic covariates were adjusted, and a generalized linear model was used to explore the association between cardiometabolic multimorbidity patterns and frailty. The analysis of frailty status used a Logit link function, while the analysis of the PFP score used an Identity link function. The significance level for statistical tests was set at  $\alpha = 0.05$ , and all tests were two-tailed.

## 3. Results

### 3.1. Basic characteristics of the study participants

This study included 6,179 participants, with an age range primarily between 60 and 74 years, and an average age of 66 ( $66 \pm 10$ ) years. In terms of gender distribution, there were 3,116 males (49.69%) and 3,063 females (50.31%). Among the participants, 1,067 (17.30%) were in a frail state. A total of 2,766 participants had cardiometabolic diseases, distributed as follows: 1,263 individuals had only hypertension, accounting for 9.51%; 171 individuals had only diabetes, accounting for 6.18%; 397 individuals had only heart disease, accounting for 14.35%; 56 individuals had only stroke, accounting for 2.02%; 182 individuals had both hypertension and diabetes, accounting for 6.58%; 408 individuals had both hypertension and heart disease, accounting for 14.75%; 73 individuals had both hypertension and stroke, accounting for 2.64%; 40 individuals had both diabetes and heart disease, accounting for 1.45%; 7 individuals had both diabetes and stroke, accounting for 0.25%; 9 individuals had both heart disease and stroke, accounting for 0.33%; 90 individuals had hypertension, diabetes, and heart disease, accounting for 3.25%; 30 individuals had hypertension, heart disease, and stroke, accounting for 1.08%; 18 individuals had hypertension, diabetes, and stroke, accounting for 0.65%; 4 individuals had diabetes, heart disease, and stroke, accounting for 0.14%; 18 individuals had hypertension, diabetes, heart disease, and stroke, accounting for 0.65%. Among the participants, 879 individuals had cardiometabolic multimorbidity, accounting for 14.23%. Detailed

data are presented in **Table 1**.

**Table 1.** Basic characteristics of study participants in two groups

Item	Category	Number	Cardiometabolic multimorbidity
Age	45–59 years	471	49 (10.4%)
	60–74 years	4,687	684 (14.6%)
	≥ 75 years	1,021	146 (14.3%)
Gender	Male	3,116	503 (16.1%)
	Female	3,063	376 (12.3%)
Living type	Rural	4,943	617 (12.5%)
	Urban	1,236	262 (21.2%)
Education level	No education	2,162	274 (12.7%)
	Primary school or below	2,832	378 (13.3%)
	High school or below (vocational)	1,101	208 (18.9%)
	College or above	84	19 (22.6%)
Marital status	Married or cohabiting	1,230	203 (16.5%)
	Not married (divorced, single, or widowed)	4,949	676 (13.7%)
BMI (kg/m <sup>2</sup> )	<18.5	511	34 (6.7%)
	18.5–24.9	3,781	374 (9.9%)
	≥25.0	1,887	471 (25.0%)
Fall situation	Had a fall (within the last two years)	1,132	195 (17.2%)
	No fall	5,047	684 (13.6%)
Smoking behavior	Never smoked	3,358	536 (16.0%)
	Currently smoking	2,323	250 (10.8%)
	Former smoker	498	93 (18.7%)
Drinking habit	Never drank	3,389	524 (15.5%)
	Currently drinking	1,982	206 (10.4%)
	Former drinker	808	149 (18.4%)
Nighttime sleep duration	≤ 6h	3,301	510 (15.4%)
	6–8h	1,056	127 (12.0%)
	≥ 8h	1,822	242 (13.3%)
Self-reported health	Excellent	674	38 (5.6%)
	Very good	247	12 (4.9%)
	Good	1,957	219 (11.2%)
	Fair	2,255	341 (15.1%)
	Poor	1,046	269 (25.7%)
Frailty	Yes	1,067	189 (17.7%)
	No	5,091	690 (13.6%)
Hypertension	Yes	2,123	819 (38.6%)
	No	4,056	60 (1.5%)
Diabetes	Yes	535	359 (67.1%)
	No	5,644	520 (9.2%)
Heart disease	Yes	1,008	599 (59.4%)
	No	5,171	280 (5.4%)
Stroke	Yes	217	159 (73.3%)
	No	5,962	720 (12.1%)

Note: Unit: Person (%).

### 3.2. Relationship between the number of cardiometabolic diseases and frailty

The results of this study indicate that among the 6,179 elderly individuals, the prevalence of CMM is 14.23%, with 189 individuals (21.50%) experiencing frailty. After adjusting for sociodemographic covariates, compared to individuals without CMD, those with 1 type of CMD and CMM had higher PFP scores ( $\beta = 0.12$ , 95% CI: 0.07–0.18;  $\beta = 0.26$ , 95% CI: 0.19–0.34) and a higher risk of frailty (OR = 1.32, 95% CI: 1.12–1.55; OR = 1.78, 95% CI: 1.45–2.19). Compared to individuals with 1 type of CMD, those with CMM had elevated PFP scores ( $\beta = 0.14$ , 95% CI: 0.06–0.22) and a higher risk of frailty (OR = 1.35, 95% CI: 1.09–1.67). The analysis results of the generalized linear models for frailty status and PFP scores with the number of CMD are shown in **Tables 2** and **3**.

**Table 2.** Generalized linear model analysis of cardiometabolic disease number and frailty

Cardiometabolic disease number	OR (95% CI)	$\beta$	SE	Wald $\chi^2$	<i>P</i>
1 type (Compared to no disease)	1.32 (1.12–1.55)	0.28	0.08	11.42	< 0.01
$\geq 2$ types (Compared to no disease)	1.78 (1.45–2.19)	0.58	0.11	29.60	< 0.01
$\geq 2$ types (Compared to 1 disease group)	1.35 (1.09–1.67)	0.30	0.11	7.62	< 0.01

Note: Adjusted for age, gender, living type, marital status, education level, fall history, smoking behavior, drinking habits, BMI, night sleep duration, and self-rated health status.

**Table 3.** Generalized linear model analysis of cardiometabolic disease number and PFP score

Cardiometabolic disease number	$\beta$ (95% CI)	Wald $\chi^2$	<i>P</i>
1 type (Compared to no disease)	0.12 (0.07–0.18)	19.38	< 0.01
$\geq 2$ types (Compared to no disease)	0.26 (0.19–0.34)	45.19	< 0.01
$\geq 2$ types (Compared to 1 disease group)	0.14 (0.06–0.22)	12.60	< 0.01

Note: Adjusted for age, gender, living type, marital status, education level, fall history, smoking behavior, drinking habits, BMI, night sleep duration, and self-rated health status.

### 3.3. Cardiometabolic disease combinations and frailty

Compared to individuals without CMD, elderly individuals with only hypertension (OR = 1.05, 95% CI: 1.02–1.07), hypertension and stroke (OR = 1.18, 95% CI: 1.06–1.31), and those with hypertension, heart disease, and stroke (OR = 1.46, 95% CI: 1.24–1.73) showed a significantly increased risk of frailty ( $P < 0.01$ ), as shown in **Table 4**.

Compared to individuals without CMD, elderly individuals with only hypertension ( $\beta = 0.13$ , 95% CI: 0.07–0.19), only heart disease ( $\beta = 0.12$ , 95% CI: 0.03–0.22), hypertension and diabetes ( $\beta = 0.22$ , 95% CI: 0.08–0.36), hypertension and heart disease ( $\beta = 0.18$ , 95% CI: 0.08–0.29), hypertension and stroke ( $\beta = 0.51$ , 95% CI: 0.26–0.76), hypertension, diabetes, and heart disease ( $\beta = 0.31$ , 95% CI: 0.12–0.51), and hypertension, heart disease, and stroke ( $\beta = 0.83$ , 95% CI: 0.42–1.24) had significantly higher PFP scores ( $P < 0.01$ ), as shown in **Table 5**.

**Table 4.** Generalized linear model analysis of cardiometabolic disease combinations and frailty

Comorbidity combination	Diseases involved	Frailty status [ <i>n</i> (%)]	OR (95% CI)	$\beta$	SE	Wald $\chi^2$	<i>P</i>
0 diseases		529 (15.50%)					
1 disease	Hypertension only	238 (18.84%)	1.05 (1.02–1.07)	0.05	0.01	13.14	< 0.01
	Diabetes only	23 (13.45%)	1.00 (0.94–1.04)	-0.01	0.03	0.07	0.79
	Heart Disease only	72 (18.14%)	1.03 (1.01–1.04)	0.03	0.02	1.91	0.17
	Stroke only	16 (28.57%)	1.13 (1.00–1.26)	0.12	0.06	4.32	< 0.05
2 diseases	Hypertension, diabetes	31 (17.03%)	1.06 (1.00–1.12)	0.06	0.03	3.76	0.05
	Hypertension, heart disease	81 (19.85%)	1.05 (1.01–1.10)	0.05	0.02	5.81	< 0.05
	Hypertension, stroke	24 (32.88%)	1.18 (1.06–1.31)	0.17	0.05	9.62	< 0.01
	Diabetes, heart disease	8 (20.00%)	1.08 (0.95–1.22)	0.07	0.06	1.36	0.24
	Diabetes, stroke	2 (28.57%)	1.15 (0.82–1.61)	0.14	0.17	0.57	0.44
	Heart disease, stroke	2 (22.22%)	1.06 (0.82–1.31)	0.06	0.13	0.18	0.67
3 diseases	Hypertension, diabetes, heart disease	16 (17.78%)	1.09 (1.01–1.18)	0.09	0.04	4.28	< 0.05
	Hypertension, diabetes, stroke	4 (22.22%)	1.13 (0.91–1.39)	0.12	0.09	1.31	0.19
	Hypertension, heart disease, stroke	16 (53.33%)	1.46 (1.24–1.73)	0.38	0.08	20.47	< 0.01
	Diabetes, heart disease, stroke	0 (0.00%)	0.87 (0.80–0.94)	-0.14	0.04	11.09	< 0.01
4 diseases	Hypertension, diabetes, heart disease, stroke	5 (27.78%)	1.18 (1.04–1.34)	0.17	0.11	2.47	0.12

Note: Adjusted for age, gender, living type, marital status, education level, fall history, smoking behavior, drinking habits, BMI, night sleep duration, and self-rated health status.

**Table 5.** Generalized linear model analysis of cardiometabolic disease combinations and PFP score

Comorbidity group	Diseases involved	PFP score	$\beta$ (95% CI)	SE	Wald $\chi^2$	<i>P</i>
0 diseases		1.51 ± 0.99	0.00			
1 disease	Hypertension only	1.59 ± 1.00	0.13 (0.07–0.19)	0.01	13.14	< 0.01
	diabetes only	1.46 ± 0.93	0.00 (-0.14–0.14)	0.03	0.07	0.10
	Heart disease only	1.61 ± 0.96	0.12 (0.03–0.22)	0.02	1.91	< 0.01
	Stroke only	1.79 ± 1.29	0.25 (-0.05–0.56)	0.06	4.32	0.10
2 diseases	Hypertension, diabetes	1.59 ± 0.95	0.22 (0.08–0.36)	0.03	3.76	< 0.01
	Hypertension, heart disease	1.65 ± 1.01	0.18 (0.08–0.29)	0.02	5.81	< 0.01
	Hypertension, stroke	2.03 ± 1.14	0.51 (0.26–0.76)	0.05	9.62	< 0.01
	Diabetes, heart disease	1.65 ± 1.12	0.24 (-0.07–0.55)	0.06	1.36	0.13
	Diabetes, stroke	2.00 ± 1.41	0.53 (-0.44–1.50)	0.17	0.57	0.29
	Heart disease, stroke	1.44 ± 1.13	-0.08 (-0.73–0.56)	0.13	0.18	0.80
3 diseases	Hypertension, diabetes, heart disease	1.62 ± 0.95	0.31 (0.12–0.51)	0.04	4.28	< 0.01
	Hypertension, diabetes, stroke	1.61 ± 0.92	0.28 (-0.09–0.65)	0.09	1.31	0.13

**Table 5 (Continued)**

Comorbidity group	Diseases involved	PFP score	$\beta$ (95% CI)	SE	Wald $\chi^2$	P
	Hypertension, heart disease, stroke	2.30 $\pm$ 1.26	0.83 (0.42–1.24)	0.08	20.47	< 0.01
	Diabetes, heart disease, stroke	1.25 $\pm$ 0.50	-0.21 (-0.63–0.20)	0.04	11.09	0.31
4 diseases	Hypertension, diabetes, heart disease, stroke	1.89 $\pm$ 1.02	0.54 (0.07–1.01)	0.11	2.47	< 0.05

Note: Adjusted for age, gender, living type, marital status, education level, fall history, smoking behavior, drinking habits, BMI, night sleep duration, and self-rated health status.

## 4. Discussion

This study found that as the number of CMD increases, the risk of frailty among Chinese middle-aged and elderly individuals also increases<sup>[13]</sup>. Similar to previous studies, we found that older adults with multiple chronic conditions are more likely to experience worsening frailty over time<sup>[14,15]</sup>. As the number of diseases increases, elderly populations with cardiovascular-metabolic multimorbidity are more prone to muscle loss, with multiple diseases interacting synergistically<sup>[16]</sup>. Hanlon *et al.* showed that the increase in frailty prevalence is associated with a greater number of chronic diseases among elderly individuals with multimorbidity<sup>[17]</sup>. Multimorbidity leads to greater physiological burden, and the side effects of polypharmacy may exacerbate the risk of frailty<sup>[18]</sup>.

The effect of different combinations of CMD on frailty varies. This study found that cardiovascular-metabolic multimorbidity that includes hypertension is associated with a higher risk of frailty, consistent with previous studies<sup>[19,20]</sup>. Hypertension and other chronic diseases are considered significant risk factors for frailty<sup>[21]</sup>. Hypertension activates chronic inflammation, which often involves pathological changes in the nervous, musculoskeletal, endocrine, immune, and blood systems<sup>[22,23]</sup>. This leads to cognitive decline, physical frailty, and a higher risk of falls, which accelerates the onset of frailty. Hypertension, diabetes, heart disease, and stroke share common risk factors such as obesity, smoking, and lack of physical activity<sup>[24]</sup>. Additionally, the physiological and biological mechanisms linking hypertension, diabetes, heart disease, stroke, and frailty are similar, including inflammation and immune dysfunction, mitochondrial dysfunction, and endocrine-metabolic imbalance leading to physical decline (sarcopenia)<sup>[25,26]</sup>. Ultimately, these factors contribute to the onset of frailty.

## 5. Conclusion

This study, based on nationwide representative data of middle-aged and elderly individuals in China, provides results with general applicability. From the dual perspective of the number and combination patterns of cardiovascular-metabolic multimorbidity and their relationship with frailty, this study offers a new methodological approach and exploration for investigating the correlation between multimorbidity patterns and frailty outcomes. However, this study has several limitations. Firstly, the data on cardiovascular-metabolic multimorbidity in the CLHLS database are primarily based on self-reports from the participants, which may lead to recall bias and reporting bias, thus affecting the accuracy of morbidity rates. Secondly, due to data accessibility constraints, this study did not conduct more detailed classifications of hypertension, diabetes, heart disease, or stroke, nor did it delve into the progression and severity of cardiovascular-metabolic diseases. Future research will further explore the specific impact of different disease subtypes and their severity on frailty.

In summary, as aging intensifies, frailty not only poses a severe challenge to the health of the middle-aged



and elderly population but also brings significant burdens to families and society. It has become an urgent public health issue that needs to be addressed. Cardiovascular-metabolic multimorbidity, especially the multimorbidity involving hypertension, is closely related to the onset of frailty. Therefore, tailored treatment and care strategies for specific cardiovascular-metabolic multimorbidity patterns should be developed, with scientific and effective prevention and intervention measures implemented in the early stages of multimorbidity. This is not only crucial for reducing the risk of frailty among the middle-aged and elderly population but also an important pathway for promoting healthy aging.

## Disclosure statement

The authors declare no conflict of interest.

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# Effects of 0.01% Atropine Eye Drops on Horizontal Meridian Choroidal Thickness Profile in Low to Moderate Myopic Children

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**Abstract:** *Purpose:* To examine the changes in choroidal thickness (ChT) after 6-month topical treatment of 0.01% atropine eye drops in myopic children. *Methods:* A total of 46 low to moderate myopic children aged 8 to 12 years were recruited and received topical 0.01% atropine once a day for 6 months. Spherical equivalent (SE), axial length (AL), and ChT were measured at baseline, 3 months, and 6 months. *Results:* During the first and second 3-month treatment, there is no significant decrease in progression of SE and AL. Within the range of 3 mm from the temporal side of the fovea to the nasal side, no significant changes in ChT have been observed at any measuring points in low and moderate myopic participants. Changes in ChT were not significantly associated with gender or AL progression. *Conclusion:* A 6-month topical treatment of 0.01% atropine could not cause significant changes in ChT in myopic children.

**Keywords:** Atropine, Choroidal thickness, Children, Myopia controlling

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## 1. Introduction

Myopia has been a growing worldwide threat to children and adolescents with its increasing morbidity, irreversible progression, and lasting visual impairment<sup>[1-3]</sup>. Of all the medical measures to control myopia, atropine is the only drug that has been widely proven to be effective in decreasing the progression of myopia. The efficacy of topical atropine treatment, as well as its adverse reaction ratio, has shown to be proportional to the medical concentration<sup>[4, 5]</sup>. Thus, 0.01% atropine drops have been widely used for its satisfactory long-term efficacy with mild side effects<sup>[5, 6]</sup>.

However, the mechanism of atropine controlling myopia still remains unknown, which leaves controversy about the safety of long-term therapy.

Atropine, as a non-selective M-cholinoceptor blocker, was previously hypothesized to decrease myopic progression by “relaxing accommodation”, since it can antagonistically bind the M-cholinoceptors in ciliaris and reduce accommodation induced by near work<sup>[7]</sup>. But this hypothesis has been disproved, because atropine treatment remained effective in chicks, which have no M-cholinoceptors in ciliaris<sup>[8,9]</sup>. M-cholinoceptor also exists in the retina and choroid<sup>[10]</sup>. As the biggest vascular structure that takes up 90% of ocular blood flow, the choroid plays an important role in regulating the physiological activities of the eye. Changes in choroidal structure and blood flow have been found in various ocular diseases<sup>[11,12]</sup>. According to available researches, choroidal thickness (ChT) was significantly decreased in high myopic patients<sup>[13,14]</sup>, and it is wondered whether atropine can cause choroidal thickening. There have been several studies that have estimated the changes in ChT after atropine treatment, but those results varied with different atropine concentrations, medication durations, and participants<sup>[15–17]</sup>. In this study, the most widely used concentration (0.01%) of atropine eye drops was chosen and the changes in ChT in low to moderate myopic children was estimated after 6-month treatment.

## 2. Methods

### 2.1. Participants

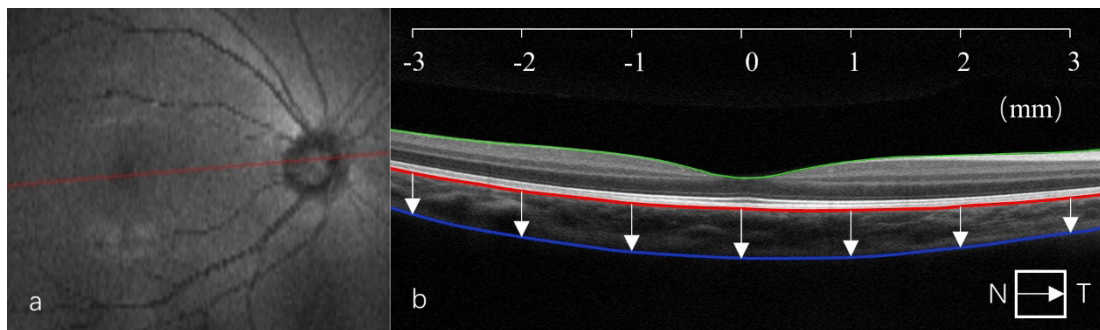
All participants were recruited from patients who visited the Fourth Affiliated Hospital of Zhejiang University School of Medicine during August 2020 to August 2022. After excluding those with other ocular diseases (such as cataract, glaucoma, amblyopia, or anisometropia) or previous use of atropine, a total of 46 children aged 8 to 12 years with myopic refractions less than -6.0D and astigmatism less than -2.0 D in both eyes were finally enrolled in our study. All participants received a 6-month treatment of 0.01% atropine sulphate eye drops (Myopine, Shenyang Xingqi Eye Hospital Co., LTD., Shenyang, China) once per night, and subsequent visits were required every 3 months. During the follow-up period, no other myopia interventions (such as pirenzepine or orthokeratology lens) that might change ChT were used. Depending on the progression of myopic diopter and axial length (AL) at each visit, it would be assessed by ophthalmologists if it's necessary to stop atropine therapy or add other interventions. The study protocol was approved by the Ethics Committee of the Fourth Affiliated Hospital of Zhejiang University School of Medicine, Jinhua, China (Approval number: K2020010), and registered at the Chinese Clinical Trial Registry. Informed consents were signed by both participants and guardians. All procedures were conducted in accordance with the tenets of the Declaration of Helsinki.

### 2.2. Study procedures

To decrease the influence of diurnal variation of choroid, all measurements were conducted between 9:00 AM to 3:00 PM, and follow-ups were made within 3 hours of the baseline time<sup>[18–20]</sup>. Outcome measures were made at 3 time points: before atropine, after 3 months and 6 months. At each visit, AL was measured using Lenstar (LS900, Haag-streit AG, Switzerland). After excluding the contradictions of tropicamide, 4 drops of topical tropicamide were administered in both eyes at 5-minute intervals. Further drops were administered if the pupillary light reflex was still present or the pupil size was less than 6.0 mm. After that, refractive diopter was performed using an autorefractor (ARK-1s, NIDEK, Japan).

Optical Coherence Tomography (RTvue XR OCT, optovue, America) was used to scan the ocular fundus

(retina and choroid) before the administration of tropicamide. A 12 mm single line of high-definition mode swept at a  $-5^\circ$  default angle, connecting the macular fovea to the central point of the optic disc. Each eye was scanned for 3 consecutive times at every visit to take the average value. The segmentation of each layer was automatically delineated using Matlab (R2021a), and manual calibration was performed by the same researcher where the software misjudged the borderline of each layer. The ChT values were then automatically measured at 0.01 mm intervals by software, taking the fovea as the 0 point and ranging from 3 mm from the temporal side (marked as “-”) of the fovea to the nasal side (marked as “+”) (**Figure 1**). For statistical analysis, 13 points at 0.5mm intervals were chosen.



**Figure 1.** The images of choroid were obtained using OCT; (a) The macular fovea and the central point of optic disc were automatically identified, and the scanning was performed with a single line connecting these two points; (b) The Matlab software automatically lined the segmentation of the inner limiting membrane (green line), the Bruch membrane (red line) and the choroid-sclera interface (blue line). The measuring area is from 3mm from the temporal side (-) of the fovea to the nasal side (+).

## 2.3. Outcome measures

The primary outcomes were the changes in the average ChT at different points over 6 months. The secondary outcomes were the changes in AL and spherical equivalent (calculated as the spherical power plus one-half of the cylindrical power).

## 2.4. Statistical analysis

All ocular measurements were described as mean  $\pm$  standard deviation. Paired t-test was used to test the differences of characteristics before and after atropine treatment. The group differences of ChT in participants of different gender, SE and AL were tested using t-test. Statistical analysis was performed using SPSS software (IBM, Armonk, NY, USA). A P value of less than 0.05 was considered statistically significant.

## 3. Results

### 3.1. Baseline characteristics

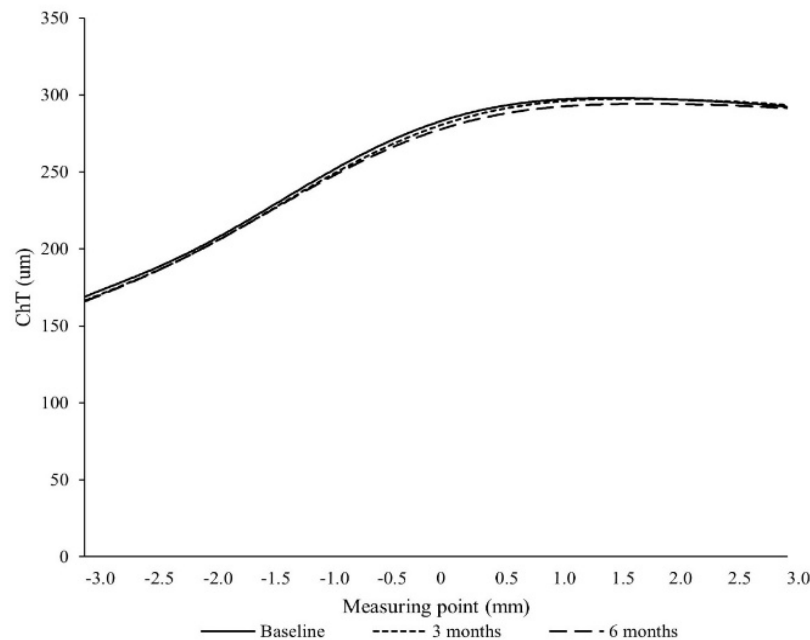
A total of 46 children aged 8–12 years ( $9.17 \pm 1.21$  years) were recruited and finished the 6-month follow-up in our research, including 25 boys and 21 girls. One out of the total 92 eyes was excluded from statistical analysis because of blurred OCT images. The baseline SE of all eyes was  $-1.83 \pm 1.14$ D, among which there were 69 low myopic eyes (less than  $-3.0$ D, average SE  $-1.37 \pm 0.78$ D) and 22 moderate myopic eyes ( $-3.0$ D to  $-6.0$ D, average SE  $-3.59 \pm 0.42$ D). The baseline AL was  $24.44 \pm 0.88$ mm (**Table 1**).



**Table 1.** SE and AL before and after atropine treatment

	SE (D)			AL (mm)		
	baseline	3 months	6 months	baseline	3 months	6 months
Total	-1.83 ± 1.14	-2.05 ± 1.18	-2.29 ± 1.17	24.41 ± 0.88	24.53 ± 0.87	24.62 ± 0.89
Gender						
Male (n=25)	-1.76 ± 1.08	-1.97 ± 1.04	-2.21 ± 1.11	24.71 ± 0.79	24.79 ± 0.77	24.92 ± 0.80
Female (n=21)	-1.92 ± 1.20	-2.15 ± 1.31	-2.39 ± 1.23	24.14 ± 0.85	24.25 ± 0.86	24.34 ± 0.86
Baseline refraction						
Low (n=69)	-1.37 ± 0.78	-1.57 ± 0.81	-1.81 ± 0.80	24.24 ± 0.81	24.37 ± 0.82	24.44 ± 0.83
Moderate (n=22)	-3.58 ± 0.42	-3.85 ± 0.54	-3.97 ± 0.67	25.15 ± 0.65	25.23 ± 0.67	25.31 ± 0.66

Within the measuring area of -3 mm to +3 mm, ChT gradually increased from the nasal to the temporal side, and remained constant from +0.5 mm point to +3.0 mm point (**Figure 2**).



**Figure 2.** Changes in ChT within -3 mm to +3 mm area during 6-month treatment of 0.01% atropine. At baseline, ChT increased from nasal to temporal side of the fovea and tended to be stable at temporal side. The minimum thickness was 168.93±46.45um at -3mm, and the maximum thickness was 297.96 ± 55.56um at +1.5 mm. The ChTs at the 3-month visit stayed nearly no change from baseline. At the 6-month visit, there was a mild decrease in ChTs within -0.5 mm to +1.5 mm area, but with no statistical significance.

There were no significant differences in ChT between male and female groups, nor between low and moderate myopia groups (**Table 2**).

**Table 2.** Baseline ChTs at each measuring point

Measuring point (mm)	ChT (um)						
	Total	Gender		*P value	Baseline Refraction		†P value
		Male	Female		Low	Moderate	
-3.0	168.93 ± 46.45	164.01 ± 47.49	174.90 ± 44.47	0.15	170.87 ± 46.16	162.57 ± 46.88	0.48
-2.5	184.40 ± 50.63	179.24 ± 53.59	189.48 ± 46.73	0.23	186.64 ± 50.06	174.70 ± 52.33	0.35
-2.0	202.38 ± 53.85	197.05 ± 58.45	208.76 ± 47.00	0.29	205.12 ± 53.53	193.19 ± 53.90	0.38
-1.5	223.50 ± 56.16	218.18 ± 61.82	229.87 ± 47.84	0.33	226.85 ± 6.242	212.33 ± 54.50	0.30
-1.0	246.21 ± 58.04	240.92 ± 64.27	252.36 ± 48.97	0.35	249.91 ± 58.40	233.39 ± 55.07	0.26
-0.5	266.21 ± 59.26	261.03 ± 65.52	272.24 ± 50.16	0.37	270.13 ± 59.76	252.69 ± 55.53	0.24
0	281.95 ± 59.58	276.80 ± 65.53	287.92 ± 50.97	0.38	285.73 ± 60.18	268.83 ± 55.60	0.26

Note: \* Comparison between male and female participants in this study using the Student t-test; † Comparison between low and moderate myopic participants in the study using the Student t-test

### 3.2. Changes in SE and AL during 6-month atropine treatment

The progression of SE after 6 months was  $-0.46 \pm 0.42\text{D}$ , with  $-0.22 \pm 0.34\text{D}$  and  $-0.24 \pm 0.24\text{D}$  in the first and second 3 months respectively. The progression of AL after 6 months was  $0.22 \pm 0.13\text{ mm}$ , with  $0.12 \pm 0.10\text{ mm}$  and  $0.10 \pm 0.07\text{ mm}$  in the first and second 3 months respectively. The progressions of myopia and eye elongation did not slow down during the therapy. In subgroups, changes in SE and AL had no significant differences between male ( $-0.46 \pm 0.43\text{D}$ ,  $0.22 \pm 0.14\text{mm}$ ) and female ( $-0.47 \pm 0.41\text{D}$ ,  $0.20 \pm 0.13\text{mm}$ ), neither between low ( $-0.43 \pm 0.39\text{D}$ ,  $0.21 \pm 0.14\text{mm}$ ) and moderate ( $-0.43 \pm 0.43\text{D}$ ,  $0.16 \pm 0.13\text{mm}$ ) myopic participants, indicating that the progressions of myopia and eye elongation do not correlate with gender and myopic degree (**Table 1**).

### 3.3. Changes in ChT during 6-month atropine treatment

Figures of ChT within the  $-3.0\text{ mm}$  to  $+3.0\text{ mm}$  area were plotted from datums automatically measured at  $0.01\text{mm}$  intervals (**Figure 2**), and statistical analysis was conducted using datums of 13 points at  $0.5\text{ mm}$  intervals (**Table 3**). At the 3-month visit, the ChTs barely changed compared with the baseline values. At the 6-month visit, a mild decrease in ChT were noticed in the macular area, but still with no statistical significance ( $p > 0.05$ ). There were also no significant differences in ChTs between subgroups of low and moderate myopic children ( $p > 0.05$ ). According to available researches, the elongation of axis in untreated myopic children and adolescents is  $0.2\text{-}0.4\text{ mm}$  per year. Thus,  $0.15\text{ mm}$  was considered the cut point between slow and fast AL progression<sup>[21, 22]</sup>. Still, no significant differences in ChT were found between these two subgroups (24 in slow group and 67 in fast group,  $p > 0.05$ ).

**Table 3.** ChTs at each measuring point during 6-month 0.01% atropine treatment

Measuring point (mm)	ChT (um)								
	Treatment time		*P value	AL progression		†P value	Baseline Refraction		‡P value
	3 months	6 months		ΔAL ≤ 0.15 mm	ΔAL > 0.15mm		Low	Moderate	
-3.0	166.51 ± 45.07	166.00 ± 47.12	0.14	164.64 ± 55.56	166.24 ± 40.48	0.88	168.18± 47.37	158.76 ± 45.55	0.69
-2.5	182.26 ± 48.64	181.97 ± 50.87	0.27	180.52 ± 61.74	182.09 ± 42.10	0.89	184.34 ± 50.83	174.26 ± 50.27	0.78
-2.0	200.54 ± 51.32	200.47 ± 53.84	0.50	199.54 ± 66.45	200.04 ± 43.48	0.97	203.29 ± 53.65	191.28 ± 53.39	0.81
-1.5	221.43 ± 53.39	221.12 ± 56.19	0.42	220.61 ± 69.52	220.29 ± 45.22	0.98	224.53 ± 56.01	210.57 ± 55.54	0.89
-1.0	243.71 ± 55.17	242.74 ± 58.02	0.23	242.31 ± 71.43	241.67 ± 47.00	0.96	246.23 ± 57.93	231.56 ± 56.92	0.91
-0.5	263.45 ± 56.58	261.65 ± 59.16	0.12	261.02 ± 72.29	260.38 ± 48.26	0.96	264.95 ± 59.31	251.31 ± 57.41	0.65
0	279.33 ± 57.53	276.73 ± 59.50	0.08	275.85 ± 72.11	275.15 ± 48.71	0.96	279.31 ± 60.02	268.37 ± 56.84	0.41
+0.5	289.88 ± 57.82	286.73 ± 58.91	0.09	285.79 ± 70.83	284.67 ± 48.22	0.93	288.42 ± 59.97	281.00 ± 54.80	0.27
+1.0	295.38 ± 57.31	291.98 ± 57.38	0.15	291.36 ± 68.57	289.37 ± 46.95	0.87	292.89 ± 59.06	288.80 ± 51.27	0.32
+1.5	297.34 ± 55.73	294.02 ± 54.95	0.25	294.10 ± 65.31	290.81 ± 45.21	0.78	294.33 ± 57.23	292.76 ± 46.57	0.23
+2.0	297.13 ± 53.21	294.13 ± 52.18	0.40	295.20 ± 61.43	290.32 ± 43.73	0.67	294.11 ± 54.86	294.03 ± 42.04	0.27
+2.5	295.81 ± 50.15	293.25 ± 49.67	0.59	295.54 ± 57.13	288.83 ± 43.28	0.54	293.07 ± 52.41	293.97 ± 39.16	0.30
+3.0	293.37 ± 47.43	291.30 ± 47.92	0.82	295.03 ± 52.85	286.17 ± 44.18	0.40	290.92 ± 50.23	292.89 ± 39.29	0.27

Note: \* Comparison between ChT at baseline at the 6-month visit using paired t-test; † Comparison between slow and rapid elongation eyes at the 6-month visit using the Student t-test; ‡ Comparison between low and moderate myopic children in the study using the Student t-test

## 4. Discussion

In this study, we observed the changes in SE, AL, and ChT in low to moderate myopic children during a 6-month topical use of 0.01% atropine. Both SE and AL increased almost the same rate in the first and second 3 months, indicating that 0.01% atropine did not significantly decrease the progression of myopia in the first 6-month treatment. This corresponded to the findings from the ATOM study and the LAMP study [23, 24], that comparing with moderate concentrations of atropine, longer treatment time (more than 6 months) is required for low concentration atropine to show its effects [5].

In review of all the available studies about the changes in ChT during atropine treatment for myopia, it is found that only the ChT under fovea was measured in almost all the previous studies, and an all-sided knowledge of the changes in ChT of the whole choroid could not be achieved. In this study, a 6mm diameter area around the macular fovea was used and measured the ChT at tiny intervals of 0.01mm. On this account, a profile of choroidal thickness within a relatively large area, covering the shortage of the previous studies to some extent, was achieved.

In the profiles of ChT taken, the choroid showed a constant thickening from nasal to temporal side and tending to be stable from +0.5 mm to +3.0 mm. After the 6-month use of 0.01% atropine, no significant changes in ChT were observed, even when the variables of gender, myopic degree and AL were taken into consideration. In the most measuring area, a mild decrease of ChT was noticed, which contradicts our initial hypothesis that 0.01% atropine may cause choroidal thickening. Similar results have also been found in several other studies, where the ChT significantly decreased after 0.01% atropine treatment, even when prolonging the treatment to 2 years [15, 17]. Meanwhile, higher concentrations of atropine (0.025%, 0.05% and 0.3%) could cause significant choroidal

thickening<sup>[15, 16]</sup>. These findings indicated that the effects of atropine on ChT may be correlated with the drug concentration. However, there are also opposite results found in several studies, showing a significant increase in ChT during 2-month treatment of 0.01% atropine<sup>[25, 26]</sup>. Until now, no definite conclusion about the impact on ChT by 0.01% atropine can be reached yet. The discrepancy may be derived from different measuring method of ChT. An inopportune timing for choroid scanning or manually tracing the choroidal boundary could both lead to significant inaccuracies. In this study, by severely controlling the time quantum for measurement and automatically plotting the choroidal boundary by software, measuring errors could be greatly reduced.

Considering that 0.01% atropine remained equally effective in controlling myopia despite of the various ChT changes in different studies, there is possibility that the changes in ChT might be an incidental or indirect effect of atropine, instead of being the essential pathway to controlling myopia.

There were several limitations in this research. First, a placebo group for comparing the changes in ChT after atropine treatment with that in untreated myopic children was not made during this study. Meanwhile, a 6-month treatment might be too short to induce significant changes in ChT, and further follow-ups are needed.

## 5. Conclusion

This research suggested that in low to moderate myopic children, topical use of 0.01% atropine for 6 months could not cause significant changes in ChT in an area of 3 mm from the temporal side of the fovea to the nasal side.

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## Disclosure statement

The authors declare no conflict of interest.

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# Observation on the Intervention Effect of Emergency Rescue Capability Among College Students

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**Abstract :** *Objective:* To explore the application effect of emergency rescue capability intervention among students in a university in Beijing. *Methods:* A total of 900 students from a university in Beijing in 2023 were selected as the research objects. Emergency rescue capability training was conducted from March 2023 to June 2023, once a month. The students' mastery of emergency rescue before and after the intervention was analyzed. Survey questionnaires were distributed to all college students to understand their channels and willingness to acquire emergency rescue knowledge. *Results:* A total of 886 valid questionnaires were collected in this study. The highest proportion of knowledge about China's general emergency telephone number and how to dial the emergency rescue hotline was 100.00%. Among the strategies for dealing with cardiac arrest in CPR, the highest proportion was 336.34%. Among the four major first aid techniques of hemostasis, bandaging, fixation, transportation, the highest proportion of knowledge about the use of rubber band signs was 31.71%. Among the first aid techniques for heatstroke, poisoning, fire, and sharp instrument injuries, the principle of emergency treatment for severe gas poisoning had the highest proportion of 41.42%, showing significant differences. College students mainly acquire knowledge of emergency rescue capability through TV programs, health education lectures, and the internet. Around 61.40% of college students hope to learn more about prevention and control knowledge. *Conclusion:* After the intervention of emergency rescue capability, the emergency rescue capability of college students in this university has been significantly improved, showing a strong training effect, which is worthy of promotion.

**Keywords:** University; Emergency rescue capability; Emergency rescue capability intervention

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## 1. Introduction

Globally, twenty percent of trauma patients die each year due to the lack of timely rescue at the scene, and the public's on-site emergency response capability in China is low, with very few people possessing this ability<sup>[1]</sup>. Article 43 of the "Emergency Response Law of the People's Republic of China" published on June 28, 2024

stipulates that “emergency education should be included in the curriculum, and emergency knowledge training and drills should be implemented for teachers and students to enhance safety awareness and self-rescue and mutual assistance capabilities.”<sup>[2]</sup>. College students are young, highly educated, and generally have strong cognitive and receptive abilities. They are enthusiastic about participating in public welfare activities. Evaluating the status of emergency rescue knowledge and skills among college students, exploring their needs for emergency rescue knowledge and ways to acquire it is crucial for promoting emergency rescue education in urban areas and enhancing students’ self-rescue and mutual rescue awareness and abilities<sup>[3]</sup>. Therefore, this study conducted an emergency rescue capability intervention among college students in Beijing in 2023 and conducted a questionnaire survey on educational needs. This study aims to develop a health education plan to control the harm caused by emergency events to students in the future.

## **2. Materials and methods**

### **2.1. General information**

Beijing Union University was selected as the research object and 900 freshmen were randomly included. Emergency rescue capability training was conducted in March 2023 and ended in June 2023. A questionnaire survey was conducted before the intervention in March 2023. A total of 900 questionnaires were distributed, and 886 valid questionnaires were collected, with an effective recovery rate of 98.44%. After the emergency rescue capability intervention ended in June 2023, a second questionnaire survey was conducted. A total of 886 questionnaires were distributed, and all 886 were validly recovered, with an effective recovery rate of 100%. Among them, there were 450 males and 436 females, aged between 19 and 20 years old, with an average age of  $(19.76 \pm 0.22)$  years old. The inclusion criteria were: (1) Full-time four-year undergraduate students; (2) Class absenteeism not exceeding 3 times in the previous year; (3) The samples in this study were all voluntary students and medical personnel. The exclusion criteria consists of: (1) Students who are unable to participate in full-time study due to force majeure; (2) Students who did not receive education within the university.

### **2.2. Methods**

#### **2.2.1. Quality control**

This study provided unified training to the responsible personnel and effectively answered any potential questions from their teams or individuals in detail. After the training, a test was required, and only those who completed the test were allowed to proceed with the formal training. Before starting this task, relevant precautions were clearly communicated to the group. It was ensured that each university student had received a detailed explanation of the survey items from the investigator before filling out the questionnaire. The questionnaires were entered into the system after being verified by two or more responsible personnel for accuracy.

#### **2.2.2. Emergency rescue capability training**

The training should cover basic first aid knowledge and corresponding skills, such as cardiopulmonary resuscitation (CPR), hemostasis and bandaging, and add emergency response strategies in specific situations according to actual needs. The training process is divided into two major parts: theoretical research and practical operations. With the help of case analysis, simulation drills, and other methods, trainees’ practical operation skills are improved<sup>[4]</sup>. Secondly, modern technological means are adopted to enhance the interactivity and fun of the

training. For example, using virtual reality to simulate actual combat drills allows trainees to immerse themselves in emergency rescue scenarios, thereby enhancing their crisis awareness and reaction speed in emergency response. With the help of an online learning platform, learning resources are provided anytime and anywhere, increasing the adaptability and convenience of the training. Teamwork and communication skills are emphasized during the training. By simulating multi-party emergency rescue scenarios, trainees' collaborative combat capabilities in a team are honed, aiming to achieve higher overall efficiency in emergency rescue<sup>[5]</sup>. Through role-playing and group discussions, communication and coordination among trainees are enhanced, shaping students' team spirit in emergency rescue.

This study adopts field research methods to collect data, referring to the first aid training standards and CPR guidelines of the Red Cross Society of China, and combining relevant research topics to design a questionnaire. The questionnaire incorporates a survey on the actual rescue abilities of vocational college students by Meng *et al.*<sup>[6]</sup>. The Cronbach's alpha coefficient is 0.772. Additionally, self-designed survey questions are included based on the actual situation, covering basic information of college students (gender, native place, ethnicity, etc.), emergency rescue-related knowledge, channels for acquiring knowledge, willingness to learn new knowledge, and other aspects. The questionnaire was reviewed by experts from the Beijing Center for Disease Control and Prevention, and a pre-test was conducted. After revision and improvement, a formal survey was implemented. All survey personnel underwent unified training. After the survey is completed, a dedicated person will review the questionnaires and enter the data.

Definition of awareness rate: (1) Single knowledge awareness rate = Number of people who correctly answered a certain knowledge item / Number of people who filled out valid questionnaires  $\times 100\%$ ; (2) Total awareness rate =  $\Sigma$  Number of correct knowledge items answered by each survey respondent / (Number of people who filled out valid questionnaires  $\times$  Number of knowledge items)  $\times 100\%$ .

### 2.2.3 Invalid questionnaires

Questionnaire surveys were conducted before and after the intervention. The following questionnaires were excluded: (1) those with a filling time of greater than or equal to 10 minutes; (2) those with illogical and incoherent content; (3) those with missing or omitted information.

## 2.3. Statistical methods

The data obtained from this study was used to establish a database using Epidat 3.1 software, and double-entry was implemented. SPSS 18.0 software was used for statistical analysis. Counting data was tested using the chi-square test, and a  $P$ -value  $< 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Basic information

Through the questionnaire survey, the study obtained a total of 886 valid questionnaires, with an effective recovery rate of 98.44% (886/900). Among them, male and female college students accounted for 50.79% and 49.20%, respectively. The largest number of respondents were aged between 21 and 22 years old. There were more Han Chinese college students, and the proportion of urban residents was the largest. The number of college students living with a partner or being single was the highest. The monthly income of college students was mostly between

5,000 and 8,000 yuan, as shown in **Table 1**.

**Table 1.** Basic information of college students [n(%)]

Basic information	Number of cases
Gender	
Male	450(50.79)
Female	436(49.20)
Age	
Under 20 years old	179(20.20)
19–20 years old	186(20.99)
21–22 years old	496(55.98)
23–24 years old	25(2.82)
Ethnicity	
Han nationality	791(89.27)
Ethnic minorities	95(10.72)
Place of residence	
City	596(67.28)
Township	198(22.34)
Rural area	92(10.38)
Monthly household income	
5000 yuan	177(19.97)
5000–8000 yuan	298(33.63)
9000–15000 yuan	223(25.17)
Over 15000 yuan	188(21.21)

### 3.2. Emergency rescue-related knowledge

After conducting two questionnaire surveys, a total of 1,772 valid questionnaires were obtained, with an effective recovery rate of 100.00% (1772/1772). Among the emergency rescue knowledge after intervention, the awareness of China's general emergency phone number and how to dial the emergency rescue hotline accounted for the highest proportion, which was 100.00%. The highest level of knowledge was about cardiac arrest handling strategies in cardiopulmonary resuscitation, with a percentage of 36.34%. Among the four major emergency techniques of hemostasis, bandaging, fixation, and transportation, the use of rubber band markers was the highest, accounting for 31.71%. Among emergency techniques for heatstroke, poisoning, fire, and sharp instrument injuries, the principles of emergency treatment for severe gas poisoning were the most known, accounting for 41.42%, which was statistically significant ( $P < 0.05$ ). There were no significant differences in knowledge about China's general emergency phone number, how to accurately dial the emergency rescue hotline, and the safe transfer steps for patients with neck injuries ( $P > 0.05$ ), as shown in **Table 2**.



**Table 2.** Emergency rescue-related knowledge [n(%)]

Category	Before Intervention	After Intervention	$\chi^2$	<i>P</i>
First aid knowledge				
China's general emergency phone number	886(100.00)	886(100.00)		
How to accurately dial the emergency rescue hotline	886(100.00)	886(100.00)		
Proper handling of burns	234(26.41)	698(78.78)	487.310	< 0.001
Rescue measures for drowning	218(24.60)	654(73.81)	429.218	< 0.001
Escape strategy during earthquakes	189(21.33)	476(53.72)	198.271	< 0.001
Cardiopulmonary resuscitation (CPR)				
Cardiac arrest handling strategies	211(23.81)	322(36.34)	33.061	< 0.001
Consciousness assessment methods	187(21.11)	278(31.37)	24.144	< 0.001
Key points of opening the respiratory tract operation	98(11.06)	192(21.67)	36.431	< 0.001
External chest compression positioning	87(9.82)	176(19.86)	35.367	< 0.001
External chest compression frequency	82(9.25)	128(14.44)	11.431	< 0.001
Four major first aid techniques: hemostasis, bandaging, fixation, and transportation				
Standard use of rubber bands	176(19.86)	281(31.71)	32.509	< 0.001
Emergency response measures for major trauma and bleeding	155(17.49)	197(22.23)	6.254	< 0.001
Bandaging techniques	143(16.13)	196(22.12)	10.246	< 0.001
On-site protection techniques for fracture injuries	123(13.88)	179(20.20)	12.517	< 0.001
Safe transfer steps for patients with neck injuries	111(12.53)	121(13.66)	0.496	0.481
First aid techniques for heatstroke, poisoning, fire, and sharp instrument injuries				
Emergency guide for gas poisoning	123(13.88)	367(41.42)	167.942	< 0.001
Emergency treatment principles for sharp instrument wounds	121(13.65)	346(39.05)	147.198	< 0.001
Treatment plan for foreign body blocking the respiratory tract	98(11.06)	265(29.90)	96.623	< 0.001
Emergency rescue steps for fires	97(10.94)	254(28.67)	87.571	< 0.001
Treatment strategies for food poisoning	76(8.57)	128(14.44)	14.979	< 0.001

### 3.3. Channels for acquiring knowledge

Among the channels for acquiring knowledge, watching TV programs was the most popular, accounting for 98.42%, followed by health education, accounting for 66.25%. Other channels included searching online, graphic promotional materials, audio and video products, and plain text materials, as shown in **Table 3**.

**Table 3.** Channels for acquiring knowledge [n(%)]

Category	Number of cases
Watching TV programs	872(98.42)
Health education	587(66.25)
Searching online	423(47.74)
Graphic promotional materials	379(42.77)
Audio and video products	294(33.18)
Plain text materials	129(14.55)

### 3.4. Willingness to learn new knowledge

There were 544 cases (61.40%) who were very willing to continue learning new knowledge, 212 cases (23.93%) who were generally willing, 111 cases (12.53%) who were indifferent, and 19 cases (2.14%) who were not willing to continue learning new knowledge.

## 4. Discussion

The overall level of emergency rescue is considered as one of the important indicators reflecting social progress and the quality of city life. Multiple research results have shown that the current level of emergency rescue knowledge among college students in responding to emergencies is still inadequate, and their self-rescue and mutual rescue skills are lacking. Colleges and universities are emergency systems and linkage mechanisms prone to various safety accidents. They enhance students' professional literacy and emergency skills, reasonably organize training for students, promote departmental collaboration and social participation, and enhance students' self-rescue and emergency response capabilities. Through professional and systematic emergency rescue knowledge training, students are effectively encouraged to pay more attention to personal safety, actively participate in rescue skill training, and comprehensively improve their comprehensive literacy and emergency response capabilities.

In this study, among the relevant knowledge of emergency rescue after intervention, the awareness of China's general emergency phone number accounted for the highest proportion of 100.00% in first aid general knowledge, and the highest level of knowledge was about cardiac arrest handling strategies in cardiopulmonary resuscitation, with a percentage of 36.34%. To master cardiopulmonary resuscitation, it is necessary to deeply understand its relevant theoretical knowledge and proficiency in specific operation steps. However, for college students, there are limited opportunities for practical practice of cardiopulmonary resuscitation in their daily lives, and it is difficult to effectively improve their operational proficiency in a wide range with only one or two training and promotional activities. Among the four major emergency techniques of hemostasis, bandaging, fixation, and transportation, the use of rubber band markers accounted for the highest proportion of 31.71%. Trauma rescue includes hemostasis, bandaging, fixation, and transportation. These skills are relatively common in daily life, and the operation steps are relatively simple. Through systematic training, continuous practice, and continuous consolidation in daily life, college students can master these skills. Among the emergency techniques for heatstroke, poisoning, fire, and sharp instrument injuries, the principles of emergency treatment for severe gas poisoning accounted for the highest proportion of 41.42%, which was statistically significant ( $P < 0.05$ ). This is similar to the research results of Lu *et al.* [7].

After intervention, the relevant knowledge of emergency rescue among college students has been improved, but some of them have relatively low mastery of professional knowledge, suggesting that students have fewer opportunities to expose to professional rescue knowledge and have not received systematic and standardized emergency training. Among the channels for acquiring knowledge, watching TV programs is the most popular, followed by health education. Other channels include searching online, graphic promotional materials, audio and video products, and plain text materials. From the survey feedback, most students mainly acquire emergency rescue knowledge through television, the internet, and books. This is similar to the research results of Zhu *et al.* targeting college students [8]. The proportion of students who are very willing to continue learning new knowledge accounts for 61.40%, indicating that a large number of college students show a urgent desire to learn emergency rescue knowledge and a positive learning attitude after intervention training, and have a high demand for health

education.

With the growth of the internet, the emergence of various related software and websites has broadened the ways for students to learn about emergency rescue. Therefore, it is necessary to follow the trend of communication integration, deeply integrate emergency rescue with cultural communication, explore innovation, and build a communication matrix for students to acquire knowledge<sup>[9]</sup>. At the same time, measures such as conducting emergency rescue training activities, introducing self-evaluation and peer evaluation mechanisms, and establishing long-term tracking mechanisms can effectively improve students' learning strategies for emergency rescue<sup>[10]</sup>.

## 5. Conclusion

In summary, through the intervention of emergency rescue capabilities, colleges and universities have significantly enhanced their awareness of emergency rescue, knowledge acquisition channels, and rescue capabilities. At the same time, this intervention has stimulated students' enthusiasm for emergency knowledge, enhanced the skills and confidence of applied college students in emergency rescue in the face of emergencies, and achieved excellent training results, which is worthy of recommendation and popularization. This study still has the following limitations. The scope of the questionnaire survey used in the study is limited, and it fails to fully investigate the comprehensive aspects of college students. Therefore, further research is needed on the health science popularization needs of people of different age groups.

## Disclosure statement

The author declares no conflict of interest.

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# Development of a Disposable Care Package for PICC Disinfection in Postoperative Clinical Surgical Patients

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**Abstract:** *Objective:* To design a disposable care package for postoperative PICC disinfection for the daily maintenance of postoperative indwelling PICC catheter patients, save the operation time of nurses, reduce the operation difficulty of nurses, increase patient comfort and improve patient satisfaction. *Methods:* The items required for the routine maintenance of PICC catheter shall be packaged separately in a sterile manner, and all items shall be packaged as disposable care package for the maintenance of PICC catheter. *Results:* The use of a special PICC disinfection disposable care package, inside all the items after strict sterile treatment, simple and convenient, save time and effort. *Conclusion:* PICC disinfection disposable care package can reduce the operation difficulty of medical staff, shorten the operation time, increase patient comfort, and facilitate the use of medical staff.

**Keywords:** Postoperative patient; PICC; Nursing; Aseptic technique

**Online publication:** April 28, 2025

## 1. Introduction

At present, many clinical diseases can be solved by arteriovenous puncture, such as upper limb venography and PICC catheterization. The full of PICC catheter is the peripheral vein catheterization to the central vein <sup>[1]</sup>. Catheterization technology is widely used in clinical due to the advantages of easy operation, safety, soft catheter, easy patient movement and easy fixation of, reducing the pain of repeated puncture, reducing vascular stimulation, and less complications <sup>[2, 3]</sup>. However, the disinfection of postoperative puncture points and the maintenance of PICC pipes are particularly important <sup>[4]</sup>. Its widely used in clinical department, has a simple operation, avoid repeated puncture, use safety advantages, but with complications often occur, infection is one of the most common complications, not only to the patient and family brought the physical and economic double pressure, also make the operator nervous, a simple and effective PICC disinfection disposable care package is particularly important <sup>[5, 6]</sup>.



Surgical patients often retain their postoperative PICC catheters in the ward, but there is no dedicated PICC maintenance care package available. In clinical practice, nursing staff must routinely prepare alcohol, iodine, sterile cotton swabs, and stickers. These items are typically scattered across different locations, and each time they are needed, staff must spend time gathering them. This process can be time-consuming and sometimes leads to the omission of certain items <sup>[7]</sup>. This increases the operational difficulty for medical staff and contributes to heightened patient anxiety.

In order to ensure the best disinfection and maintenance effect, a new type of PICC disinfection disposable care package has been designed in this study, which can effectively solve the above problems.

## **2. Materials and methods**

### **2.1. Materials**

The outer packaging of the disinfection bag is made from PVC material. The disinfection bag primarily consists of five parts: sterile gloves, iodine cotton balls, alcohol cotton balls, film, and tweezers. When disinfecting the catheter, a square package is used. The inner wall of the square package is connected to a rotating column, and the side wall of the rotating column is equipped with disinfection components. These disinfection components are used for disinfecting the catheter. The inner wall of the square package is also fitted with export components, which facilitate the removal of the catheter from the square package.

Additionally, the disinfection assembly includes a partition that is fixed to the inner wall of the square package. The square package, located on either side of the partition, contains a disinfection chamber and a storage chamber. Inside the storage chamber, an airbag is fixed to the inner wall of the square package. The inner wall of the storage chamber is also connected to elastic components, with the end of the elastic assembly fixed to a baffle. This baffle is positioned against the partition's inner wall and serves to separate the disinfection chamber from the liquid storage chamber <sup>[8]</sup>. The sidewall of the airbag within the square package, as well as the elastic assembly, includes a first sleeve. The first sleeve is fixed to the inner wall of the square package and is connected to a first sliding column and a first sliding cylinder. The first sliding cylinder is linked to the first sleeve by a fixed spring, providing an elastic mechanism <sup>[9]</sup>.

The export assembly features a second sleeve, which is mounted on both sides of the top wall of the square package. The inner wall of the second sleeve is connected to a threaded column. This threaded column passes through the bottom end of the square package, with a top plate fixed to a connecting block. The catheter is connected to the connecting block, which interfaces with both the input and output ports. The output port is wound in the opposite direction to the side wall of the rotating column <sup>[10]</sup>.

The square package side wall is provided with a square mouth, the outer side of the square mouth is fixed connected with a first connecting plate, the square package side wall above the first connecting plate has the top of the second connecting plate, the second sliding plate has a sliding pad, the second sliding column and the second sliding plate with a rotating plate, the top of the square mouth is provided with a protective cover, the square package is provided as a transparent material.

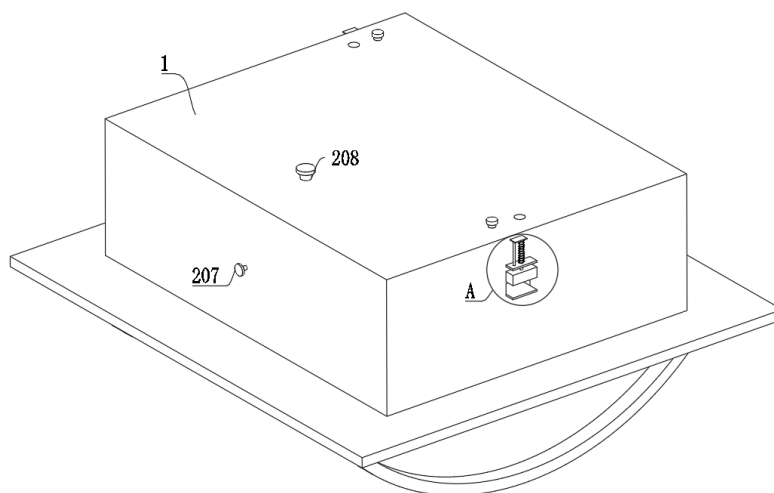
### **2.2. Methods**

To begin, open the PICC disinfection disposable care kit and put on sterile rubber gloves. Start by disinfecting the skin around the catheter insertion site, followed by using an alcohol cotton ball to clean the puncture point. Once

this is done, secure the catheter with a protective film. During the catheterization process, regularly monitor the skin around the insertion site and carefully observe and document any signs of blood infiltration at the puncture point.

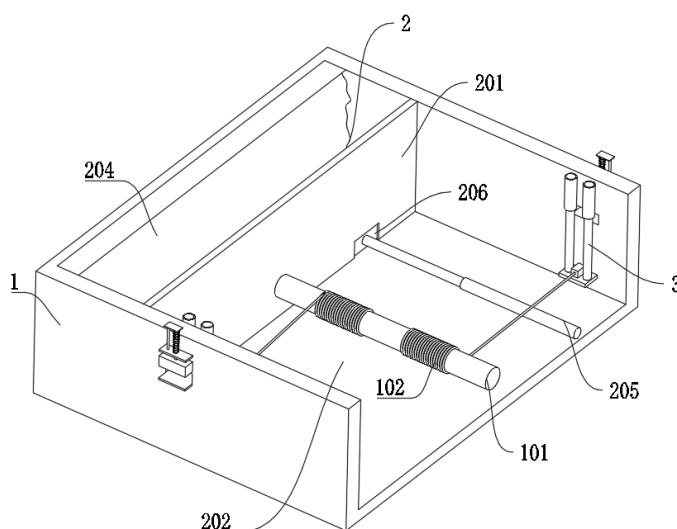
When disinfecting the catheter, rotate the rotating plate to move it away from the limit column. This action causes the second spring's elastic force to drive the second sliding column, which in turn moves the sponge pad downward. The sponge pad will then gently press against the top of the first connecting plate, allowing it to clean any remaining disinfectant from the catheter's side walls

Attached below is **Figure 1**, which is a structural diagram of the utility model device.



**Figure 1.** A structural diagram of the utility model device.

The technical scheme of the utility model embodiment will be described in detail below, with reference to the accompanying drawings. It is important to note that the described embodiment represents only one example of the utility model, rather than all possible embodiments. Based on the embodiments of the utility model, any other variations or embodiments that can be derived by those skilled in the art, without inventive effort, will fall within the scope of the utility model's protection. **Figure 2** shows the local amplification structure of point A in **Figure 1**.

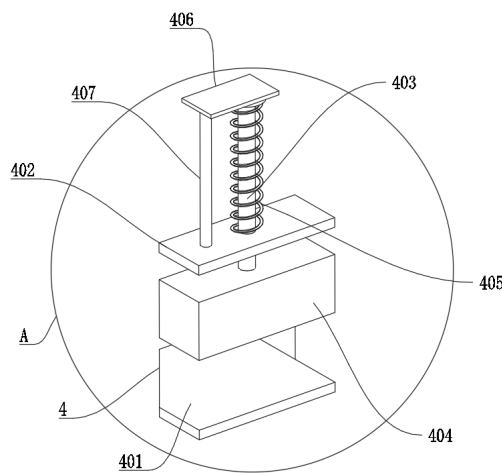


**Figure 2.** The local amplification structure of point A.

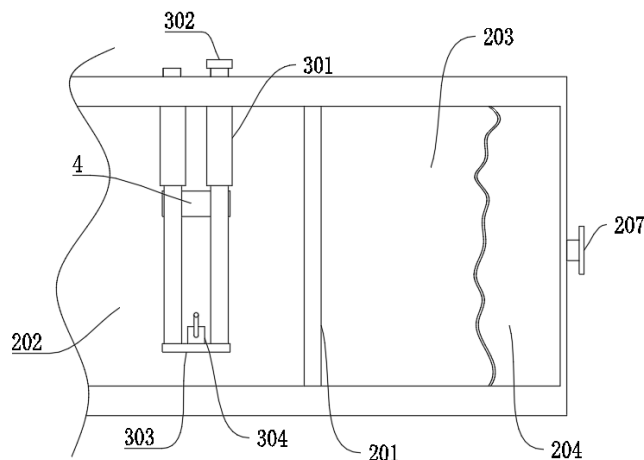
Referring to **Figure 2** above, a disposable care package for PICC disinfection is provided, consisting of a square bag (1). The inner wall of the square bag (1) is connected to a rotating column (101), which is wrapped with a catheter (102). The square bag's inner wall also houses a disinfection component (2), which is designed to disinfect the catheter (102). Additionally, the square bag's inner wall is equipped with an export assembly (3), which serves to guide the catheter (102) out of the square bag (1).

The disinfection component (2) includes a partition (201), which is fixed to the inner wall of the square bag (1). The square bag (1) is divided by the partition (201) into a disinfection chamber (202) and a storage chamber (203). The storage chamber (203) is connected to an air chamber (204) and is equipped with an elastic assembly (205). The elastic assembly (205) includes a baffle (206), which, along with the partition (201), helps separate the disinfection chamber (202) from the storage chamber (203).

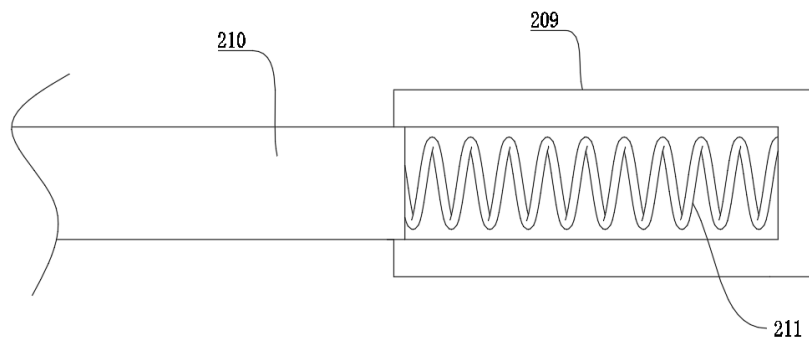
Next, **Figure 3** below is a schematic diagram of the partial section structure of the utility model device and **Figure 4** is a schematic diagram of the utility model device (forward section). **Figure 5** is a schematic diagram of the elastic component of the utility model (schematic).



**Figure 3.** Schematic diagram of the partial section structure of the utility model.



**Figure 4.** A schematic diagram of the utility model device (forward section).



**Figure 5.** A schematic diagram of the elastic component of the utility model (schematic).

Based on **Figure 1–5**, the side wall of the outer airbag (204) within the square package (1) is fixed with an air inlet (207), and the top of the square package (1) is equipped with an inlet (208). The elastic assembly (205) includes a first sleeve (209) fixed to the inner wall of the square package (1). The first sleeve (209) is connected to a first sliding column (210), which is fixed to the baffle (206). A first spring (211) is placed between the first sliding column (210) and the first sleeve (209).

To use the catheter (102), disinfectant is filled into the reservoir chamber (203) through the inlet (208). When sterilizing the catheter, the airbag (204) can be inflated through the air inlet (207). This inflates the airbag within the reservoir chamber (203), increasing the pressure inside the chamber. As a result, the first sliding column (210) moves the baffle (206) away from the partition (201), allowing the inner cavity of the first sleeve (209) to connect the disinfection chamber (202) and the reservoir chamber (203). This connection causes the disinfectant from the reservoir chamber (203) to flow into the disinfection chamber (202), effectively disinfecting the catheter (102) wrapped around the rotating column (101).

Referring to **Figure 1–4**, the export assembly (3) includes a second sleeve (301), which is mounted on both sides of the inner top wall of the square bag (1). The second sleeve (301) is equipped with a threaded column (302), and the bottom end of the threaded column (302) is connected to a connecting plate (303). The connecting block (304) passes through the connecting plate (303) and the output port, which is positioned opposite to the side wall of the rotating column (101).

After disinfection, turning the threaded column (302) causes it to slide onto the connecting plate (303), which in turn moves the connecting block (304) along the end of the catheter (102). This action pulls the catheter (102) out of the square bag (1). To prevent the catheter from extending too far outside the square bag (1), the rotating column (101) is tightened by rotating it, effectively controlling the length of the catheter (102) outside the square bag.

Referring to **Figures 1–5**, the side wall of the square package (1) features a square port (4). Outside the square port (4), the side wall of the square package (1) is fixed with a first connecting plate (401), and above this, the side wall is connected to a second connecting plate (402). A second sliding column (403) is attached to the top of the second connecting plate (402), and a sponge pad (404) is mounted on the second sliding column (403). The second sliding column (403) works with the second connecting plate (402) and a limit column (407), with a protective cover surrounding the square port (4). The square package (1) is made of transparent material.

It is important to note that when the catheter (102) is pulled out from the square port (4), the rotating plate (406) is turned away from the limit column (407). Due to the elastic force of the second spring (405), the second sliding

column (403) moves downward, causing the sponge pad (404) to press against the top of the first connecting plate (401). The sponge pad (404) then cleans any remaining disinfectant on the side wall of the catheter (102). The transparent material of the square package (1) allows for clear visibility of the situation inside.

The operation begins by filling the disinfectant into the storage chamber (203) through the inlet (208). Before using the catheter (102) for sterilization, the airbag (204) is inflated via the air inlet (207), causing the airbag to expand within the reservoir chamber (203) and increase the pressure inside. This pressure causes the first sliding column (210) to move the baffle (206) away from the partition (201), connecting the disinfection chamber (202) to the reservoir chamber (203). As a result, the disinfectant in the reservoir chamber (203) flows into the disinfection chamber (202), disinfecting the catheter (102) wrapped around the sidewall of the rotating column (101). After disinfection, the threaded column (302) is rotated, making it slide along the support plate (303) and driving the connection block (304), which pulls the catheter (102) away from the limit plate (406) by rotating the rotating plate (406). Meanwhile, the second sliding column (403) moves downward, causing the sponge pad (404) to press against the top of the first connecting plate (401), cleaning any residual disinfectant from the catheter's sidewall.

### 3. Advantages

(1) Easy to operate and easy to use

The device offers a simple and reliable solution for clinical operations, ensuring safety and efficiency. It effectively addresses issues such as unprofessional PICC disinfection, incomplete supplies, and the inconvenience of traditional disinfection methods. Designed for ease of use, the device allows a single medical staff member to efficiently prepare all necessary items, saving time and effort during disinfection. This improvement in work efficiency helps reduce resource waste. Additionally, the device's convenient daily maintenance enhances patient comfort. With its compact size, it also helps lower medical costs for patients, contributing to increased satisfaction for both patients and their families.

(2) The material is simple and safe, and the device is practical and reliable

The product is made from non-toxic, tasteless polyethylene polymer material, ensuring no irritation to the patient's skin or respiratory system. It is cost-effective and offers significant advantages over traditional sterile items, particularly in reducing postoperative allergies and enhancing patient comfort. This makes it ideal for widespread use in clinical settings. Additionally, the device features a compact, reasonable design with a simple structure, offering the benefit of easy disinfection and eliminating the complexities of traditional disinfection processes. As a result, it helps reduce the infection rate, further improving patient safety.

### 4. Conclusion

The PICC Disinfection Disposable Care Package significantly enhances clinical efficiency and patient care by streamlining the disinfection and maintenance process for peripherally inserted central catheters (PICCs). This all-in-one kit reduces the operational difficulty for healthcare professionals by providing pre-packaged, standardized components, eliminating the need for time-consuming manual preparation. As a result, it shortens procedural time, allowing medical staff to focus more on patient assessment and care rather than logistical setup.

Additionally, the disposable care package improves patient comfort by ensuring consistent, aseptic techniques, minimizing infection risks, and reducing skin irritation through high-quality, hypoallergenic materials.



Its user-friendly design facilitates quick and hassle-free application, making it convenient for nurses and clinicians to perform PICC line maintenance with precision and confidence.

## Disclosure statement

The authors declare no conflict of interest.

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# Exploration on the Chemical Constituents and Pharmacological Effects of Korla Fragrant Pears

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**Abstract:** Korla fragrant pears are one of the “famous, excellent, and special” fruits in Xinjiang. They belong to the white pear variety in the genus *Pyrus* of the Rosaceae family. With a long-standing planting history and strong regional characteristics, they are mainly produced in southern Xinjiang. Due to unique natural conditions such as large temperature differences between day and night and sufficient sunlight, Korla fragrant pears have a crispy texture, a sweet but not cloying taste, and their flesh is delicate and juicy, with excellent quality. Korla fragrant pears contain a variety of bioactive substances, mainly including polysaccharides, polyphenolic compounds, flavonoid compounds, triterpenoids, and sterols. They have medical effects such as “moistening the lungs, calming the heart, reducing phlegm, anti-inflammation, relieving cough, and resolving carbuncle toxins”. Uyghur and Mongolian medicine often use them as a good dietary therapy product. Based on recent literature reports, this paper reviews the main chemical constituents and pharmacological effects of Korla fragrant pears, aiming to provide references for the research and utilization of the deep processing of Korla fragrant pears.

**Keywords:** Korla fragrant pears; Chemical constituents; Antioxidation; Immunomodulation; Pharmacological effects

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## 1. Introduction

Korla fragrant pears are representative varieties of the Xinjiang pear system, mainly distributed in southern Xinjiang. In recent years, research has shown that their fruits contain a variety of active ingredients, including polysaccharides, polyphenolic compounds, flavonoid compounds, triterpenoids, and sterols<sup>[1,2]</sup>. Domestic research mainly focuses on the pharmacological effects, content determination, and extraction processes of components such as polysaccharides, while foreign research mostly pays attention to the compositional analysis of soluble solids in fragrant pear flowers and fruits<sup>[3]</sup>.

Korla fragrant pears have the effects of nourishing Yin and moistening the lungs, relieving fatigue and improving intelligence, protecting the liver, and improving eyesight. They are a natural green food. Modern

research shows that they have significant effects in reducing cholesterol, preventing atherosclerosis, reducing oxidative damage, delaying aging, and enhancing immunity<sup>[4]</sup>. Given their unique nutritional and medicinal values, Korla fragrant pears have become an ideal raw material for the development of functional foods. Researchers have explored deep-processing technologies for them and developed functional foods with specific health-care functions, providing scientific basis and practical support for promoting the research of Korla fragrant pears in the field of food-medicine homology and their application in the health field.

## 2. Research progress on the chemical constituents of Korla fragrant pears

In recent years, systematic research on the chemical constituents of Korla fragrant pears has shown that their main active ingredients include polyphenols, polysaccharides, triterpenoids, and sterols. At the same time, they also contain a variety of nutrients such as volatiles, esters, vitamins, amino acids, and minerals. These components not only endow Korla fragrant pears with unique flavors and nutritional values but also provide a scientific basis for their food-medicine dual-use functions.

### (1) Polyphenols

Polyphenolic compounds are a class of secondary metabolites rich in Korla fragrant pears, mainly including phenolic acids, flavonoids, tannins, lignans, and coumarins<sup>[3, 5]</sup>. Among them, flavonoid compounds such as quercetin, kaempferol, and their glycoside derivatives are important active ingredients in Korla fragrant pears, with a total flavonoid content of 0.5–1.2mg/g (fresh weight). Research shows that phenolic acid compounds are not only closely related to the sensory characteristics of fruits such as color, flavor, and texture but also have significant antioxidant, anti-inflammatory, and anti-cancer activities<sup>[6, 7]</sup>.

### (2) Polysaccharides

Polysaccharides are important functional components in Korla fragrant pears, mainly composed of pectin, cellulose, hemicellulose, and starch, with a molecular weight range of 10–200kDa. Research shows that Korla fragrant pear polysaccharides are mainly pectin-type polysaccharides and arabinogalactans. They have significant immunomodulatory effects, can promote intestinal health, and may play a prebiotic function by regulating the gut microbiota. In addition, polysaccharide compounds also exhibit antioxidant and anti-tumor activities, providing theoretical support for the development of functional foods.

### (3) Terpenoids and sterols

Terpenoid compounds are important active ingredients in Korla fragrant pears, mainly including monoterpenoids, sesquiterpenoids, diterpenoids, and triterpenoid derivatives. These components have anti-inflammatory, antibacterial, and anti-tumor cell proliferation activities. In addition, Korla fragrant pears are rich in  $\beta$ -sitosterol, a sterol compound widely distributed in the plant kingdom. It can regulate cholesterol metabolism and play a lipid-lowering function, providing potential application value for the prevention of cardiovascular diseases.

### (4) Vitamins and minerals

Korla fragrant pears are rich in a variety of vitamins and minerals, which are the core of their nutritional value. The vitamin C content is prominent (about 5–8mg/100g), and they also contain B-group vitamins (B1, B2) and a small amount of vitamin E. In terms of minerals, Korla fragrant pears are rich in potassium (120–150mg/100g), calcium, magnesium, iron, and other elements. Potassium plays an important role in regulating blood pressure and maintaining electrolyte balance. It is worth noting that due to the selenium-

rich soil in the Xinjiang production area, the selenium content of Korla fragrant pears in this area is significantly higher than that in other production areas, further enhancing their nutritional value and health-care functions.

#### (5) Other components

The unique aroma of Korla fragrant pears comes from esters (such as ethyl acetate), aldehydes (such as hexanal), and terpenoid compounds. Yuan L *et al.* analyzed the mature fruits of 10 pear varieties from 5 species and identified 18 primary metabolites and 144 volatiles. The results showed that Korla fragrant pears had the richest content of volatiles and esters<sup>[8]</sup>. In addition, Korla fragrant pears also contain 17 amino acids, with high contents of glutamic acid and aspartic acid. The proportion of umami-tasting amino acids is about 40%, which contributes significantly to the formation of their flavor characteristics.

### 3. Research progress on the pharmacological effects of Korla fragrant pears

#### 3.1. Antioxidant effect

Korla fragrant pears are rich in a variety of antioxidant components, including polyphenols, flavonoids, and polysaccharides. These components have a strong scavenging ability against superoxide anion radicals, hydroxyl radicals, DPPH radicals, etc. Flavonoid compounds can not only reduce the generation of free radicals by chelating metal ions but also directly scavenge free radicals, thus exerting an antioxidant effect. Polyphenolic substances can provide hydrogen atoms to combine with free radicals due to the multiple phenolic hydroxyl groups in their molecular structure, stabilizing the free radicals and interrupting the oxidative chain reaction.

Research shows that the neutral polysaccharides PSNP-1 and PSNP-2 in Korla fragrant pears have significant antioxidant activities<sup>[8]</sup>. Their mechanism of action may be related to regulating the expression levels of proteins related to the TLR4/NF- $\kappa$ B signaling pathway, thereby inhibiting the production and release of inflammatory factors. Among them, the antioxidant activity of PSNP-1 is better than that of PSNP-2, which may be related to its larger molecular weight and more effective groups. Natural plant polysaccharides have become ideal raw materials for the development of functional foods and drugs due to their high activity and low side effects. Therefore, the neutral polysaccharides PSNP-1 and PSNP-2 of Korla fragrant pears are expected to be used as low-toxicity and high-efficiency antioxidant components in the development of health products or in combination with other drugs to improve the quality of life of patients. Zhou *et al.* evaluated the scavenging abilities of Korla fragrant pear polysaccharide components (PSNP-1, PSNP-2, PSAP-1, and PSAP-2) against DPPH radicals, hydroxyl radicals, superoxide radicals, and ABTS<sup>+</sup> radicals. The results showed that although their scavenging abilities were lower than those of vitamin C at the same concentration, Korla fragrant pear polysaccharides still exhibited good antioxidant activities overall<sup>[9]</sup>.

The scavenging rates of total polyphenols in the peel, pulp, exocarp, and core of Korla fragrant pears against DPPH radicals are 85%, 60%, 67%, and 72% respectively. The antioxidant ability of the peel is the strongest (with the lowest IC<sub>50</sub> value), indicating that the peel of Korla fragrant pears is an important source of antioxidant active ingredients<sup>[10]</sup>.

#### 3.2. Immunomodulatory effect

Components such as polysaccharides in Korla fragrant pears can significantly stimulate the proliferation of RAW264.7 macrophages and enhance the phagocytic ability of macrophages, thus more effectively

clearing foreign substances such as pathogens. Wu *et al.* confirmed the enhancing effect of polysaccharides on the phagocytic ability of mononuclear macrophages in immune organs by studying the effects of crude polysaccharides from Korla fragrant pears on serum immune factors in immunosuppressed mice, indicating that they have significant immunomodulatory functions<sup>[11]</sup>.

In terms of the immunological effects of cytokines, the crude polysaccharides of Korla fragrant pears can regulate the levels of T-lymphocyte subsets and enhance the mechanisms of IL-2 and IFN-1, showing good immune-enhancing effects<sup>[12]</sup>.

### 3.3. Expectorant and antitussive effects

Sputum is a mixture of mucus secreted by the glands and goblet cells of the trachea and bronchi and the fluid, electrolytes, and antibacterial substances secreted by the submucosal glands of the airway mucosa. This mucus can adsorb pathogens in the airway and be discharged from the body through ciliary movement, thus playing a role in protecting the respiratory tract.

By establishing a cough mouse model, it was found that the crude polysaccharides of Korla fragrant pears could significantly increase the excretion of phenol red in the trachea of mice, indicating their expectorant effect. Compared with the blank control group, the three dose groups of the crude polysaccharides of Korla fragrant pears could significantly reduce the number of coughs in mice ( $P < 0.05$ ), and the effect of the high-dose group was equivalent to that of the positive control group. In addition, Korla fragrant pear polysaccharides also showed significant antitussive effects on cough models induced by concentrated ammonia water and sulfur dioxide, further confirming their potential in the treatment of respiratory diseases<sup>[13]</sup>.

### 3.4. Anti-inflammatory effect

Korla fragrant pear polysaccharides can inhibit the expression of cell-pyroptosis-related genes such as IL-1 $\beta$  and IL-18 and proteins such as NLRP3 and GSDMD, exerting an anti-inflammatory effect. In addition, they can also intervene in the TLR4/NF- $\kappa$ B signaling pathway to inhibit cell pyroptosis, thereby improving airway inflammation in allergic asthma mice.

Research has found that Korla fragrant pear polysaccharides can significantly inhibit the inflammatory response in the cell-pyroptosis model of RAW264.7 cells induced by lipopolysaccharide (LPS) and adenosine triphosphate (ATP). Compared with the model group, the cell proliferation rate of the drug-intervention group was significantly increased ( $P < 0.01$ ), indicating that Korla fragrant pear polysaccharides can enhance the immune-protective ability of cells, inhibit the expression of GSDMD proteins and genes, and thus reduce cell swelling death and the release of inflammatory factors<sup>[14]</sup>.

In addition, flavonoid compounds in Korla fragrant pears can reduce oxidative stress by scavenging free radicals, thereby reducing the production of inflammatory factors. They can also inhibit inflammation-related enzymes such as COX and reduce the synthesis of inflammatory mediators such as prostaglandins. For example, flavonoids such as rutin can effectively reduce the inflammatory response<sup>[15]</sup>.

## 3. Conclusions and prospects

As a typical representative of “food-medicine homology”, Korla fragrant pears have a scientific basis for their traditional edible value due to their rich chemical constituents and diverse pharmacological activities. At the



same time, they also lay a foundation for the development of new functional foods and natural drugs. In recent years, with the continuous in-depth research on Korla fragrant pears, their pharmacological effects in antioxidant, immunomodulation, anti-inflammation, expectorant, and antitussive aspects have gradually been revealed, showing broad application prospects in the health field.

However, although some progress has been made in existing research, there are still many mysteries in the pharmacological mechanism of Korla fragrant pears. For example, the mechanisms of action of their potential anti-cancer and anti-tumor effects have not been fully elucidated, and the “component-efficacy-mechanism” relationship between active ingredients and biological effects remains in a “black box” state. In addition, the synergistic mechanism of multiple active ingredients (such as polysaccharides, polyphenols, flavonoid compounds, etc.) in Korla fragrant pears and their metabolic pathways in the human body remain to be further explored.

In summary, the research on Korla fragrant pears not only has important scientific significance but also has significant economic value and social benefits. Through the in-depth integration of interdisciplinary research (such as food science, pharmacology, molecular biology, etc.) and technological innovation, it is expected to make breakthroughs in the following aspects in the future:

- (1) In-depth analysis of the pharmacological mechanism: Clarify the action targets and molecular pathways of the active ingredients of Korla fragrant pears, providing a theoretical basis for their pharmacodynamics.
- (2) Development and optimization of functional products: Develop functional foods or natural drugs with specific functions such as antioxidant, immunomodulation, and anti-inflammation based on their active ingredients.
- (3) Industrial application and promotion: promote the transformation of Korla fragrant pears from basic research to industrialization, realize the high-value utilization of Xinjiang's characteristic resources, and contribute to the sustainable development of the regional economy.

These research results will not only provide new solutions for human health but also inject new vitality into rural revitalization and regional economic development, with far-reaching social significance and application prospects.

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# Integrating Ideological and Political Education into the Pathogen Biology Curriculum: Promoting the All-Round Development of Nursing Students through Diversified Teaching

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**Abstract:** In order to better implement the “Three-Dimensional Education” and cultivate high-quality nursing talents, the integration of ideological and political education into the pathogen biology curriculum promotes curriculum reform and application. This article explores the use of various teaching methods and means in the teaching process of pathogen biology under the guidance of ideological and political education, aiming to stimulate students’ learning interest, cultivate their autonomous learning ability, independent thinking, problem-analyzing and problem-solving abilities, and thus improve their comprehensive qualities and medical professional literacy.

**Keywords:** Pathogen biology; Curriculum-based ideological and political education; Diversified teaching; Comprehensive quality

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## 1. Introduction

Pathogen biology is a basic compulsory course for various majors in medical colleges. It integrates multiple courses and covers knowledge about the morphology, epidemiology, pathogenesis, prevention, and treatment of pathogens. The knowledge points are complex, and the curriculum has a high degree of integration, with strong theoretical, practical, and applied characteristics. In the traditional teaching mode, students have a poor overall understanding of pathogens, lacking logic, innovation, and high-order thinking. At the same time, they cannot understand the formulation of personal and national epidemic prevention policies for corresponding diseases.

To solve these problems, it is necessary to adopt innovative interactive teaching methods to stimulate students’ learning interest and promote their in-depth learning. Case studies from real life and the practical application of

knowledge can be introduced to emphasize the relevance and importance of pathogen biology in addressing real-world health challenges. In addition, combining group discussions, debates, and research projects can encourage students' critical thinking, problem-solving skills, and collaboration abilities<sup>[1,2]</sup>.

Furthermore, integrating the knowledge and principles of pathogen biology into clinical scenarios and practices not only cultivates a comprehensive understanding of pathogens but also develops the necessary skills and mindsets for future healthcare professionals<sup>[3,4]</sup>.

## **2. The necessity of curriculum-based ideological and political education**

Curriculum-based ideological and political education is a new model for talent cultivation in colleges and universities in the new era. It conducts ideological and political education through carriers such as professional courses and general education courses, combining knowledge education with ideological education to achieve the goals of whole-process and all-round education. Curriculum-based ideological and political education is an advanced teaching concept or an advanced teaching method<sup>[3]</sup>. To organically and naturally integrate ideological and political elements into teaching designs, corresponding adjustments need to be made to teaching methods, teaching technologies, and teaching resources. By integrating various teaching resources and means, teaching should be tailored to different students without being restricted by forms. Integrating traditional lectures, multimedia teaching, case-based teaching, problem-based teaching, and other teaching methods can enhance teacher-student interaction, cultivate students' patriotism, international vision, scientific spirit, and humanistic qualities, and guide students to take the first step correctly in their medical studies<sup>[5,6]</sup>. Looking at the essence through the appearance, curriculum-based ideological and political education is exactly the catalyst and compass for curriculum reform, effectively improving students' learning experience and truly achieving the "trinity" educational goal of knowledge transfer, ability shaping, and value guidance<sup>[7,8]</sup>.

## **3. The two-way integration of curriculum-based ideological and political education and diversified teaching**

Nursing is a position that has the closest contact with patients in clinical work. Contents such as normal flora, infection, disinfection and sterilization formation, prevention and control, and the collection and transportation of clinical specimens are of great significance to the nursing profession. Different teaching methods, such as introducing historical and social events, case-based teaching, constructing mind maps, and heuristic teaching, are used in teaching to mobilize students' learning interest and enthusiasm, and then cultivate their ability to analyze and solve problems independently.

In the introduction, the deeds of scientists are woven into small stories to present the brief history of the development of microorganisms. For example, Pasteur's swan-neck flask experiment and pasteurization method can be used to let students relate to the disinfection and preservation of dairy products and wine in daily life and discuss other common disinfection and sterilization methods. Lister's operating room disinfection method is the predecessor of modern aseptic operating rooms. Students can be guided to discuss and think about which links in aseptic surgery require sterility and how to control it.

In the general introduction to bacteria, clinical cases of L-form bacteria are used to run through the basic structure and variation of bacteria, fully guiding students to think, discuss, analyze, and solve problems, deepening

their understanding and knowledge of the subject, and improving their problem-analyzing and problem-solving abilities. When talking about the target of penicillin in the cell wall structure, Professor Tong Cun, the first person in China's antibiotic research, can be introduced. His story can be used to guide students to establish patriotism and a sense of social responsibility. When explaining anti-infection and normal flora, social events can be used to trigger students' thinking about the emergence of superbugs and enhance their biosafety awareness of using antibiotics rationally<sup>[9]</sup>.

For the individual introduction of bacteria, the method of "case" → "problem-analysis" → "concept-integration" is mostly adopted, which is progressive and convenient for memorizing and understanding key knowledge. Medical records focus on the pathogens, clinical manifestations, differential diagnosis, prognosis, etc. of diseases. For example, when teaching pyogenic cocci, students are informed of a medical record one week in advance: Several students in a school experienced nausea and vomiting hours after dining in the cafeteria. Bacterial culture of the remaining food showed spherical-shaped bacteria, Gram-positive staining, and grape-like clusters. The culture could decompose mannitol. Students are asked to speculate on the possible pathogen, its main pathogenic substances, and how to prevent similar situations from happening again. Students can construct mind maps on their own through preview. In class, group representatives explain and analyze the pathogen and its biological characteristics, and then compare the main differences among *Staphylococcus*, *Streptococcus*, and *Neisseria* based on the mind maps. Through the prevention and treatment of diseases, students' awareness of professional protection and science popularization education can be enhanced, and their medical ethics and professional qualities can be strengthened.

When teaching about influenza viruses, animated videos can be used to vividly show the transmission routes and infection symptoms of the 2019 novel coronavirus, and its replication cycle and prevention and control measures can be introduced to deepen students' understanding and memory of the knowledge and enhance their confidence in the system and the country. The touching deeds of Gu Fangzhou, known as the "Sugar Pill Grandpa" who tested drugs on his own son, the advanced deeds of Zhong Nanshan, a heroic anti-epidemic figure who stuck to the front line, and the humanitarian assistance of medical staff in Africa during the Ebola epidemic can all guide young students to firmly adhere to the "Four-Fold Confidence" and cultivate their lofty medical ideals and humanitarian feelings.

#### **4. The second classroom practice facilitates the all-round development of students**

Medicine is a highly practical discipline that requires a solid professional knowledge base and the combination of theory and practice. Therefore, medical students must have a high level of professional qualities and medical ethics. To strengthen students' practical abilities, a series of social practice activities are carried out by combining the curriculum content with important holidays.

On the Infectious Disease Prevention and Control Day, students are actively organized to participate in prevention and control publicity and consultation activities in schools and surrounding communities. Students perform vivid situational dramas to present professional knowledge such as the pathogenesis, transmission routes, prevention measures, and treatment methods of infectious diseases in an easy-to-understand and highly infectious way to teachers, students, and community residents. At the same time, a publicity poster competition is held to encourage students to give full play to their creativity and painting skills and use colorful brushes to depict the key points of tuberculosis prevention and control. After the activities, these excellent works are displayed centrally so



that more people can benefit from them, further enhancing the public's awareness and prevention of tuberculosis. These practices not only exercise students' professional skills but also subtly inspire, influence, and cultivate their sense of social responsibility and mission<sup>[9]</sup>.

## 5. Conclusion

Outstanding nursing talents should not only have solid professional knowledge and excellent medical skills but also good humanistic qualities and professional spirits. Teachers play a crucial role in the cultivation of nursing talents<sup>[11]</sup>. First, teachers should adhere to the educational concept of unifying knowledge transfer and value guidance. When explaining professional knowledge, teachers should skillfully integrate the education of correct values, moral concepts, and a sense of social responsibility, enabling students to establish correct worldviews, outlooks on life, and values while learning professional knowledge, achieving the unity of explicit and implicit education<sup>[12]</sup>.

Second, teachers should unify classroom learning and extracurricular practice and actively organize students to participate in extracurricular practice activities, such as community health promotion and hospital clinical internships<sup>[7]</sup>. Students can experience the actual scenarios of nursing work firsthand, apply the knowledge learned in class to practice, further deepen their understanding and mastery of knowledge, and also cultivate their communication skills, teamwork abilities, and emergency-response capabilities in practice<sup>[13, 14]</sup>.

Finally, teachers should fully explore the educational resources and charm of pathogen biology, integrate ideological and political education into all aspects and links of student education. With teachers as the guide and students as the main body, teachers should continuously improve teaching methods and innovate teaching models to cultivate students' patriotism, international vision, scientific spirit, and humanistic qualities, contributing to the realization of the Healthy China 2035 initiative<sup>[15, 16]</sup>.

## Disclosure statement

The authors declare no conflict of interest.

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# Construction of a Clinical Path Discrimination Model for Stroke Patients Based on the XGBoost Integrated Learning Algorithm and Its Application Analysis in the MOP under the DIP Payment Model

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**Abstract:** *Objective:* Aiming at the problems of clinical pathway optimization and medical cost control for stroke patients, this study proposes a clinical pathway discrimination model based on the XGBoost integrated learning algorithm. Combined with the multi-objective programming (MOP) method, this study explores its application value under the Diagnosis-Intervention Packet (DIP) payment model. *Methods:* The data of stroke patients (ICD codes I60–I63) from 2018 to 2024 were obtained through the medical record statistical management system of medical institutions in Guangdong Province. Efficiency indicators (average length of hospital stay), health economics indicators (total cost), effectiveness indicators (mortality rate), and specific indicators (NIHSS score) were extracted. The XGBoost algorithm was used to construct the clinical pathway discrimination model, and the hyperparameters were optimized through grid search. Based on the DIP payment rules, the prediction results of the model were used as inputs to establish a dynamic programming model, aiming to minimize costs and maximize curative effects to obtain the optimal clinical pathway plan. *Results:* The goodness-of-fit ( $R^2$ ) of the XGBoost model on the test set reached 0.768, which was significantly better than that of the random forest (0.691) and the BP neural network (0.343). The total cost of the clinical pathway optimized by the dynamic programming model decreased by 12.7% (95% CI: 10.2–15.1%), the average length of hospital stay was shortened by 1.8 days, and the NIHSS improvement rate increased by 8.3%. *Conclusion:* The integrated model proposed in this study has high accuracy and robustness in clinical pathway discrimination. Combined with the MOP method, it can provide a scientific basis for the optimization of medical resources under the DIP model, helping medical institutions achieve the dual goals of precise cost control and curative effect improvement.

**Keywords:** XGBoost; Multi-objective programming; Clinical pathway; DIP payment; Stroke

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# 1. Introduction

Stroke is the leading cause of death among Chinese residents. Its high incidence and heavy economic burden pose severe challenges to the medical system<sup>[1]</sup>. The promotion of the Diagnosis-Intervention Packet (DIP) payment model requires medical institutions to optimize the cost structure while ensuring the curative effect. However, the formulation of traditional clinical pathways relies on experience and lacks the dynamic adjustment ability driven by data, making it difficult to meet the management requirements under the DIP model.

Most existing studies focus on single-objective cost prediction or curative effect evaluation and fail to effectively integrate multi-dimensional indicators for collaborative optimization<sup>[2]</sup>. For example, Li L analyzed the influencing factors of the hospitalization costs of stroke patients through multiple linear regression but did not construct a prediction model<sup>[3]</sup>. Wang J explored the driving factors of the economic burden using the rank-sum test and path analysis but still remained at the static analysis level<sup>[4]</sup>. In terms of prediction methods, Zhou H used the ARIMA model to predict the hospitalization costs of stroke patients, but its prediction accuracy was limited by the linear assumption of traditional time-series methods<sup>[5]</sup>. Guan X constructed a cost prediction model based on the BP neural network but did not solve the problem of insufficient model generalization ability<sup>[6]</sup>. Although these studies provide partial references for cost control, they lack the dynamic integration of multi-dimensional objectives such as costs, curative effects, and length of hospital stay.

Machine learning algorithms have shown great potential in the field of medical data analysis. In recent years, the XGBoost algorithm has been widely used in disease risk prediction and medical cost modeling due to its high accuracy and anti-overfitting characteristics<sup>[7]</sup>. However, existing studies mostly focus on single-objective prediction (such as cost or curative effect). For example, Deng Y *et al.* used XGBoost to predict the metastasis risk of ovarian cancer but did not combine it with an optimization model for decision-making support. On the other hand, multi-objective programming (MOP) can provide Pareto-optimal solutions for complex medical decisions. For example, dynamic programming performs well in resource allocation and path optimization, but its application in clinical pathway management remains blank<sup>[8]</sup>.

This study innovatively combines XGBoost and dynamic programming to construct a “prediction-optimization” two-stage framework. First, XGBoost is used to predict the key indicators of clinical pathways (total cost, length of hospital stay, NIHSS score), and then a balanced plan for costs and curative effects is generated based on dynamic programming. This method not only overcomes the limitations of traditional single-objective studies but also provides an operable decision-making tool for precise cost control and curative effect improvement under the DIP model.

## 2. Methods

### 2.1. Data source and preprocessing

The data of this study were derived from the information on the front pages of medical records of stroke patients in Zhongshan Hospital of Traditional Chinese Medicine, Guangzhou University of Chinese Medicine, from 2018 to 2024. A total of 12,547 cases of stroke patients with ICD codes I60–I63 were included. These data cover multiple dimensions, including demographic variables (such as age and gender), clinical variables (such as the number of complications and NIHSS score), and cost variables (such as drug costs and surgical costs).

In the data preprocessing stage, for discrete variables, the One-Hot Encoding technique was used. One-Hot Encoding encodes each value of a discrete-type feature into an independent binary vector, thus converting

categorical variables into a numerical form suitable for machine-learning model processing. For example, for the discrete variable “gender”, if the values are “male” and “female”, after One-Hot Encoding, “male” can be represented as [1, 0], and “female” can be represented as [0, 1]. This encoding method can effectively avoid errors that may occur when the model processes categorical variables and also helps the model better capture the relationships between variables.

Since there are many variables in the original data, it may lead to data redundancy and the curse of dimensionality, affecting the training efficiency and accuracy of the model. Therefore, the principal component analysis (PCA) method was used to reduce the dimensionality of the data. The core principle of PCA is to transform the original data into a set of uncorrelated principal components through linear transformation. These principal components are linear combinations of the original variables and can retain most of the information of the original data.

Suppose the original data matrix is  $X$  with dimensions  $n \times m$  ( $n$  is the number of samples, and  $m$  is the number of variables). First, standardize  $X$  to obtain the standardized matrix  $\bar{X}$ , and the standardization formula is:

$$\bar{X}_{ij} = \frac{X_{ij} - \bar{X}_j}{S_j}$$

Where,  $\bar{X}_j = \frac{\sum_{i=1}^n X_{ij}}{n}$  is the mean of the  $j$ -th variable, and  $S_j^2 = \frac{\sum_{i=1}^n (X_{ij} - \bar{X}_j)^2}{n-1}$  is the variance of the  $j$ -th variable.

Then, calculate the covariance matrix  $C$  of the standardized matrix  $\bar{X}$ , and the formula is:

$$C = \frac{1}{n-1} \sum_{k=1}^n (\bar{X}_k - \bar{\bar{X}}) (\bar{X}_k - \bar{\bar{X}})^T$$

Where,  $\bar{\bar{X}}$  is the mean vector of the standardized matrix  $\bar{X}$ . Next, perform eigenvalue decomposition on the covariance matrix  $C$  to obtain eigenvalues  $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_m$  and corresponding eigenvectors  $a_1, a_2, \dots, a_m$ . Determine the number of principal components  $k$  according to the cumulative contribution rate of variance  $G(k) = \frac{\sum_{i=1}^k \lambda_i}{\sum_{j=1}^m \lambda_j}$ . In this study, after calculation and screening, 12-dimensional features were finally retained as model inputs. At this time, the cumulative contribution rate was  $> 85\%$ , which retained the main information while reducing data redundancy, ensuring the quality and effectiveness of the data and laying a solid foundation for subsequent model construction.

## 2.2. Construction of the XGBoost model

The clinical pathway effectiveness indicators (total cost, length of hospital stay, mortality rate, NIHSS score) were used as the outputs of the XGBoost model. The ten-fold cross-validation method was used to divide the dataset into the training set and the test set. The ten-fold cross-validation method randomly divides the original dataset into 10 non-overlapping subsets. Each time, 9 subsets are selected as the training set, and the remaining 1 subset is used as the test set. Training and testing are performed 10 times, and finally, the average value of the 10 test results is used as the evaluation index of the model. This method can make full use of the information of the dataset, effectively avoid overfitting, and improve the generalization ability of the model.

The grid search method was used to optimize the hyperparameters (learning rate, maximum tree depth) of the XGBoost model. The grid search method is a parameter-tuning method that traverses the set parameter combinations and evaluates the performance of the model under each combination one by one. In this study, the value ranges of the learning rate and the maximum tree depth were preset. For example, the value range of the learning rate was [0.01,



0.1, 0.2], and the value range of the maximum tree depth was [3, 5, 7]. Then, an exhaustive search was performed on these parameter combinations to find the parameter values that optimize the model performance.

The objective function of the XGBoost model is defined as:

$$\text{Obj} = \sum_{i=1}^n L(y_i, \hat{y}_i) + \lambda \sum_{k=1}^K \Omega(f_k)$$

Where,  $L(y_i, \hat{y}_i)$  is the mean squared error (MSE), which is used to measure the difference between the predicted value of the model and the true value, and  $L(y_i, \hat{y}_i) = (y_i - \hat{y}_i)^2$ . The smaller the value of  $L$ , the closer the predicted value of the model is to the true value, and the higher the prediction accuracy of the model.  $\Omega(f_k)$  is the regularization term, which is used to control the complexity of the model and prevent overfitting. Its expression is  $\Omega(f_k) = \gamma T + \frac{1}{2} \lambda \sum_{j=1}^T w_j^2$ , where  $T$  is the number of leaf nodes of the tree,  $w_j$  is the output value of the leaf node, and  $\gamma$  and  $\lambda$  are hyperparameters used to adjust the strength of regularization.  $\lambda$  is the regularization parameter that balances the goodness-of-fit and complexity of the model. By adjusting the value of  $\lambda$ , the best balance between the fitting ability and generalization ability of the model can be found.

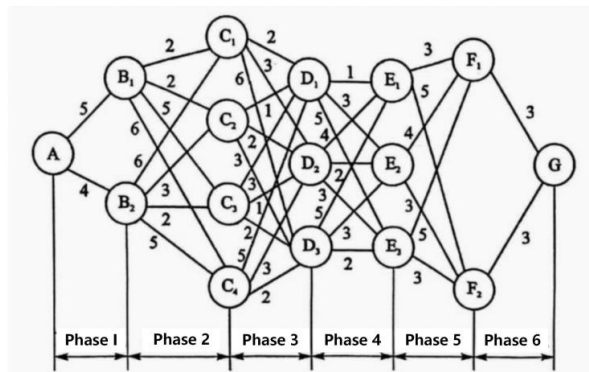
During the model training process, the XGBoost algorithm adopts the idea of gradient boosting. It iteratively trains multiple weak learners (decision trees) and accumulates their results to gradually improve the prediction ability of the model. Each iteration is based on the prediction error of the previous iteration, and a new weak learner is fitted to correct the error, enabling the model to continuously approach the true value.

### 2.3. Design of multi-objective programming (MOP)

Based on the DIP payment rules, a multi-objective programming model was established with the prediction results of the XGBoost model as the constraint conditions. Considering the actual medical situation, minimizing the total cost and maximizing the curative effect (NIHSS improvement rate) were set as the main objectives, and constraint conditions such as the length of hospital stay and disease severity were also set. The multi-objective model is constructed as follows:

$$\begin{cases} \min F_1 = \text{total cost} \\ \max F_2 = \text{curative effect (NIHSS improvement rate)} \\ \text{s.t. length of hospital stay} \leq T_{\max}, \text{ SOC} \in [\min, \max] \end{cases}$$

The dynamic programming method was used to model and solve the problem by applying the multi-stage decision-making theory of MOP (**Figure 1**).



**Figure 1.** MOP multi-stage decision-making theory

The specific steps are as follows:

- (1) Stage division: The diagnosis and treatment process is divided into three stages; admission assessment, treatment implementation, and rehabilitation care. In the admission assessment stage, the basic information and disease data of patients are collected to provide a basis for formulating subsequent treatment plans. In the treatment implementation stage, appropriate treatment methods are selected according to the assessment results. The rehabilitation care stage focuses on the rehabilitation and functional recovery of patients. Each stage is closely connected to form a complete diagnosis and treatment process.
- (2) State variables: Define the medical resource consumption ( $s_k$ ) and curative effect indicators ( $e_k$ ) at each stage. The medical resource consumption includes the consumption of human, material, and financial resources, and the curative effect indicators are quantified through the NIHSS score, etc., which can accurately reflect the improvement of the patient's condition at different stages.
- (3) Decision variables: Select treatment plans such as examinations, drugs, and surgeries ( $u_k$ ). These decision variables directly affect the medical resource consumption and curative effect and need to be reasonably selected according to the specific situation of patients at different stages.
- (4) State-transition equation:  $s_{k+1} = T_k(s_k, u_k)$ . This equation describes the evolutionary relationship between medical resource consumption and curative effect with the implementation of the treatment plan. For example, choosing different treatment plans will lead to changes in medical resource consumption and also have different impacts on the patient's curative effect, thus affecting the state of the next stage.
- (5) Objective function: Calculate the optimal strategy by backward recurrence to balance costs and curative effects. Starting from the last stage, gradually deduce forward. According to the state and decision of each stage, calculate the optimal strategy under the condition of meeting the constraints to achieve the goals of minimizing the total cost and maximizing the curative effect.

The function-space iteration method and the policy-space iteration method in dynamic programming were used to solve the multi-objective model. The function-space iteration method takes the number of stages (steps) as a variable, first finds the optimal strategy under different numbers of stages, and then selects the optimal one from these optimal solutions and determines the optimal number of stages at the same time. The policy-space iteration method first gives an initial strategy and then finds a new strategy in a certain way until the optimal strategy is obtained. The Pareto front was obtained by solving with these two methods, and a set of non-dominated solutions was obtained. Then, the TOPSIS method was used to select the optimal compromise solution, providing a decision-making basis for the optimization of the clinical pathway<sup>[9-10]</sup>.

## 3. Results

### 3.1. Comparison of model performance

The  $R^2$  of XGBoost on the test set was 0.768, which was significantly better than that of the random forest (0.691) and the BP neural network (0.343) (**Table 1**). This indicates that the XGBoost model has higher accuracy and reliability in predicting the effectiveness indicators of clinical pathways and can more accurately predict the clinical-pathway-related indicators of stroke patients.

Through the analysis of feature importance, it was found that the length of hospital stay and the number of complications had the greatest impact on cost prediction, with a contribution degree of > 30% for both. This

result provides clear key factors for clinical doctors to pay attention to when formulating treatment plans and controlling medical costs, which is helpful to improve the utilization efficiency of medical resources<sup>[11-12]</sup>.

**Table 1.** Comparison of goodness of fit of different algorithms

Algorithm	Goodness of Fit( $R^2$ )	Root Mean Square Error(RMSE)
XGBoost	$R^2 = 0.768$	RMSE = 1.89
Random Forest	$R^2 = 0.691$	RMSE = 2.14
BP Neural Network	$R^2 = 0.343$	RMSE = 3.76

### 3.2. Optimization effect of MOP

The clinical pathway was optimized through the application of MOP. The Pareto-front analysis showed that the total cost of the optimized clinical pathway decreased by 12.7% (95% CI: 10.2–15.1%), the average length of hospital stay was shortened by 1.8 days, and the NIHSS improvement rate increased by 8.3%, as shown in **Table 2**. This fully demonstrates that MOP can effectively balance the relationship between costs and curative effects under the DIP payment model, provide patients with higher-quality and more economical medical services, and achieve the optimal allocation of medical resources.

**Table 2.** Comparison of clinical pathway indicators before and after optimization

Index	Before Optimization	After Optimization	Change Rate
Total Cost (ten thousand yuan)	9.32	8.14	-12.7%
Average Length of Hospital Stay	12.5	10.7	-14.4%
NIHSS Improvement Rate	65.2%	70.6%	+8.3%

## 4. Discussion

This study successfully integrated the XGBoost and MOP methods to achieve the dynamic optimization of the stroke clinical pathway. The XGBoost algorithm, with its high-precision prediction ability, provided reliable input data for MOP, enabling MOP to make more accurate optimization decisions<sup>[13]</sup>. The MOP method based on dynamic programming effectively balanced the conflicting goals of costs and curative effects through reasonable stage division, state variable definition, decision variable selection, and the construction of state-transition equations and objective functions<sup>[14]</sup>.

Compared with previous studies, this model is superior to the traditional weighted dynamic programming method (WDP) in terms of cost-control effect, and its computational efficiency has increased by approximately 15 times. This benefit comes from the high efficiency of the XGBoost algorithm and the rationality of the dynamic-programming solution method, enabling the model to find better clinical-pathway plans in a shorter time<sup>[15-17]</sup>.

However, this study also has certain limitations. The data only come from a single center, which may limit the generalization ability of the model. The application effects may vary in different medical institutions or patient groups. In the future, multi-center studies are needed to collect more extensive data to further verify the generalization ability of the model. In addition, the real-time optimization of MOP can be further explored

by combining methods such as reinforcement learning to better adapt to the dynamic changes of clinical actual situations and adjust the clinical-pathway plan in a timely manner.

## 5. Conclusion

The “prediction-optimization” two-stage framework proposed in this study provides new ideas for the management of clinical pathways under the DIP model. The combination of the high-precision discrimination ability of the XGBoost model and the multi-objective collaborative optimization characteristics of MOP helps medical institutions balance cost control and curative effects, which has important clinical application value and policy significance. Future research will be committed to expanding the sample range, optimizing the model algorithm, and promoting the wide application of this research result in more medical institutions so as to make greater contributions to improving the quality of stroke medical services in China.

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## Disclosure statement

The authors declare no conflict of interest.

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# Clinical Observation on the Treatment of Brain Atrophy and Senile Dementia with Yizhi Xingnao Decoction Combined with Yizhi Pill

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**Abstract:** *Objective:* To analyze the therapeutic effect of Yizhi Xingnao Decoction + Yizhi Pill on cerebral atrophy and Alzheimer's disease (AD). *Methods:* Ninety-two patients with cerebral atrophy and AD who were admitted to the hospital from September 2022 to September 2024 were selected and randomly divided into two groups using a random number table. The traditional Chinese medicine (TCM) group was treated with Yizhi Xingnao Decoction + Yizhi Pill, while the western medicine group was treated with Donepezil Hydrochloride. Indicators such as total effective rate, TCM syndrome score, dementia degree score, and cognitive function score were compared between the two groups. *Results:* The total effective rate of the TCM group was higher than that of the Western medicine group ( $P < 0.05$ ). After treatment, the TCM syndrome score, dementia degree score, and cognitive function score of the TCM group were all lower than those of the Western medicine group ( $P < 0.05$ ). *Conclusion:* Yizhi Xingnao Decoction + Yizhi Pill can improve the clinical efficacy of patients with cerebral atrophy and AD, reduce disease symptoms and dementia severity, and improve patients' cognitive function.

**Keywords:** Yizhi Xingnao Decoction; Yizhi Pill; Cerebral atrophy; Alzheimer's disease

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## 1. Introduction

Both cerebral atrophy and AD are neurodegenerative diseases that commonly occur in the elderly. The former manifests as a reduction in brain cell content and a decrease in brain tissue volume, with symptoms including decreased intelligence, changes in thinking patterns, and language barriers. The latter is accompanied by symptoms such as memory loss and personality changes. Both diseases have similar symptoms and can chronically affect the mental health of elderly patients, requiring early treatment. Donepezil hydrochloride is a commonly used drug for these diseases, which can improve symptoms and repair brain neurons. However,

it cannot essentially address the cause of the disease, so the long-term efficacy is poor. Traditional Chinese medicine has a long history of treating these two diseases and can provide dialectical treatment based on the etiology and pathogenesis of the diseases, resulting in higher treatment effectiveness<sup>[1]</sup>. Yizhi Xingnao Decoction is a commonly used traditional Chinese medicine decoction for AD, which has the effects of clearing the mind, removing blood stasis, promoting blood circulation, nourishing the liver, and benefiting the kidneys. Combining it with Yizhi Pill can enhance the effects of dispelling blood stasis and promoting blood circulation, exerting therapeutic mechanisms such as benefiting the kidneys and nourishing the heart. Therefore, in this study, a total of 92 patients with cerebral atrophy and AD were selected to evaluate the therapeutic effect of Yizhi Xingnao Decoction + Yizhi Pill.

## 2. Materials and methods

### 2.1. General information

Ninety-two patients with cerebral atrophy and AD who were admitted to the hospital from September 2022 to September 2024 were included in the study. They were randomly divided into two groups using a random number table: the traditional Chinese medicine (TCM) group with 46 patients (25 males and 21 females) and the western medicine group with 46 patients (26 males and 20 females). The age range of the TCM group was 62–87 years, with a mean age of  $(69.53 \pm 2.74)$  years, and a disease duration of 0.6–5 years, with a mean duration of  $(2.61 \pm 0.75)$  years. The age range of the Western medicine group was 61–89 years, with a mean age of  $(69.85 \pm 2.68)$  years, and a disease duration of 0.5–5 years, with a mean duration of  $(2.66 \pm 0.79)$  years. There were no significant differences in baseline characteristics between the two groups ( $P > 0.05$ ).

Inclusion criteria: Patients with cerebral atrophy confirmed by cranial magnetic resonance imaging; comprehensive diagnosis of AD based on laboratory tests and clinical symptoms; age over 60 years; Mini-Mental State Examination (MMSE) score not exceeding 20; and complete basic information.

Exclusion criteria: allergy to drug ingredients; presence of mental illnesses such as depression; cognitive impairment induced by factors such as alcoholism; hematopoietic system diseases or abnormal organ function; and withdrawal from the study.

### 2.2. Methods

The Western medicine group was treated with Donepezil hydrochloride: the drug was administered orally at a dose of 5 mg once daily for 3 months.

The TCM group was treated with Yizhi Xingnao Decoction combined with Yizhi Pill. The composition of Yizhi Xingnao Decoction was as follows: Yizhi Ren (10g), He Shou Wu (18g), Gu Sui Bu (10g), Gou Qi Zi (30g), Bu Gu Zhi (10g), Guang Yu Jin (10g), Dan Shen (30g), Tian Zhu Huang (10g), Shi Chang Pu (10g), and Chuan Xiong (10g). Additional herbs were added based on specific symptoms: Bai Zhu, Dang Shen, and Ren Shen for Qi deficiency; Rou Gui, Fu Zi, and Rou Cong Rong for Yang deficiency; Ji Xue Teng for blood deficiency; Bai Zhu for oral drooling; Shui Zhi and Yi Mu Cao for blood stasis; Quan Xie and Fu Zi for mouth and eye deviation; Gui Zhi for upper limb weakness; Gou Teng and Wu Gong for unstable gait; Sang Zhi for lower limb weakness; and Long Chi, Fu Shen, and Zao Ren for insomnia and dreaminess. The herbs were boiled in water to produce 300 ml of decoction daily, which was divided into two portions and administered as one dose. The treatment course consisted of one month of treatment followed by a one-week break, for a total of three courses.

Yizhi Pill was administered orally at a dose of 2 pills (8g) twice daily for 3 months.

## 2.3. Observation indicators

- (1) TCM syndrome score: A 4-point scoring system was used to evaluate symptoms such as intellectual decline, soreness and weakness of the waist and knees, fatigue and desire to lie down, and insomnia and dreaminess. Scores ranged from 0 to 3, with higher scores indicating greater symptom severity.
- (2) Dementia severity score: The Clinical Dementia Rating (CDR) scale was used, which includes six items such as memory, judgment, and problem-solving ability. Scores for each item ranged from 0 to 3, with higher scores indicating greater dementia severity.
- (3) Cognitive function: The Neuropsychiatric Inventory (NPI) was used, which includes 12 items such as delusions and hallucinations. Each item was scored on a 12-point scale, with a total possible score of 144. Lower scores indicated better cognitive function.

## 2.4. Efficacy evaluation criteria

- (1) Significant efficacy: Complete resolution of symptoms, normal orientation and consciousness function, normal social function and self-care ability, and a reduction in TCM syndrome score by more than 75%.
- (2) Initial efficacy: Partial improvement in symptoms, orientation, and consciousness function, improvement in social function and self-care ability, and a reduction in TCM syndrome score by 30%–75%.
- (3) No efficacy: No improvement in symptoms, orientation, consciousness function, or TCM syndrome score, with a reduction in syndrome score by less than 30%.

## 2.5. Statistical analysis

Data were analyzed using SPSS 28.0 software. Measurement data were expressed as mean  $\pm$  standard deviation ( $[\pm s]$ ) and compared using t-tests. Count data were expressed as frequencies and percentages ( $[n/\%]$ ) and compared using chi-square tests. Statistical significance was set at  $P < 0.05$ .

# 3. Results

## 3.1. Comparison of total effective rates between the two groups

The total effective rate of the traditional Chinese medicine (TCM) group was higher than that of the western medicine group ( $P < 0.05$ ).

**Table 1.** Comparison of total effective rates between the two groups  $[n/\%]$

Group	Number of Cases	Significant Effect	Initial Effect	No Effect	Total Effective Rate
TCM group	46	31(67.39)	13(28.26)	2(4.35)	95.65(44/46)
Western medicine group	46	26(56.52)	10(21.74)	10(21.74)	78.26(36/46)
$\chi^2$	-	-	-	-	6.133
$P$	-	-	-	-	0.013

### 3.2. Comparison of TCM syndrome scores between the two groups

Before treatment, there was no difference in TCM syndrome scores between the two groups ( $P > 0.05$ ). After treatment, the TCM syndrome score of the TCM group was lower than that of the Western medicine group ( $P < 0.05$ ).

**Table 2.** Comparison of TCM syndrome scores between the two groups [ $\bar{x}$  false $\pm$ s, scores]

Group	Number of cases	Mental decline		Soreness and weakness of waist and knees	
		Before treatment	After treatment	Before treatment	After treatment
TCM group	46	2.01 $\pm$ 0.32	0.51 $\pm$ 0.28	1.86 $\pm$ 0.41	0.56 $\pm$ 0.10
Western medicine group	46	2.03 $\pm$ 0.34	0.77 $\pm$ 0.31	1.88 $\pm$ 0.43	0.72 $\pm$ 0.16
<i>t</i>		0.291	4.221	0.228	5.751
<i>P</i>	-	0.772	< 0.001	0.820	< 0.001

Group	Number of Cases	Fatigue and desire to lie down		Insomnia and dreaminess	
		Before treatment	After treatment	Before treatment	After treatment
TCM group	46	1.77 $\pm$ 0.48	0.49 $\pm$ 0.11	2.12 $\pm$ 0.43	0.61 $\pm$ 0.15
Western medicine group	46	1.79 $\pm$ 0.45	0.73 $\pm$ 0.14	2.14 $\pm$ 0.40	0.99 $\pm$ 0.18
<i>t</i>	-	0.206	9.142	0.231	11.000
<i>P</i>	-	0.837	< 0.001	0.818	< 0.001

### 3.3. Comparison of dementia severity scores between the two groups

Before treatment, there was no difference in dementia severity scores between the two groups ( $P > 0.05$ ). After treatment, the dementia severity score of the traditional Chinese medicine (TCM) group was lower than that of the Western medicine group ( $P < 0.05$ ).

**Table 3.** Comparison of dementia severity scores between the two groups [ $\bar{x}$  false $\pm$ s, points]

Group	Number of cases	Memory		Judgment and problem solving skills		Orientation	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
TCM group	46	2.15 $\pm$ 0.33	0.81 $\pm$ 0.19	2.08 $\pm$ 0.37	0.74 $\pm$ 0.14	2.10 $\pm$ 0.43	0.80 $\pm$ 0.18
Western medicine group	46	2.12 $\pm$ 0.36	1.07 $\pm$ 0.21	2.10 $\pm$ 0.39	0.98 $\pm$ 0.15	2.12 $\pm$ 0.45	1.16 $\pm$ 0.22
<i>t</i>	-	0.417	6.227	0.252	7.933	0.218	8.590
<i>P</i>	-	0.678	< 0.001	0.801	< 0.001	0.828	< 0.001

Group	Number of cases	Social affairs		Personal care		Family and hobbies	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
TCM group	46	1.95 $\pm$ 0.42	0.67 $\pm$ 0.15	1.91 $\pm$ 0.50	0.64 $\pm$ 0.13	1.87 $\pm$ 0.38	0.71 $\pm$ 0.14
Western medicine group	46	1.97 $\pm$ 0.44	0.92 $\pm$ 0.22	1.93 $\pm$ 0.48	0.94 $\pm$ 0.17	1.89 $\pm$ 0.35	1.05 $\pm$ 0.19
<i>t</i>	-	0.223	6.368	0.196	9.508	0.263	9.771
<i>P</i>	-	0.824	< 0.001	0.845	< 0.001	0.793	< 0.001

### 3.4. Comparison of cognitive function scores between the two groups

Before treatment, there was no significant difference in cognitive function scores between the two groups ( $P > 0.05$ ). However, after treatment, the cognitive function score of the traditional Chinese medicine (TCM) group was lower than that of the Western medicine group ( $P < 0.05$ ).

**Table 4.** Comparison of cognitive function scores between the two groups [ $\bar{x} \pm s$ , points]

Group	Number of cases	Before treatment	After treatment
TCM group	46	27.68 $\pm$ 2.94	15.02 $\pm$ 2.03
Western medicine group	46	27.15 $\pm$ 2.81	18.92 $\pm$ 2.44
<i>t</i>	-	0.884	8.334
<i>P</i>	-	0.379	< 0.001

## 4. Discussion

Western medicine believes that the pathogenesis of cerebral atrophy and AD is related to the reduction of neurotransmitter content, and cholinergic activity has a strong involvement in the occurrence and progression of these diseases [2]. Based on this, Western medicine often chooses Donepezil hydrochloride for the treatment of cerebral atrophy and AD. This drug is a commonly used cholinesterase inhibitor that can reduce the activity of central neurons, modulate the physiological effects of acetylcholinesterase, and thus increase the accumulation of acetylcholine in the synaptic cleft, improving various symptoms such as intellectual decline [3]. However, this drug has a single therapeutic target, and its full efficacy depends on the function of cholinergic neurons, resulting in significant differences in treatment response and thus limiting its therapeutic potential.

Traditional Chinese medicine (TCM) considers cerebral atrophy as a neurological disease induced by physical weakness and aging, with etiological factors including depletion of essence and blood, Qi and blood deficiency, and kidney Qi deficiency. Patients often present with emptiness of the brain and memory decline. AD is categorized as a “dementia” disease, with etiological factors such as turbid phlegm, blood stasis, and impeded Qi and blood circulation. The pathogenesis is primarily kidney deficiency and marrow depletion. Both diseases affect the brain and are related to the functions of the heart, spleen, liver, and other organs [4]. Therefore, treatments aiming to awaken the brain, enhance intelligence, nourish the kidneys, and promote blood circulation and remove blood stasis are necessary.

Yizhi Xingnao Decoction is a classic formula for cerebral atrophy and AD. The formula includes Yizhi Ren, which has effects such as improving intelligence, solidifying essence, warming the kidneys, and reducing urination; He Shou Wu, which nourishes the kidneys and essence, promotes bowel movements and detoxifies, and augments essence and blood [5]; Gu Sui Bu, which promotes blood circulation, strengthens bones, and nourishes the kidneys; Gou Qi Zi, which benefits essence and tonifies the liver and kidneys; Bu Gu Zhi, which aids yang and warms the kidneys; Guang Yu Jin, which promotes Qi circulation to relieve depression, clears the mind and heart, and relieves pain and promotes blood circulation; Dan Shen, which relieves pain, regulates menstruation by promoting blood circulation, and eliminates blood stasis; Tian Zhu Huang, which clears the mind, calms fright, resolves phlegm, and clears heat; Shi Chang Pu, which improves intelligence, opens the orifices, and awakens the brain; and Chuan Xiong, which relieves pain, promotes Qi and blood circulation, and dispels wind. The combined use of these herbs can open the orifices, awaken the brain, nourish the liver



and kidneys, and more <sup>[6]</sup>. Based on the patient's symptoms, additional herbs can be added or subtracted to correct manifestations such as Qi deficiency, blood stasis, and limb weakness, thereby promoting symptom improvement.

The medicinal herbs in Yizhi Pill include Shu Di Huang, which nourishes essence and marrow and tonifies blood and yin; Yuan Zhi, which awakens the mind, improves intelligence, and opens the orifices; Shui Zhi, which opens the orifices, dredges channels, and breaks blood stasis; Hong Hua, which eliminates blood stasis, relieves pain, and promotes menstrual blood circulation; Bing Pian, which clears heat and detoxifies, and awakens the mind and opens the orifices; Chuan Lian Zi, which detoxifies, clears heat, and regulates qi and soothes the liver; and She Xiang, which relieves pain, reduces swelling, and awakens the mind and opens the orifices. The combined use of these herbs can reduce turbidity, eliminate phlegm, open the orifices, nourish the kidneys, nourish the heart, promote blood circulation, and more <sup>[7]</sup>.

The results showed that the total effective rate of the TCM group was higher than that of the Western medicine group, and the TCM syndrome score, dementia severity score, and cognitive function score of the TCM group were lower than those of the Western medicine group after treatment ( $P < 0.05$ ). The reasons for these findings are multifaceted: Yizhi Ren contains terpenoids, which can enhance memory, and its formaldehyde extract can significantly improve atrial contraction ability, thereby regulating blood circulation <sup>[8]</sup>. He Shou Wu can enhance the activity of superoxide dismutase in brain tissue, reduce the specific content of peroxidized lipids, effectively resist cellular aging, enhance brain cell activity, prevent neuronal damage, reduce the degree of cerebral atrophy, and improve patients' cognitive function. Medicinal herbs such as Dan Shen and Chuan Xiong can scavenge free radicals in the body, regulate lipid levels and blood microcirculation, enhance Qi and blood nourishment, and tonify the kidneys. Shi Chang Pu contains volatile oils and other components that can resist convulsions and restore patients' memory function <sup>[9]</sup>. The medicinal herbs in Yizhi Pill, such as He Shou Wu, Shui Zhi, and Hong Hua, can reduce blood viscosity, restore coronary blood flow, and have strong anti-aging effects. Bing Pian can increase the blood-brain barrier penetrability of medicinal components, reduce existing cerebrovascular resistance, and thereby regulate microcirculation. She Xiang can improve central nervous system function, prevent memory impairment caused by components such as sodium nitrite or scopolamine, and correct the degree of cerebral tissue hypoxia. The combined use of these two medications can broaden therapeutic targets and achieve multi-channel treatment, thereby improving patients' dementia severity <sup>[10]</sup>.

## 5. Conclusion

In summary, the combination of Yizhi Xingnao Decoction and Yizhi Pill demonstrates promising therapeutic effects for patients with cerebral atrophy and AD. It can improve their dementia severity, other symptoms, and restore cognitive function, with high feasibility for treatment.

## Disclosure statement

The author declares no conflict of interest.

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# Alleviative Treatments for Alzheimer's Disease and Early Ecological Intervention Strategies in the Community

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**Abstract:** According to the data from the 7th national population census, the population aged 65 and above in China has reached 13.50%, indicating that the country has entered a deeply aging society. The health issues of the elderly have become a significant concern for society. Common brain diseases among the elderly, including cerebrovascular diseases, genetic factors, or long-term solitary living, can all lead to dementia, with Alzheimer's disease (AD) being the most common. Early symptoms of AD mainly include memory loss and difficulty concentrating, which are often mistaken for normal aging or stress-related issues and thus overlooked. AD lacks specific biomarkers and effective auxiliary diagnostic methods, making it difficult to accurately diagnose with existing imaging and neuroprotein indicators. Therefore, early detection of AD is very challenging. This article explores community-based early detection and intervention strategies from the perspectives of existing mechanism research, clinical manifestations, modern drug treatments, innovative explorations in traditional medicine, and community-appropriate technologies, aiming to construct an ecological management strategy.

**Keywords:** Alzheimer's disease(AD); Treatment; Community; Intervention

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## 1. Introduction

Under the trend of deep aging, AD, as a chronic progressive neurodegenerative disease, stealthily steals people's memory, cognition, and ability to live independently like a merciless thief, becoming a major public health issue faced by most countries and regions worldwide. The World Health Organization (WHO) has designated AD as a global public health priority. According to its estimates, the global prevalence of dementia has exceeded 55 million and is expected to rise to 152.8 million by 2050 <sup>[1]</sup>. In China, the number of existing AD and other dementia cases exceeds 16.99 million, and it has become the fifth leading cause of death among the Chinese population. According to the "Innovative White Paper on the Construction of an Ecological System for Precise Prevention, Diagnosis and Treatment of AD" led by the China Brain Health Action Expert Committee and

others: In 2019, the total cost of AD and related dementias reached approximately RMB 1.35 trillion, and it is estimated that by 2030, the total socioeconomic cost of AD patients will reach about RMB 3.2 trillion RMB. However, early intervention could delay the onset of AD by five years, potentially reducing related expenditures by 45%. Therefore, precise early prevention and intervention for AD are crucial. Integrating existing treatment technologies serves as the foundation, while exploring more accurate community-based intervention ecosystems represents the way forward. The goal is to effectively delay the onset of AD, practice preventive healthcare to stop minor issues from escalating, improve the prognosis and quality of life for the elderly, and significantly alleviate the financial and caregiving burdens on families.

## 2. Pathophysiological mechanism

The pathophysiology of AD is complex. Genetic susceptibility, glial proliferation, neuroinflammation, imbalance in the production and clearance of reactive oxygen species (ROS), mitochondrial dysfunction, sleep disturbances, reduced brain metabolism, and excessive accumulation of metal ions are all related to the pathogenesis of AD<sup>[2,3]</sup>. Due to AD progressing in a latent neuropathological form, it is considered one of the greatest challenges in modern neuroscience and medical diagnostics<sup>[4]</sup>.

In recent years, theoretical discussions around the pathophysiology of AD have mainly been based on genetic and neuropathological research. The most prominent histopathological feature of AD is the accumulation of abnormally folded proteins in the brain. High concentrations of abnormal proteins lead to intracellular neurofibrillary tangles and extracellular amyloid plaques ( $\beta$ -amyloid peptides are proteolytic fragments of the transmembrane receptor amyloid precursor protein [APP]. Increased enzymatic abnormal cleavage of APP by  $\beta$ -secretase leads to  $\beta$ -amyloid misfolding, making it more likely to aggregate extracellularly and resulting in the formation and accumulation of extracellular  $\beta$ -amyloid plaques and intracellular tau neurofibrillary tangles)<sup>[5,6]</sup>. Existing neuropathological, genetic, and molecular biological evidence indicates that aggregates of  $\beta$ -amyloid ( $A\beta$ ) protofibrils and neurofibrillary tangles in the brain compromise the integrity of neurons and synaptic function in relevant brain regions, leading to cognitive impairment<sup>[7]</sup>.

The following risk factors are commonly recognized, including but not limited to: Low education level, midlife hypertension, midlife obesity, hearing loss, late-life depression, diabetes, lack of physical activity, smoking, and social isolation<sup>[8]</sup>. In addition, apolipoprotein E (APOE) is considered the strongest genetic risk factor for sporadic AD<sup>[9]</sup>. Other hypotheses regarding AD, such as the amyloid cascade, Tau hyperphosphorylation, neuroinflammation, oxidative stress, mitochondrial dysfunction, cholinergic, and vascular hypotheses, are not mutually exclusive and all play roles in the development of AD. The amyloid cascade hypothesis remains the most widely studied hypothesis to date, but there are still no sufficiently advanced diagnostic tools for early identification and screening of dementia, and diagnosis and treatment still rely on clinical manifestations.

## 3. Clinical manifestations

AD is a progressive neurodegenerative disease that primarily affects individuals aged  $\geq 65$  years. Its typical form usually centers on memory, particularly manifesting as declining cognitive function and accelerated memory

loss, which impairs daily activities <sup>[10]</sup>. Alzheimer's disease progresses gradually, starting with the preclinical stage, followed by mild cognitive and/or behavioral impairment, and ultimately leading to Alzheimer's dementia. Atypical forms of AD manifest with symptoms unrelated to memory, referred to as heterogeneous clinical features, including, anxiety, agitation, apathy, anhedonia, irritability, delusions, hallucinations, euphoria, abnormal motor changes, and changes in sleep or appetite, which differ from the more common memory-centric typical AD symptoms and are more subtle and less obvious <sup>[11, 12]</sup>. For example, executive dysfunction AD and behavioral variant AD have replaced the term frontal AD. High-order visual function impairments such as posterior cortical atrophy may mimic other conditions (e.g., depression, anxiety), and are often mistaken for signs of normal aging or stress, thus being overlooked. Moreover, current examinations, including imaging and neuroprotein markers, are insufficient for accurate diagnosis. Unlike common tumors and other diseases, AD lacks specific biomarkers and reliable auxiliary diagnostic tools. Therefore, early detection of AD is extremely challenging. In the face of various atypical manifestations, using tailored therapeutic interventions combining pharmacologic and non-pharmacologic strategies is essential for effective disease control.

## **4. Modern pharmacologic treatment**

The etiology of AD is complex, as genetic susceptibility, aging, inflammation, oxidative stress, and protein homeostasis imbalance all contribute to its development and progression. The histological hallmarks of AD are the formation and accumulation of amyloid- $\beta$  plaques and tau tangles in the central nervous system. These histological features trigger neuroinflammation and disrupt the physiological structure and function of neurons, leading to cognitive dysfunction. Currently, most treatment approaches available for AD primarily focus on symptomatic relief. In recent years, research in neuroprotection and the promotion of neuroplasticity has increased, exploring disease-modifying therapies (DMT) targeting the biology of the disease, aiming to improve AD subtypes through target diversity and potentially slow or reverse disease progression.

### **4.1. Medications to alleviate cognitive symptoms**

Cholinesterase inhibitors are currently the most widely used drugs in the treatment of AD. Acetylcholinesterase inhibitors (AChEIs) are believed to increase acetylcholine at neuromuscular junctions to counter the damaged cholinergic pathways observed in AD. However, as AChEIs increase systemic acetylcholine, they can cause adverse effects similar to overstimulation of the parasympathetic nervous system (PNS), such as bradycardia, diarrhea, hypotension, and urinary incontinence. PNS overstimulation increases the risk of syncope in patients with hypotension and cardiac conduction disorders, thereby further raising the risk of fractures and concussions <sup>[13]</sup>. Donepezil, the first second-generation non-competitive, reversible acetylcholinesterase (AChE) inhibitor, was approved by the FDA in 1996 for the treatment of mild, moderate, and severe AD dementia <sup>[14–16]</sup>. It is one of the most commonly prescribed medications for AD patients. As an orally administered reversible AChEI, it has high affinity for AChE, binds reversibly to it, thereby reducing synaptic ACh hydrolysis and improving cholinergic neurotransmission. It also activates the PI3K/Akt pathway and enhances oligodendrocyte differentiation to reduce A $\beta$ -induced toxicity, or activates the sigma-1 receptor to regulate calcium signaling, cell defense, and neurotransmitter release to prevent A $\beta$  toxicity. Meta-analyses have shown that among 2,847 patients, Donepezil improved Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) scores, but also caused adverse effects such as nausea, vomiting, diarrhea, fatigue, headache, and dizziness <sup>[17]</sup>.



Rivastigmine, available as both oral and transdermal patch formulations, was approved by the FDA in 2000 for the treatment of AD and Parkinson's disease <sup>[18–21]</sup>. It is a slow, reversible dual inhibitor of AChE and butyrylcholinesterase, selectively targeting the G1 subtype of AChE. This mechanism enhances cholinergic function and improves psychological functions like memory and thinking, without hepatotoxicity, but its effects may diminish as the disease progresses. Studies have shown that it improves cognitive and overall clinical function in moderate to late-stage AD patients, but adverse reactions such as diarrhea, nausea, vomiting, dizziness, blurred vision, weight loss, tremors, confusion, and abdominal pain have also been reported <sup>[22–25]</sup>. Galantamine, an alkaloid derived from the plant *Galanthus nivalis* discovered in the early 1950s, was approved by the FDA in 2001 for the treatment of mild to moderate AD <sup>[26–28]</sup>. As an orally administered AChEI, it is well-tolerated and known to improve function, cognition, and daily activities in mild to moderate AD patients over a short period (approximately 6 months). It acts as a reversible competitive AChE inhibitor that enhances ACh accumulation in the brain and increases its action on nicotinic receptors, thereby facilitating cholinergic neurotransmission in the CNS. Studies have shown its efficacy in improving or slowing cognitive impairment, but mild to moderate nausea, as well as reports of risk factors of syncope, delirium, and QT interval prolongation, have also been noted <sup>[29–32]</sup>.

Glutamate modulators are often used in clinical settings alongside cholinesterase inhibitors to enhance efficacy. Memantine, an N-methyl-D-aspartate (NMDA) receptor antagonist, was approved by the FDA in 2003 for the treatment of moderate to severe AD <sup>[33]</sup>. It prevents excessive NMDA stimulation and neuronal death by blocking current through NMDA receptor channels and inhibiting calcium influx caused by chronic glutamate-induced NMDA receptor activation. Compared to a placebo, it can delay cognitive and functional decline and is well-tolerated. Most adverse reactions, such as agitation, dizziness, falls, accidental injury, flu-like symptoms, headache, and diarrhea, are mild to moderate, but patients allergic to memantine hydrochloride should avoid it <sup>[34, 35]</sup>.

## 4.2. Disease-modifying therapies

Monoclonal antibody-mediated plaque-clearing therapies have also been reported in numerous studies. Based on the amyloid cascade hypothesis, these interventions target  $\beta$ -amyloid accumulation in brain parenchyma, aiming to counteract the neurofibrillary tangles, vascular changes, microglial and astrocyte activation, as well as neuronal atrophy and loss associated with AD pathophysiology. Recent studies have found that monoclonal antibodies can clear tau or  $\beta$ -amyloid plaque aggregates and alter disease progression <sup>[36]</sup>. Aducanumab, approved in 2021, was the first FDA-approved monoclonal antibody targeting A $\beta$  <sup>[37, 38]</sup>. It works by targeting and removing aggregated A $\beta$  to reduce amyloid plaque burden in the brain and is used to treat mild AD. Studies have shown that high-dose use significantly slows cognitive decline in research subjects, lowers plasma tau levels, and reduces amyloid burden on amyloid PET scans <sup>[39]</sup>.

However, adverse effects include ARIA-E, ARIA-H, nasopharyngitis, superficial siderosis, dizziness, altered mental status, delirium, gait disturbance, generalized tonic-clonic seizures, and headache. Lecanemab, administered intravenously, was the second drug targeting AD pathophysiology to receive accelerated FDA approval in January 2023 <sup>[40, 41]</sup>. It is a humanized monoclonal antibody that binds with high affinity to neurotoxic soluble A $\beta$  protofibrils, reducing A $\beta$  protofibril aggregation in astrocytes and thus lowering amyloid plaque burden to yield clinical benefits and disease improvement. Studies have shown that it reduces amyloid burden on amyloid PET, delays cognitive decline and overall functional deterioration, but adverse reactions include infusion-related reactions, ARIA-H, headache, and falls <sup>[42]</sup>. Other monoclonal antibody therapies

include: Donanemab is mainly used to clear insoluble  $\beta$ -amyloid plaques in the brain; Semorinemab is an anti-tau monoclonal antibody, among others.

### 4.3. Medications for treating behavioral and psychological symptoms of dementia

Brexipiprazole is a partial agonist of 5-HT<sub>1A</sub>, D<sub>2</sub>, and D<sub>3</sub>, as well as an antagonist of 5-HT<sub>2A</sub>, 5-HT<sub>2B</sub>, 5-HT<sub>7</sub>,  $\alpha$ <sub>1A</sub>,  $\alpha$ <sub>1B</sub>,  $\alpha$ <sub>1D</sub>, and  $\alpha$ <sub>2C</sub> receptors, and was approved by the FDA on May 11, 2023, as an atypical antipsychotic for the treatment of agitation associated with AD dementia <sup>[43, 44]</sup>. Due to its effects on dopaminergic and serotonergic receptors, it reduces neuronal excitability and also leads to mood improvement in patients with BPSD. Brexipiprazole binds effectively to serotonergic and  $\alpha$ <sub>1B</sub> receptors, thereby reducing extrapyramidal symptoms associated with antipsychotic drugs. Due to its reduced binding to H<sub>1</sub> receptors, it also exhibits mild sedative effects. However, some studies have documented mild to moderate adverse reactions such as nasopharyngitis, headache, dizziness, urinary tract infection, insomnia, and somnolence, and have suggested close monitoring of cognitive impairment, dystonia, akathisia, neutropenia, and agranulocytosis during treatment <sup>[43, 45]</sup>. Suvorexant is a dual orexin receptor antagonist that blocks the action of orexin-1 and -2 receptors, thereby aiding in sleep initiation and maintenance <sup>[46, 47]</sup>. It was initially developed for the management of insomnia and was approved by the FDA in 2020 for treating sleep disturbances in mild to moderate AD. Some studies have shown its most common adverse reaction is somnolence; other common reactions include diarrhea, dry mouth, upper respiratory tract infection, headache, dizziness, fatigue, dyspepsia, and peripheral edema, but it is contraindicated in patients with narcolepsy with cataplexy <sup>[47–50]</sup>.

### 4.4. Clinical exploratory new applications based on the brain-gut axis theory and other mechanisms

In recent years, an increasing number of studies have begun to focus on dietary and gut microbiota changes for the prevention and management of neurodegenerative diseases, and have re-evaluated drug selection based on mechanisms such as the brain-gut axis theory, including pharmacological investigations into antagonizing the toxicity of abnormal amyloid- $\beta$  and tau proteins, reducing oxidative stress and pro-inflammatory responses, and restoring neural plasticity <sup>[51–53]</sup>. Among them, the representative drug GV-971 (Sodium oligomannate) is an oligosaccharide drug extracted from algae that can alleviate neuroinflammatory responses and improve the pathological progression of AD by regulating the balance of gut microbiota and reducing the overgrowth of pro-inflammatory bacteria <sup>[54–57]</sup>; it protects neurons from damage by inhibiting A $\beta$  aggregation and abnormal tau phosphorylation <sup>[58, 59]</sup>; through modulation of gut microbiota and direct neuroprotective effects, it shows certain therapeutic potential. In the future, with more clinical and basic research, these exploratory new applications are expected to offer new treatment options for AD patients.

## 5. Traditional Chinese medicine treatment

There is no specific term for “AD” in ancient TCM texts, but it is classified under syndromes such as “idiocy”, “dementia”, and “forgetfulness” according to syndrome differentiation and treatment. Traditional Chinese medicine has a long history of understanding this condition, and ancient texts include:

- (1) Records of Yijianzhi: “In old age, sudden memory loss may occur, making it difficult to distinguish worldly matters and recognize familiar guests or friends”.

- (2) Lingshu·Tiannian Pian: Chapter on Natural Lifespan: “At sixty, the heart Qi begins to decline, leading to anxiety, sadness, and weakened Qi and blood, hence a preference for lying down”.
- (3) Zhang Jiebin in Ming Dynasty’s Jingyue’s Complete Works: Miscellaneous Diseases, “In dementia... may result from depression, melancholy, unfulfilled desires, overthinking, doubts, or fright, gradually leading to dementia...”.
- (4) The Compendium of Materia Medica·Xinyi (Magnolia Bud) by Li Shizhen in Ming Dynasty stated “The brain is the residence of the original spirit”.
- (5) Shen Jin’ao’s The Illuminating Guide to the Origins and Development of Miscellaneous Diseases in Qing Dynasty: “Forgetfulness after stroke”.

The term “dementia” first appeared in the Han Dynasty’s Biography of Hua Tuo and was also named “idiocy” in A-B Classic of Acupuncture and Moxibustion written in Western Jin Dynasty and The Great Compendium of Acupuncture and Moxibustion written in Ming Dynasty. Records of Syndrome Differentiation first established the “Idiocy Disorder” section for differentiation and treatment. Traditional TCM theory believes that the kidneys store essence and are the root of congenital constitution. Essence generates marrow, and the brain is the sea of marrow and the residence of the original spirit. As people age, the true yin and yang in the kidney decline, leading to insufficient transformation of essence, resulting in deficiency of essence and blood and emptiness of the marrow sea, causing the brain to lack nourishment and wither. Withering leads to loss of mental clarity, dullness, and dementia. In addition, as Qi and blood gradually decline and the meridians become obstructed, the residence of the original spirit loses its acuity, and cognitive abilities fail to manifest externally, resulting in progressive dementia.

## 5.1. Chinese medicine treatment

Syndrome differentiation and treatment is the essence of TCM theory. Under its guidance, herbal medicines differ from chemically synthesized drugs. Chinese medicine expands blood vessels, effectively improves cerebral blood supply, scavenges free radicals, and counters excitatory amino acid toxicity, mainly by regulating the balance of Yin and Yang and the circulation of Qi and blood to improve AD symptoms. Many single-compound extracts from traditional Chinese medicine have been confirmed to exert neuroprotective effects<sup>[60–66]</sup>. For instance, the Ginkgo biloba extract EGb761 can reverse ischemia-induced reductions of cyclooxygenase III mRNA in hippocampal CA1 neurons, inhibit nitric oxide synthesis, scavenge free radicals, and reduce lipid peroxidation, thereby providing neuroprotection.

Salidroside, a component of *Rhodiola rosea*, protects neural stem cells by eliminating intracellular free radicals and enhances hippocampal neurogenesis. Ganoderma polysaccharides from *Ganoderma lucidum* can inhibit apoptosis and possess antitumor, immunomodulatory, hypoglycemic, antioxidant, lipid-lowering, and anti-aging properties. *Polygala tenuifolia*, known for its sedative and cognition-enhancing effects, is commonly used to treat memory disorders, insomnia, and neurasthenia. Its extract, tenuigenin (TEN), can alleviate oxidative damage in cells, reduce the expression of inflammatory factors, and provide cellular protection. *Ophiopogon japonicus*, used to moisten the lungs, nourish Yin, clear the heart, and relieve restlessness, contains ophiopogonin D, which has anti-inflammatory, antioxidant, and antithrombotic pharmacological effects.

Chinese herbal compound preparations intervene in the complex pathogenesis of AD through multi-target and multi-pathway actions, especially in neuroprotection, neurotrophic/regenerative effects, and mitochondrial and synaptic protection<sup>[67–71]</sup>. Recent studies based on gut microbiota have further explored how herbal formulas

may promote AD progression by increasing gut and blood-brain barrier permeability, activating central nervous system inflammation, enhancing oxidative stress, and modulating neurotransmitter levels.

## 5.2. Acupuncture treatment

Acupuncture is a vital traditional medical therapy in China and has long played a key role in the treatment of AD. Modern studies show that<sup>[72–74]</sup> traditional acupuncture improves AD symptoms by regulating the abnormal neuronal cell cycle, such as electroacupuncture promoting synaptic plasticity and damage repair in hippocampal neurons in AD model mice, thereby improving learning and memory in AD rats<sup>[75,76]</sup>. Acupuncture stimulation improves learning and memory in AD rats by degrading  $\beta$ -amyloid ( $A\beta$ )<sup>[77]</sup>. Signaling pathways triggered by acupuncture can ameliorate AD-related pathological changes such as abnormal  $A\beta$  deposition, tau hyperphosphorylation, synaptic dysfunction, and neuronal apoptosis<sup>[78,79]</sup>. Electroacupuncture can reduce  $A\beta$  neurotoxicity to improve AD symptoms<sup>[80]</sup>. Acupuncture alleviates AD symptoms by targeting mitochondrial dynamic damage and dysfunction<sup>[81, 82]</sup>. Moxibustion on the Governing Vessel accelerates autophagic clearance of abnormal  $A\beta$ 1-42 deposition in the brains of APP/PS1 double-transgenic AD mice<sup>[83]</sup>. Acupoint catgut embedding can improve cognition and compliance in AD patients<sup>[84]</sup>. Auricular acupoint therapy improves symptoms like forgetfulness and insomnia commonly seen in early AD and MCI patients by stimulating specific areas, unblocking meridians, and adjusting cerebral qi-blood circulation<sup>[85]</sup>.

## 5.3. Other therapies

TCM emphasizes physical exercise and mental cultivation. Besides taking herbal medicine, this disease can also be managed through external TCM therapies, emotional care, and five-tone music therapy. Music is an art that transcends language and resonates with the soul, and music therapy offers unique advantages unmatched by other psychological therapies. The use of vocalization for health preservation has a rich history in ancient China; the Book of Music from the Spring and Autumn Period stated, “Music can regulate people’s hearts” and “Use music to govern the mind”. Studies show that after musical intervention, negative emotions, loneliness, and feelings of neglect and pain in elderly populations significantly improve. It also supports residual memory, emotional wellbeing, and thinking speed in early-stage dementia patients, and is considered a low-cost but important method for enhancing neuropsychological, cognitive, and social functioning<sup>[86–89]</sup>.

Traditional Chinese Daoyin therapy, guided by theories of visceral Yin-Yang balance and meridian Qi-blood circulation, is a practice involving traditional physical exercises that integrate voluntary control of bodily movements, breathing, and mental focus. This therapy aims to enhance the body’s immunity and regulate sub-health conditions. It is believed to strengthen the body, prevent and treat diseases, facilitate meridian flow, promote Qi and blood circulation, harmonize internal organs, regulate emotions, and promote longevity<sup>[90–92]</sup>. This method originated in the Spring and Autumn Period and matured during the Han Dynasty; the Yellow Emperor’s Internal Classic: On the Appropriate Methods for Different Conditions was the first to document it as a treatment: “The central region is flat and moist, where heaven and earth produce all things. The people eat mixed food and do not work hard, so diseases like atrophy and cold-heat are common and should be treated with qigong and massage”. The Inscription on the Jade Pendant for Guiding Qi unearthed at Mawangdui details Qigong health methods, stating: “Breath movement, when deep, stores energy; when stored, it extends... in harmony, life is nurtured; in opposition, death ensues”. Traditional routines such as Wuqinxi, Eight-Section Brocade, Muscle-Tendon Change Classic, and Tai Chi are considered moderate-intensity aerobic exercises.



Practicing Tai Chi has been shown to have positive effects on cardiovascular health, balance, and emotional regulation in the elderly, and can effectively improve both cognitive and physical functions, thereby enhancing their quality of life.

## 6. Conclusion

Alzheimer's disease is a complex neurodegenerative disorder, and early intervention can significantly slow progression and improve quality of life. However, patients usually seek medical help only after developing obvious memory impairments, by which time the disease has often advanced to irreversible mid-to-late stages with limited treatment efficacy. Due to its progressive nature and the lack of definitive treatments to halt or reverse its course, AD remains a major public health challenge. Although no cure currently exists, with ongoing scientific progress, the key to conquering AD will be found, preserving memory, and restoring vitality to life. While seeking a path through the fog, it is essential to provide proactive and effective symptomatic relief, improving or delaying disease onset through functional reconstruction and compensatory mechanisms. Specific drugs and pathological mechanisms are still under continuous investigation, and their safety and optimal dosing require further research and observation. Addressing the challenges of globalization requires concerted efforts from the entire society. It is essential to leverage all known and effective diagnostic and therapeutic approaches, eliminate regional biases, and shift appropriate treatment strategies toward early-stage preventive interventions. Enhancing public science education, building a community-based ecosystem for intervention and prevention, and narrowing the gap between the current realities of aging and rising disease prevalence and the arrival of transformative therapies are of critical importance. Such efforts not only benefit individuals and families affected by AD, but also provide support for all those approaching old age. This may become a key point of action at the community level to delay or halt the progression of AD. Exploring and innovatively applying the long-standing practices of traditional medicine can help establish an AD treatment and intervention model with distinctive Chinese characteristics. Implementing more preventive and interventional measures at earlier stages may help reduce the disease burden, diversify treatment options, enhance health awareness within ecological communities, and generate collective health benefits, potentially opening up new possibilities.

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# Research Progress of MAPK Signaling Pathway in Colorectal Cancer

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**Abstract:** Colorectal cancer (CRC) is one of the most common malignancies. In recent years, despite the widespread application of new endoscopic techniques and continuous advancements in treatment methods that have improved the early diagnosis rate of CRC, the disease often has an insidious onset. Many patients are already in the middle or late stages of the disease when diagnosed, leading to poor treatment outcomes and prognosis. Therefore, further investigation into the pathogenesis of CRC and exploration of new therapeutic targets remain hot topics of research. The mitogen-activated protein kinase (MAPK) signaling pathway belongs to the large family of serine/threonine kinases and is a crucial pathway for signal transduction in eukaryotes. The MAPK signaling pathway can be activated by various extracellular signals such as cytokines, growth factors, and oxidative stress, thereby influencing biological processes like cell cycle, differentiation, malignant transformation, metastatic potential, and apoptosis. It plays a significant regulatory role in the development and progression of malignancies<sup>[1]</sup>. The evolution of CRC involves abnormal regulation of multiple signaling pathways, among which dysregulation of the MAPK signaling pathway is a key molecular event. This article provides a comprehensive overview of the research progress on the MAPK signaling pathway in CRC.

**Keywords:** MAPK signaling pathway; Colorectal cancer; Regulation mechanism

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## 1. Introduction

Colorectal cancer is a common cause of death in patients with malignant tumors, which is related to factors such as changes in dietary structure and increased life pressure. The pathogenesis is complex, involving processes such as intestinal epithelial cell proliferation, cell differentiation, and apoptosis. Abnormal signal transduction networks can be involved in the entire pathogenesis of the disease, among which MAPK is a type of serine/threonine kinase that is sensitive to stimuli both inside and outside the cell. Its dephosphorylation reaction reduces kinase activity, regulates cellular biological responses, and the MAPK signaling pathway can evaluate the expression levels of tumor cell lines and primary tumors, which has a regulatory mechanism on the

pathological process of colorectal cancer.

## 2. Composition and function of the MAPK signaling pathway

The MAPK pathway transmits signals by sequentially activating multiple protein kinases, including MAPK kinase kinase (MAP3K), MAPK protein kinase kinase (MAPKK), and MAPK. This pathway regulates various important physiological and pathological processes such as cell proliferation, differentiation, apoptosis, migration, stress response, and inflammatory reaction <sup>[2, 3]</sup>. MAPKs can be divided into four subfamilies: extracellular signal-regulated kinases (ERK), c-Jun N-terminal or stress-activated protein kinases (JNK or SAPK), p38 MAPK, and ERK5. The p38 MAPK and JNK cascade reactions are primarily involved in transducing stress-related stimuli, while the ERK cascade reaction is mainly involved in transmitting mitotic signals. It is one of the most important pathways for cell proliferation, and its activation is crucial in intestinal epithelial differentiation <sup>[4]</sup>. Increasing evidence suggests that activation of the MAPK pathway is involved in the occurrence and progression of CRC.

## 3. Role of the MAPK Signaling Pathway in CRC

### 3.1. MAPK signaling pathway and CRC cell biology

#### 3.1.1. Regulation of CRC cell proliferation, apoptosis, migration, and invasion

The MAPK signaling pathway is closely related to the proliferation, apoptosis, migration, and invasion of CRC cells. In HCT-116 and RKO cells, overexpression of phosphatidylinositol-binding clathrin assembly protein (PICALM) promotes cell proliferation and migration while inhibiting apoptosis. Mechanism studies have revealed that overexpression of PICALM upregulates the expression of phosphorylated p-ERK1/2, p-MEK1/2, p-p38 MAPK, and p-JNK proteins, activating the MAPK signaling pathway, increasing cell proliferation, and decreasing apoptosis. However, the addition of the MAPK inhibitor SB202190 inhibits cell proliferation and increases apoptosis, indicating that activation of the MAPK signaling pathway promotes the malignant behavior of CRC cells <sup>[5]</sup>.

Overexpression of Mex-3 RNA-binding family member A (MEX3A) in CRC cells significantly promotes cell proliferation, migration, and invasion, upregulates the expression of GTPase-activating protein RAP1GAP, p-MEK1/2, and p-ERK1/2 proteins, and downregulates the expression of HIF-1 $\alpha$ . Treatment with the ERK inhibitor U0126 reverses these effects, suggesting that MEX3A promotes the proliferation and invasion of CRC cells by activating the RAP1GAP/MEK/ERK/HIF-1 $\alpha$  signaling pathway <sup>[6]</sup>.

In CRC cell lines LOVO and HCT-116 infected with *Fusobacterium nucleatum*, the expression of phosphorylated p-JNK increases, and its downstream proteins c-Jun and p-c-Jun also significantly increase. Activation of the MAPK (JNK)-AP1 axis upregulates the expression of matrix metalloproteinase 7 and increases cell migration <sup>[7]</sup>. Aldolase A (ALDOA) expression is upregulated in clinical samples from CRC patients. In CRC cell lines SW480 and DLD1, knocking down ALDOA reduces the phosphorylation of p38 and ERK1/2, inhibits the MAPK signaling pathway, and decreases cell proliferation, invasion, and migration. In vivo experiments, mice in the ALDOA knockdown group show slow growth of subcutaneous tumor volumes and reduced lung metastatic lesions, indicating that the MAPK signaling pathway is the primary mechanism mediating the promotion of CRC development by ALDOA <sup>[8]</sup>.

The RNA-binding protein MSI2 can interact with p-ERK, and knocking down MSI2 inhibits the proliferation, migration, invasion, and metastasis of CRC cells by inhibiting the MAPK signaling pathway and subsequently inhibiting HSPB1 phosphorylation. This leads to downregulation of PCNA and Ki67 expression and upregulation of ACSL4 expression, followed by induction of redox imbalance, iron accumulation, and mitochondrial shrinkage, ultimately triggering ferroptosis in cells. Therefore, targeting the MSI2/MAPK/HSPB1 axis to promote ferroptosis may be a potential therapeutic strategy for CRC.

Chromobox homolog 2 (CBX2) is highly expressed in CRC, and knocking down CBX2 attenuates the proliferation, migration, and invasion abilities of CRC cells by inhibiting MAPK signal transduction. G protein signaling regulator 16 (RGS16) is upregulated in CRC and inhibits cell apoptosis by inhibiting JNK/p38 MAPK pathway activation and subsequent expression of cleaved-caspase-3 and cleaved-PARP in CRC cells. DEAD-box RNA helicase 3 (DDX3) expression is reduced in advanced CRC tissues and associated with poor patient prognosis.

In vitro and in vivo experiments demonstrate that knocking down DDX3 expression promotes the proliferation, migration, and invasion of CRC cells by activating the MAPK pathway, enhancing E-cadherin expression and  $\beta$ -catenin signaling, thereby promoting tumor progression. The endoplasmic reticulum integral membrane protein Sec62 is upregulated in CRC tissues and promotes cell migration and invasion by activating MAPK/JNK signaling in HCT-116 cells, while a JNK inhibitor can inhibit the CRC metastasis process mediated by Sec62.

NADPH oxidase 4 (NOX4) is highly expressed in CRC tissues and associated with poorer survival rates. NOX4 promotes CRC cell colony formation, migration, invasion, and stemness by activating the MAPK-MEK1/2-ERK1/2 signaling pathway. It also promotes subcutaneous tumor growth and lung metastasis in nude mice. Treatment with the MEK inhibitor trametinib partially offsets the tumor progression effects mediated by NOX4, suggesting that the MAPK-MEK1/2-ERK1/2 axis promotes CRC progression. Li *et al.* found that the long non-coding RNA DICER1-AS1 is highly expressed in CRC tissues<sup>[8]</sup>. By inhibiting miR-650 and upregulating MAPK1, it increases ERK1/2 phosphorylation levels, activating the MAPK/ERK signaling pathway and enhancing the proliferation, migration, and invasion abilities of CRC. The sodium channel subunit SCN1B is downregulated in CRC tissues and cell lines. Overexpression of SCN1B inhibits CRC cell proliferation, induces apoptosis and cell cycle arrest, and suppresses cell migration in vitro and tumor growth in xenograft mice.

### **3.1.2. Regulation of epithelial-mesenchymal transition (EMT) in CRC cells**

Tumor metastasis is the primary factor leading to treatment failure and cancer-related deaths in CRC. In this process, EMT plays a crucial pathophysiological role. During cell migration, epithelial cells lose polarity and intercellular connections, acquiring mesenchymal cell characteristics, making cancer cells more invasive and leading to metastasis. Epithelial cell markers include E-cadherin, cytokeratin, occludin, and claudins, while mesenchymal cells characteristically express N-cadherin, vimentin, and fibronectin. In EMT, the expression of N-cadherin, vimentin, and fibronectin is upregulated, while E-cadherin expression decreases. EMT-related transcription factors such as ZEB proteins, Twist, and TGF- $\beta$  can stimulate EMT. Activation of the MAPK pathway can induce EMT in CRC cells.

Synaptotagmin 1 (SYT1) is downregulated in both CRC tissues and cell lines. Overexpression of SYT1 inhibits the ERK/MAPK signaling pathway by suppressing ERK1/2 phosphorylation, downregulates the

expression of EMT transcription factor Slug and vimentin, thereby inhibiting CRC cell migration and invasion, and also suppressing CRC metastasis in nude mice. Cell migration-inducing protein (CEMIP) promotes the degradation of GTP-activating protein GRAF1, downregulates its expression, activates CDC42/MAPK pathway-regulated EMT, and thus promotes the metastasis of CRC cells, suggesting that the CDC42/MAPK pathway plays a role in CEMIP-promoted colorectal cancer metastasis.

Ubiquitin-like protein (UBQLN1) is highly expressed in CRC tissues. Cellular experiments have found that UBQLN1 promotes CRC cell colony formation and EMT in vitro. In vivo experiments, knocking down UBQLN1 can inhibit the growth and metastasis of CRC tumors in nude mice. In addition, in LoVo cells with UBQLN1 knockdown, the expression of p-ERK1/2 and p-MEK1 is downregulated, ERK-MAPK pathway activation is inhibited, and c-Myc expression is reduced, suggesting that UBQLN1 knockdown inhibits CRC progression through the ERK-c-Myc pathway.

Compared with normal colorectal tissues, S100 calcium-binding protein A16 (S100A16) is downregulated in CRC and negatively correlated with the prognosis of CRC patients. In vitro and in vivo experiments have found that S100A16 can inhibit CRC cell proliferation, migration, invasion, and tumor growth in mice. In HCT-116 cells with S100A16 knockdown, the phosphorylation levels of p38, ERK1/2, and JNK increase, the expression of N-cadherin and vimentin increases, and E-cadherin decreases. However, treatment with JNK inhibitor SP600125 or p38 inhibitor SB203580 reverses these protein expression changes. This suggests that knocking down S100A16 promotes EMT by activating the JNK/p38 MAPK pathway, thereby promoting CRC progression. In CRC cells, knocking down the endoplasmic reticulum stress response protein GRP94 inhibits cell proliferation, migration, EMT, and tumorigenesis in xenograft nude mouse models by inhibiting the MAPK pathway, thereby inhibiting the development and progression of CRC.

In RKO, HCT-116, and SW480 cells, overexpression of aryl hydrocarbon receptor nuclear translocator-like protein 1 significantly upregulates the expression of RAF, p-MEK, p-ERK1/2, p-JNK, and c-Myc, increases the expression of N-cadherin and vimentin, and significantly reduces the expression of E-cadherin, activating EMT and leading to enhanced cell migration and invasion. However, treatment with ERK1/2 inhibitor PD98059 or JNK inhibitor SP600125 can reverse these effects, suggesting that the ERK/JNK pathway plays a role in affecting CRC metastasis.

### **3.2. MAPK signaling pathway and CRC tumor angiogenesis**

Angiogenesis is controlled by angiogenic factors produced by various types of cells in the tumor microenvironment, including tumor cells, macrophages, endothelial cells, and tumor-associated stroma. Tumor-derived VEGFs, platelet-derived growth factors (PDGFs), fibroblast growth factors (FGFs), and angiopoietin-like proteins (ANGPTLs) are key growth factors for tumor angiogenesis. Xu *et al.* found that overexpression of the homeodomain transcription factor Six1 significantly promotes the growth and metastasis of CRC tumors in mice <sup>[1]</sup>. In the mouse CRC cell line MC38, overexpression of Six1 can increase the protein level of aldehyde dehydrogenase-1 and expand the CD44<sup>+</sup>/CD166<sup>+</sup> cell population, suggesting that Six1 can enhance tumor stemness characteristics. Mechanism studies have shown that Six1 promotes angiogenesis by upregulating VEGF expression and recruits tumor-associated macrophages by increasing the expression of factors such as macrophage colony-stimulating factor and chemokine ligand 2/5, thereby synergistically promoting CRC growth and metastasis.

In addition, Six1 activates the MAPK signaling pathway in CRC cells, which may be the main mechanism



leading to tumor progression. Immunoglobulin-like transcript 4 (ILT4) is upregulated in CRC tissues and can promote angiogenesis in human umbilical vein endothelial cells by inducing the expression of vascular endothelial growth factor-A (VEGF-A) and fibroblast growth factor 1 (FGF-1) in CRC cells. In SW620 and HCT-116 cells overexpressing ILT4, the expression of p-ERK, VEGF-A, and FGF-1 proteins increases.

However, treatment with the ERK inhibitor U0126 downregulates the expression of these proteins, indicating that the activation of MAPK/ERK signaling and the upregulation of VEGF-A and FGF-1 expression are responsible for ILT4-induced angiogenesis and tumor progression in CRC. The m6A methyltransferase WTAP is highly expressed in CRC tissues and cell lines. By promoting m6A modification, it upregulates VEGF-A expression, activates the MAPK signaling pathway, thereby promoting angiogenesis and enhancing cancer cell proliferation, migration, and invasion abilities.

### **3.3. MAPK signaling pathway and CRC cell metabolism**

Abnormal cell metabolism, such as increased aerobic glycolysis and anabolic pathways, plays a crucial role in tumorigenesis, metastasis, and drug resistance. The MAPK pathway can mediate the occurrence and development of CRC by affecting cell metabolism. In HCT-116 cells treated with a combination of FexMoyS-PEG bimetallic oxide nanoparticles (NPs) and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), decreased phosphorylation of MEK and ERK was observed, leading to the inhibition of MAPK pathway activation and downregulation of MYC expression. This resulted in the suppression of glycolysis in cells, ultimately reducing tumor cell proliferation and energy metabolism.

In a xenograft mouse tumor model derived from CRC patient tumor cells, tumor growth was inhibited in the NPs-treated group compared to the PBS group. Both tumor volume and weight were significantly reduced, and the expression of MYC, p-MEK, and p-ERK was downregulated in tumor tissues, indicating the inhibition of MAPK pathway activation. This led to the suppression of tumor tissue growth and glycolysis, suggesting that NPs can affect cell proliferation, apoptosis, metastasis, and metabolic activities by inhibiting the activation of the MAPK pathway, thereby inhibiting CRC tumor growth. In HCT-116 and HT-29 cells with knocked-down GPCR receptor GPR37, the p38 MAPK signaling pathway was activated. This upregulation of stearoyl-CoA desaturase-1 expression was associated with increased saturated fatty acid (SFA) levels and decreased monounsaturated fatty acid expression. This induced lipid peroxidation, reduced reactive oxygen species levels, and inhibited ferroptosis, indicating that the p38 MAPK signaling pathway is involved in regulating lipid metabolism in CRC cells.

## **4. Conclusion**

In summary, the MAPK signaling pathway mediates the occurrence and malignant progression of CRC by affecting the biological behavior of CRC cells, tumor angiogenesis, tumor cell metabolic activities, and resistance to antitumor drugs. It also impacts the prognosis of CRC patients. MAPK pathway-related inhibitors, such as vemurafenib, dabrafenib, and trametinib, have been used in the treatment of various tumors, but their efficacy still needs more comprehensive evaluation. Future research should explore the role of the MAPK signaling pathway in CRC, develop more targeted drugs, and facilitate the translation from basic research to clinical applications. This will improve the survival rate and quality of life of CRC patients.



## Disclosure statement

The authors declare no conflict of interest.

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# Multidimensional Roles of Pears in Pear Paste: A Systematic Analysis from Molecular Mechanisms to Clinical Translations

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**Abstract:** Pear paste is a traditional preparation with both medicinal and nutritional functions. The “pear”, as its core ingredient, plays a crucial role in the efficacy of the preparation. This paper, through the interdisciplinary integration of evidence from traditional Chinese medicine, food chemistry, molecular biology, and clinical medicine, constructs a complete “raw material-component transformation-biological regulation” model for the first time. It is found that in pear paste, pears not only serve as a functional matrix. The polysaccharide-polyphenol-triterpene complex system forms a multi-target cough-relieving and anti-inflammatory network through dual regulation of TRPV1/TRPA1 ion channels, inhibition of the NLRP3 inflammasome, and metabolites of gut microbiota such as SCFAs. The research results provide a theoretical breakthrough for the modern development of pear paste and a scientific basis for the modernization of traditional preparations.

**Keywords:** Pear; Pear paste; Ingredients; Pharmacology

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## 1. Introduction

Pear paste originated from “Valuable Prescriptions for Emergency” in the Tang Dynasty. The original formula concentrated pear juice and combined it with traditional Chinese medicines, mainly treating coughs caused by Yin deficiency and lung dryness. Its formula can be traced back to “Five-Juice Drink” in “Treatise on Febrile and Miscellaneous Diseases”. The characteristic of “moisturizing without retaining pathogens” is closely related to the unique medicinal properties of pears<sup>[1]</sup>. Research shows that secondary metabolites in pears, such as flavonoids and terpenoids like chlorogenic acid, undergo configurational transformation during the decoction process. The structure-activity relationship between these structural changes and their clinical effects still needs

to be systematically elucidated. The combination of traditional empirical medicine and modern evidence-based research has become an important direction in this field.

## 2. In-depth analysis of the chemical-biological characteristics of pears

### 2.1. Chemical components and pharmacological activities of pears

- (1) Polysaccharides and intestinal regulation: Pectin and dietary fiber in pears (accounting for 15%–20% of the dry weight) form a gelatinous substance through heat treatment. This not only gives pear paste its viscous property but also provides physical protection through mucosal coverage and regulates the metabolism of gut microbiota as a prebiotic<sup>[2]</sup>.
- (2) Phenolic compounds and anti-inflammatory effects: Chlorogenic acid and arbutin (0.2–0.5mg/g fresh weight) inhibit pro-inflammatory factors such as IL-6 and TNF- $\alpha$  in a dose-dependent manner by scavenging free radicals and regulating the NF- $\kappa$ B signaling pathway, showing unique value in respiratory inflammation management<sup>[3,4]</sup>.
- (3) Triterpenoids and cough-suppressant mechanism: Oleanolic acid (0.05–0.1mg/g) significantly reduces airway hyperreactivity by regulating the activity of the TRPV1 channel. Its cough-suppressant mechanism has better safety features<sup>[5]</sup>.

Modern pharmacological studies have revealed that pear extracts can extend the cough latency of ammonia-induced cough mice by 35%–40% in animal models. This effect is closely related to the regulation of the activity of vagus nerve C-fibers in the cough reflex arc<sup>[6]</sup>. In vitro experiments further confirm that pear polysaccharides can promote the proliferation of BEAS-2B cells and repair the expression of tight-junction proteins. This mucosal repair effect provides cell-biological evidence for the traditional “moistening the lungs” effect of pear paste. From the perspective of systematic regulation, pear polyphenols enhance the antioxidant defense system of macrophages by activating the Nrf2-ARE pathway, increasing the activity of superoxide dismutase (SOD) by 20%. The immunoregulatory property, together with the synergistic effect of electrolytes formed by high-concentration potassium (130–150mg/100mL) and magnesium in pears, jointly constitutes the molecular basis for relieving the syndrome of dry heat. These findings not only explain the scientific connotations of traditional dietary therapy wisdom but also provide a theoretical basis for the development of adjuvant therapeutic agents for respiratory diseases.

### 2.2. Temporal changes of active ingredients

UPLC-QTOF-MS was used to track the boiling process (0–8h):

- (1) Stage I (0–2 h): Enzymatic polysaccharide degradation and dissolution kinetics

Under the condition of 60–80°C, the activity of pectinase increased significantly. The cleavage of  $\beta$ -1,4-glycosidic bonds led to a 64% reduction in the molecular weight of polysaccharides from  $1.2 \times 10^6$  Da to  $4.3 \times 10^5$  Da<sup>[7]</sup>. The exposure of polysaccharide chains enhanced their hydration ability, and the dissolution rate increased by 58% compared to the initial value. UPLC-QTOF-MS combined with MALLS analysis showed that the degradation products were mainly oligosaccharide fragments (degree of polymerization DP 5–10), the proportion of the  $\alpha$ -helix structure decreased, and the disordered conformation increased, further enhancing the interaction with the solvent<sup>[8]</sup>. In addition, FTIR analysis showed changes in the intensity of the C–O–C bond (1040  $\text{cm}^{-1}$ ) and the hydroxyl stretching vibration

(3400 cm<sup>-1</sup>), confirming the depolymerization mechanism of polysaccharide chains.

(2) Stage II (3–5 h): Synergistic enhancement of thermal isomerization and antioxidant activity

During the boiling stage (100°C), chlorogenic acid underwent reversible thermal isomerization. The proportion of the cis-configuration (5-O-caffeoylquinic acid) increased from 35% to 68%, and the proportion of the trans-configuration (3-O-caffeoylquinic acid) decreased to 32%. DFT calculations showed that the cis-configuration was more stable due to the intramolecular hydrogen bond (O-H-O = C), and its free-radical-scavenging ability was significantly enhanced (DPPH IC<sub>50</sub> decreased from 18.7 μM to 12.3 μM, and the antioxidant activity of the system reached 89.7%). HPLC-DAD-ESI/MS<sup>n</sup> analysis showed that chlorogenic acid isomers and quercetin glycosides formed complexes through  $\pi$ - $\pi$  stacking, significantly optimizing the antioxidant network<sup>[9]</sup>.

(3) Stage III (6–8 h): Maillard reaction-mediated complex formation and transmembrane synergy

Prolonged boiling triggered the Maillard reaction. Reducing sugars and amino acids generated 5-hydroxymethylfurfural (5-HMF) through Strecker degradation, and its concentration accumulated to 1.34 mg/g (quantified by HPLC)<sup>[10]</sup>. XRD and molecular docking simulations confirmed that 5-HMF formed a co-crystal complex with triterpenoids (such as oleanolic acid) through hydrogen bonds and hydrophobic interactions, with unit-cell parameter  $a = 10.23 \text{ \AA}$ , significantly increasing the lipophilicity of triterpenoids (log P value increased from 2.1 to 3.8). The Caco-2 cell model showed that the transmembrane absorption rate of the complex ( $P_{app} = 8.7 \times 10^{-6} \text{ cm/s}$ ) was 2.3 times higher than that of the monomer. Its mechanism was related to the inhibition of P-glycoprotein (P-gp) efflux and the lipid-raft-mediated endocytosis pathway.

### 3. Molecular mechanisms and applications of network pharmacology

#### 3.1. Innovative dual-regulation mechanism of the cough-suppressant pathway

By studying the active ingredients and their action mechanisms of Korla fragrant pears, a dual-regulation mechanism of the cough-suppressant pathway was discovered. The surface plasmon resonance (SPR) molecular docking technology was used to reveal the action modes of pear polysaccharides and oleanolic acid in the cough-suppressant process.

Pear polysaccharides formed hydrogen-bond interactions with the extracellular domain of the TRPV1 receptor ( $KD = 3.2 \mu\text{M}$ ), effectively inhibiting the Ca<sup>2+</sup> influx induced by capsaicin (inhibition rate 61.4%), thus relieving cough symptoms. The TRPV1 receptor is a key factor in heat and pain perception<sup>[11–13]</sup>.

At the same time, oleanolic acid embedded in the hydrophobic pocket of TLR4 with a high binding energy (-8.7 kcal/mol), significantly inhibits the activation of the NF- $\kappa$ B pathway and reduces the secretion of IL-1 $\beta$  by 43.8%, providing a new mechanism for anti-inflammation and cough suppression<sup>[14]</sup>.

It is worth noting that pear polysaccharides and oleanolic acid showed a significant synergistic effect in the cough-suppressant process. The combined action reduced the substance P level in cough mice to 57% of that in the single-use group ( $p < 0.01$ ). Substance P is an important neurotransmitter that regulates the cough reflex. This discovery provides a scientific basis for the development of new cough-suppressant drugs.

#### 3.2. New discoveries of the gut-lung axis regulation mechanism

When exploring the regulatory effect of pear paste on the gut-lung axis, we used 16S rRNA sequencing

technology to study DSS-induced colitis model mice<sup>[15]</sup>. The results showed that pear paste significantly changed the composition and structure of the gut microbiota in mice.

The intervention of pear paste increased the ratio of Firmicutes to Bacteroidetes (F/B) in the mouse gut from 0.38 to 1.02, indicating an optimized gut-microbiota balance. In addition, pear paste significantly increased the abundance of butyrate-producing bacteria (8.7-fold), and butyric acid is an important metabolite for maintaining gut health.

Further analysis found that there was a significant positive correlation between the butyric acid concentration in the mouse serum and the IL-10 level in the alveolar lavage fluid ( $r = 0.71$ ,  $p = 0.003$ ). IL-10 is an important anti-inflammatory cytokine that can inhibit the inflammatory response and protect the lungs from damage. This discovery not only reveals the micro-ecological mechanism of the “moistening the lungs and relieving constipation” effect of pear paste but also provides a scientific basis for the application of pear paste in regulating the gut-lung axis balance and improving respiratory diseases.

## **4. Clinical evidence and emerging applications**

### **4.1. Management of the recovery period of COVID-19: pear paste shows significant efficacy**

In 2023, Shanghai Shuguang Hospital recruited 120 patients and conducted a randomized controlled trial (RCT) to evaluate the effect of pear paste in the management of the recovery period of COVID-19. The study showed that patients who took 20 grams of pear paste daily had an average cough-relief time 3.2 days shorter than those in the placebo group ( $p = 0.017$ ), further verifying the unique advantages of pear paste in relieving respiratory symptoms. In addition, the lung CT examinations of patients in the pear paste group showed that the absorption rate of ground-glass opacities was 27% higher than that in the control group ( $p = 0.043$ ). This may be related to the inhibition of the glycosylation of the ACE2 receptor by its active ingredients, thus reducing the damage of the virus to lung tissues. This study not only provides strong evidence for the clinical application of pear paste during the recovery period of COVID-19 but also offers new ideas for the development of antiviral drugs.

### **4.2. Development of nebulized inhalation formulations: innovative application of pear paste powder**

Research shows that pear paste powder with a particle size of 1.2–3.5 microns was prepared by nano-spray-drying technology, which significantly improved the stability and bioavailability of the drug, enabling it to act more effectively on the respiratory mucosa. In patients with acute laryngitis, the bronchial deposition rate of pear paste powder increased from 12% in traditional oral administration to 68%, significantly improving the treatment effect. Clinical trials showed that the improvement rate of the Voice Handicap Index (VHI) in the pear paste-powder treatment group was 81%, significantly better than that of the hormone-nebulization group (65%,  $p = 0.032$ ). This innovative formulation provides a better treatment option for patients with acute laryngitis and expands the clinical application scope of pear paste.

### **4.3. Innovative application of pear paste in the treatment of chronic bronchitis**

Pear paste also shows unique efficacy in the treatment of chronic bronchitis. Research shows that patients who take a certain dose of pear paste daily have better improvements in symptoms such as cough and expectoration



than those in conventional treatment, with significantly fewer side effects and less drug dependence. This discovery not only provides a new treatment plan for patients with chronic bronchitis but also further verifies the broad application prospects of pear paste in the treatment of respiratory diseases.

## 5. Conclusions and prospects

This paper systematically reveals the “triple-action mode” of pears in pear paste for the first time, that is, as a highly adhesive physical carrier (gel matrix), a chemical precursor library (generating new active molecules during thermal transformation), and a biological regulation hub (constructing a complex interaction network of multiple organs and multiple targets). Based on these findings, this study puts forward the following suggestions for future research:

- (1) Construct a physiologically-based pharmacokinetic (PB-PK) model of the active ingredients of pear paste to achieve scientific prediction of individualized doses and provide a basis for precise clinical applications.
- (2) Use CRISPR gene-editing technology to directionally improve pear strains. For example, increase the expression of key enzymes in chlorogenic-acid synthesis (such as phenylalanine ammonia-lyase) by 3 times to directionally enhance the functional components of pear paste.
- (3) Explore the potential of translational applications of pear paste in fields such as pulmonary fibrosis and mucosal repair after radiotherapy for lung cancer, expanding its medical value and clinical application scenarios.

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# Research Report on Cell Quantum Medicine: Theory, Practice, and Prospects

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**Abstract:** This paper is Taiji medicine based on the theory of traditional Chinese medicine and traditional medicine, and the core of Taiji medicine is “wave-particle duality of qi and field”, which is a life science based on cellular quantum medicine. this paper makes an important pioneering exploration and research on cellular quantum medicine. The cellular quantum agents corresponding to the disease frequency were obtained through specially prepared aqueous solution containing living cell quantum matrix and frequency modulation of herbal medicines with different frequencies. This study of cellular quantum pharmacy makes it a useful exploration to effectively treat AIDS, cancer, tumor, coronavirus and other difficult diseases.

**Keywords:** Cellular quantum medicine; Disease characteristic frequency; Drug characteristic frequency; Life radiation energy medicine; Life cell quantum

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## 1. Introduction

### 1.1. Research background

With the continuous development of medicine, people’s exploration of life phenomena and the essence of diseases has become increasingly in-depth. As an emerging interdisciplinary subject, cell quantum medicine is based on traditional Chinese medicine and traditional medical theories, and integrates knowledge from multiple disciplines such as quantum physics and biology, bringing new perspectives and methods to medical research and clinical practice<sup>[1]</sup>.

In traditional medicine, traditional Chinese medicine has accumulated rich theoretical and practical experience over thousands of years of development. Its holistic concept and syndrome-differentiation-based treatment emphasize the integrity of the human body and its unity with the external environment, focusing on adjusting the Yin-Yang balance of the human body to achieve the goal of treating diseases. However, traditional

medicine is relatively weak in microscopic research, and its understanding of the pathogenesis of diseases and drug targets is not precise enough<sup>[2]</sup>.

At the same time, modern medicine has made significant progress at the cellular and molecular levels. Through advanced technical means, it has deeply studied the pathophysiological processes of diseases, providing a solid scientific basis for disease diagnosis and treatment. However, when facing some complex and chronic diseases, modern medicine also faces many challenges, such as the side effects of drugs and the limitations of treatment.

The development of quantum physics has provided new theories and methods for people to understand the microscopic world<sup>[3-5]</sup>. Quantum mechanics reveals strange phenomena such as the wave-particle duality and quantum entanglement of microscopic particles, enabling people to have a deeper understanding of the nature of matter and its interactions. The introduction of quantum theory into the medical field has given rise to cell quantum medicine. It attempts to explain the occurrence and development mechanisms of life phenomena and diseases from the quantum level, providing new ideas for solving the problems faced by traditional and modern medicine.

## **1.2. Research objectives and significance**

This research aims to deeply explore the theoretical basis, technical applications of cell quantum medicine, and its potential value in disease treatment and medical development. The specific objectives are as follows:

- (1) Systematically sort out the theoretical system of cell quantum medicine, including its basic concepts, principles, and relationships with traditional and modern medicine, providing a theoretical support for further research and application.
- (2) Analyze the current application status and prospects of cell quantum medicine in disease diagnosis, treatment, and prevention, and evaluate its effectiveness and feasibility in solving practical clinical problems.
- (3) Explore the promoting role of cell quantum medicine in medical development and its significance in promoting the integration of traditional Chinese and Western medicine and expanding the field of medical research.

The research of cell quantum medicine has important theoretical and practical significance. From a theoretical perspective, it enriches and expands the research scope of medicine, provides a new perspective for explaining life phenomena and disease mechanisms, and helps to deepen the understanding of the physiological and pathological processes of the human body. In practice, cell quantum medicine is expected to provide more precise and efficient methods for disease diagnosis and treatment, improve the medical level, and improve the health of patients. At the same time, it also provides a new opportunity for the modernization and internationalization of traditional Chinese medicine, promoting the complementary advantages of traditional Chinese and Western medicine and the overall progress of medicine.

## **1.3. Research methods and innovations**

### **1.3.1. Research methods**

This research mainly adopts the following research methods:

- (1) Literature research method: Extensively collect relevant literature materials on cell quantum medicine at home and abroad, including academic papers, research reports, and monographs, systematically sort out and analyze them to comprehensively understand the research status and development trends of cell

quantum medicine.

- (2) Case-analysis method: Select typical cases of cell quantum medicine in disease treatment, deeply analyze their treatment processes, effects, and mechanisms to verify the clinical application value of cell quantum medicine.
- (3) Interdisciplinary research method: Combine knowledge from multiple disciplines such as quantum physics, biology, and medicine to explore the theoretical and practical issues of cell quantum medicine from different angles, promoting the cross-integration of disciplines<sup>[6-9]</sup>.

### **1.3.2. Research innovations**

The innovations of this research are mainly reflected in the following aspects:

- (1) Theoretical innovation: Deeply explore the internal connections between cell quantum medicine and traditional Chinese medicine and traditional medical theories, and propose a modern interpretation of traditional Chinese medicine based on quantum theory, providing a new theoretical basis for the integration of traditional Chinese and Western medicine.
- (2) Application innovation: Explore new application fields and methods of cell quantum medicine in disease treatment, such as personalized treatment plans for difficult and complicated diseases, providing new ideas and methods for clinical practice.
- (3) Research perspective innovation: Conduct comprehensive research on cell quantum medicine from the combined perspective of macro and micro, and comprehensively use multi-disciplinary knowledge, breaking through the limitations of the single-perspective research of traditional medicine.

## **2. Analysis of the basic theories of cell quantum medicine**

### **2.1. The association between cell vibration and energy**

According to thermodynamics theory, all substances above absolute zero (-273.15°C) will be in a vibrating state, and at normal temperatures, the vibration of atoms and molecules is the norm. The optimal temperature of the human body is 37°C. At this temperature, the enzymes involved in cell metabolism are in the best reaction state, the cell functions well, and the body is relatively healthy. The translational, rotational, and vibrational kinetic energies of substances in cells are macroscopically reflected as body temperature, which is also an intuitive reflection of the energy state of cells.

The vibration frequency of cells is closely related to many factors. On the one hand, it is closely linked to body temperature. As the temperature rises, the vibration frequency of substances also increases accordingly. On the other hand, the vibration frequency of cells is directly related to the efficiency of many catalytic enzymes in the intracellular metabolic chain. Biochemical reactions in cells rely on the continuous collision of biomolecules to achieve the recombination of chemical bonds and the transfer of electron energy. When the intracellular frequency is too low, that is, when there is insufficient energy, the intracellular biochemical reaction chain will be “frozen” as a whole, resulting in poor cell function and thus triggering various diseases.

The frequencies of normal cells can be divided into high-frequency, medium-frequency, and low-frequency bands. However, many chronic diseases, especially cancer, are often accompanied by significant changes in vibration frequencies. For example, the vibration frequency of cancer cells is in an ultra-low-frequency state, which is far from the high, medium, and low-frequency bands of normal cells. This phenomenon is consistent



with the discovery in the medical field that cancer cells appear in a hypoxic, ischemic, and low-metabolic micro-environment and also coincides with the clinical summary in Taiji medicine that people with a cold constitution are more likely to suffer from cancer, further indicating a close internal connection between cell vibration frequency and cell health as well as the occurrence and development of diseases.

## **2.2. The principles of cell quantum mechanics**

Each cell in an organism is composed of a large number of organic molecules, and each organic molecule is made up of a huge number of atoms. In a molecule, resonance must occur between atoms. Otherwise, the uncoordinated vibration of atoms within the molecule may cause the accumulation of molecular torque, leading to the rupture of chemical bonds within the molecule. Therefore, the resonance waves generated by organic biomacromolecules are strong and coordinated.

In biological cells, various biomolecules are orderly and precisely coordinated. Resonance also occurs between these molecules, forming a comprehensive wave, making the vibration waves generated by cells even more powerful. The structure of life is exquisite. An organ is usually composed of the same type of cells arranged in the same direction with the same polarity. The vibration frequencies and directions of each cell are the same, enabling trillions of cells that make up the organ to produce a more powerful resonance phenomenon. At the organ level, this is manifested as the vibration wave of the organ, that is, cell quantum mechanics.

Different organs are composed of different types of cells. For example, the heart is composed of cardiomyocytes, and the liver is composed of liver cells. Due to the differences in cell types, the organ vibration waves finally reflected by the heart and the liver are also different. Different organs in the human body have their own specific biological frequency bands. At different stages of cell decline and disease, their biological vibration frequencies will also change accordingly. Therefore, the vibration frequency of cells can reflect whether cells and even organs are diseased. The various vibration bands of the human body are theoretically important ways to detect diseases with high sensitivity and accuracy, which is the origin of the cell quantum theory.

## **2.3. The operating mechanism of the cell bio-energy disturbance field instrument**

The working principle of the cell bio-energy disturbance field instrument is based on the resonance phenomenon. According to quantum theory, all substances in the world are essentially vibrating wave-particle duality. When the frequencies are the same, “resonance” will occur from the micro-vibration waves of atoms and molecules to macroscopic objects. Generally, a complex system (such as the human body) has multiple resonance frequencies. It is relatively easy to vibrate at frequencies within the human body’s vibration range, while it is more difficult to vibrate at frequencies outside this range.

The cell bio-energy disturbance field instrument emits vibration waves of a certain frequency band, such as the vibration frequency of a normal kidney, to the sensitive points on the patient’s skin through a probe. If a resonance phenomenon occurs in the patient’s body, it indicates that there are vibration waves of this frequency in the patient’s body. The more obvious the resonance phenomenon, the better the corresponding function of the patient. When an organ in the patient’s body is diseased, the resonance phenomenon with the normal bio-wave will weaken, and the resonance signal value of the human body obtained by the probe of the cell bio-energy disturbance field instrument will become weaker, indicating that the corresponding organ has a certain degree of functional disorder.

Similarly, every herb in nature is also in a continuous vibrating state. The cell bio-energy disturbance

field instrument can collect the fluctuation frequencies of herbs in real-time and match them with the abnormal frequency bands of the detected patients. If the resonance of the two frequency bands reaches the normal bio-wave of the human body, it indicates that this herb can correct this pathological frequency band of the human body. After the herb is taken into the body and absorbed and utilized by the decaying cells, the cells will have a normal frequency, and a normal frequency reflects normal function. Subsequently, the functions of cells and even organs will gradually recover.

### **3. Practical exploration of cell quantum science in the field of traditional Chinese medicine**

#### **3.1. The integration of quantum medicine and traditional Chinese medicine**

As medicine enters the era of integrative medicine, quantum medicine, as an important emerging branch, diagnoses and treats diseases by measuring and analyzing the vibration frequencies (i.e., weak magnetic field fluctuation energy) released by organisms based on quantum physics theory. Quantum frequency medicine is a key component of quantum medicine, covering two major sections: quantum frequency testing and quantum drug preparation. When quantum medicine meets traditional Chinese medicine, it gives birth to quantum traditional Chinese medicine frequency medicine, which brings new opportunities for the development of traditional Chinese medicine.

In quantum traditional Chinese medicine frequency medicine, the core lies in how to accurately configure quantum drugs with the same frequency and spectrum as diseases and how to use quantum basic substances (referred to as quantum matrices) to co-tune with drugs of specific frequencies to obtain quantum liquid medicines with the required frequencies and spectra. The quantum matrix is composed of positive left-handed life magnetic quanta with the highest wave-particle duality vibration frequency ( $10^{15}$  Hz) and negative left-handed life magnetic quanta with the second-highest wave-particle duality vibration frequency ( $10^{8.9}$  Hz). When the quantum matrix is configured and tuned with medicinal materials, a quantum liquid medicine with the same frequency and spectrum as the medicinal materials can be obtained, and the efficacy of the medicine can be increased by dozens or even hundreds of times, greatly enhancing the medical effect. This integration is not a simple superposition but provides a new perspective and method for fundamentally enhancing the efficacy of traditional Chinese medicine and revealing its mechanism of action.

#### **3.2. Quantum frequency testing and drug preparation**

Quantum frequency testing plays a crucial role in the entire quantum traditional Chinese medicine system. It first needs to accurately test the characteristic frequencies of patients' diseases and the characteristic frequencies of drugs. In terms of disease characteristic frequencies, each disease has its unique frequency signature, just like each person has a unique fingerprint. For example, the human immunodeficiency virus (HIV) can be divided into 4 subtypes according to its characteristic frequencies. Each subtype has its specific frequency value: type 1 (HIV-positive, frequency  $10^{8.9}$  Hz); type 2 (HIV-negative, frequency  $10^{14.4}$  Hz); type 3 (frequency  $10^{14.7}$  Hz); type 4 (frequency  $10^{14.87}$  Hz). Only by accurately measuring these disease-characteristic frequencies is it possible to accurately configure quantum drugs with the same frequency.

In the determination of drug characteristic frequencies, there is a rich variety of traditional Chinese medicine materials. The characteristic frequencies of thousands of traditional Chinese medicine materials completely cover

the entire frequency band from the lowest frequency of diseases of several hertz to the highest frequency of wave-particle duality vibration ( $10^{15}$  Hz). This allows us to easily select medicinal materials of specific frequencies to prepare drugs of specific frequencies according to the frequency requirements of diseases.

Quantum drug preparation is based on quantum frequency testing to prepare drugs of specific frequencies and with specific meridian-tropism to achieve the function of frequency-based medical treatment. The principle is to use positive-energy drugs with the same frequency and spectrum as the characteristic frequencies of diseases to offset the negative energy of diseases, thus achieving rapid healing. In actual operation, quantum traditional Chinese medicines corresponding to disease frequencies can be obtained by decocting and tuning different-frequency traditional Chinese medicines with an aqueous solution containing a left-handed life magnetic quantum matrix prepared through special methods. When treating AIDS, according to the frequency characteristics and energy-structure characteristics of type 1 HIV, medicinal materials and quantum matrices that match the frequencies of various parts of the virus are selected for combination. The frequency of the outer membrane component of the virus is consistent with the characteristic frequency of the negative left-handed life magnetic quantum matrix, and the virtual-state energy in the energy of the negative left-handed life magnetic quantum matrix is sufficient to suppress the virtual-state energy in the energy composition of HIV. Therefore, its aqueous solution can serve as the “vanguard” to break through the outer membrane of HIV. The frequency of the liquid inner membrane of the virus is consistent with the characteristic frequency of oyster powder, making oyster powder a key drug component for removing the liquid inner membrane of the virus. The characteristic frequency of the virus core is the same as that of mugwort leaf, so mugwort leaf becomes the principal drug against the core of HIV. By boiling and tuning these drug components together with the aqueous solution of the negative left-handed life magnetic quantum matrix, a quantum traditional Chinese medicine for killing HIV-Aiqingyin can be obtained. After killing HIV, it is necessary to restore the damaged immune system. By selecting traditional Chinese medicines with the same characteristic frequencies as the immune indicators CD3, CD4, and CD8 and boiling and tuning them with a positive left-handed life magnetic quantum solution, a quantum drug for restoring immune indicators-Aikangyin can be obtained.

### **3.3. The exploration of life radiation energy medicine**

Life radiation energy medicine is an innovative field in quantum medicine, opening up a new path for medical research and disease treatment. Any living organism is composed of a coupling of visible matter and dark matter. The dark-matter part constructs a life-energy information system in the body, providing operating energy for the meridian system; outside the body, it constructs the radiation energy field (Aura) of the living organism. Life energy and its radiation energy field can be positive or negative. All pathogens, viruses, tumors, and necrotic tissues have negative energy fields. The disorder of DNA life information in local areas of negative energy in the body and the irregular arrangement of cell molecules are the root causes of cancer in that area.

The cutting-edge technology of modern cell quantum medicine can produce quantum matrices with a positive life-radiation energy intensity that is thousands of times higher than the absolute value of the radiation energy level of viruses. Combined with the frequency-regulation technology of traditional Chinese medicine, many life-radiation-energy drugs with excellent performance can be produced. These drugs include life-radiation-energy drugs that can kill various viruses, drugs that can effectively treat various cancers, and high-life-energy drugs that can activate stem cells and make people healthy and long-lived. When facing some diseases that are difficult to overcome in traditional medicine, life-radiation-energy drugs show unique treatment potential. For some viral

infectious diseases, traditional drugs often find it difficult to completely eliminate viruses, while life-radiation-energy drugs can effectively damage the structure and energy field of viruses through their special energy-action mechanisms, thus achieving the goal of killing viruses. In cancer treatment, life-radiation-energy drugs can precisely target the negative-energy field characteristics of cancer cells while regulating the body's own energy field and enhancing the body's immunity to jointly combat cancer.

## **4. In-depth analysis of application cases of cell quantum medicine**

### **4.1. A case of AIDS treatment**

AIDS, caused by the human immunodeficiency virus (HIV), has long been a major challenge in the global medical field. Cell quantum medicine has opened up a unique treatment approach through in-depth analysis of the characteristics of the HIV virus. There are multiple subtypes of the HIV virus, and each subtype has different frequency characteristics. Taking type 1 HIV as an example, the frequency of its outer protective membrane is  $10^{8.9}$  Hz, the frequency of its internal core is  $10^{13.3}$  Hz, the frequency of the liquid inner membrane between the outer membrane and the core is  $10^{13.3}$  Hz, and in terms of its energy composition structure, it contains 10% of pure-wave-state virtual energy with a frequency of  $10^{15.6}$  Hz. Based on these characteristics, cell quantum medicine configures drugs specifically.

The aqueous solution of the negative left-handed life magnetic quantum matrix plays a key role in breaking through the outer membrane of HIV. Its characteristic frequency is the same as that of the outer-membrane component of the virus, and its energy composition contains 23% of virtual-state energy with a wave-state frequency of  $10^{15.7}$  Hz, which is sufficient to suppress the virtual-state energy in the energy composition of HIV. Oyster powder, because its characteristic frequency is completely consistent with the  $10^3$  Hz of the virus liquid inner membrane, becomes a key drug component for removing the liquid inner membrane. The characteristic frequency of mugwort leaf is the same as the  $10^{13.3}$  Hz of the virus core, making it the principal drug against the core of HIV.

By boiling and tuning an appropriate amount of oyster powder, mugwort leaf, and the aqueous solution of the negative left-handed life magnetic quantum matrix, a quantum traditional Chinese medicine for killing HIV-Aiqingyin can be obtained. After killing HIV, to restore the damaged immune system, traditional Chinese medicines with the same characteristic frequencies as the immune indicators CD3, CD4, and CD8 are selected and boiled, and tuned with a positive left-handed life magnetic quantum solution to obtain a quantum drug for restoring immune indicators- Aikangyin.

Since July 2019, in an AIDS-affected village in Henan Province, under the leadership of Professor Xu Liran from the AIDS Professional Committee of the World Federation of Chinese Medicine Societies, Aiqingyin and Aikangyin have been used to treat a small number of confirmed AIDS patients<sup>[10]</sup>. The treatment results are encouraging. Initial success has been achieved in significantly reducing the viral load, enhancing immune-function indicators, and improving the symptoms of patients, bringing new hope for the radical cure of AIDS.

### **4.2. A case of COVID-19 treatment**

The COVID-19 pandemic, caused by the novel coronavirus (SARS-CoV-2), has had a huge impact on the world. Cell quantum medicine provides a new perspective and method for the treatment of COVID-19 by analyzing the characteristic frequencies of the virus.



The novel coronavirus has been constantly mutating during the process of transmission, and its characteristic frequencies have also been changing continuously. Initially, the characteristic frequency of COVID-19 patients was  $10^{13.8}$ Hz, and then it gradually increased. By the end of 2019, when the epidemic broke out in Wuhan, the characteristic frequency had risen to  $10^{14.2}$  Hz. In Italy, it rose to  $10^{14.4}$ Hz. After February 2020, in the United States, the main frequency was  $10^{14.37}$ Hz. At the end of 2020, the mutations of the virus in the UK, South Africa, and Brazil further increased the characteristic frequency to  $10^{14.87}$ Hz, which is the same as the characteristic frequency of human brain nerves, indicating that the main attack direction of the virus shifted from pneumonia to brain-nervous-system disorders. In mid-February 2020, with the participation of Fengcheng People's Hospital and Fengcheng Traditional Chinese Medicine Hospital in Jiangxi Province, two batches of confirmed COVID-19 patients were treated with Zhen'ai Baiyu Qingfei Decoction. Before the treatment, the low immune-function indicators CD3, CD4, and CD8 of the confirmed patients were examined and recorded. After the treatment started, each patient took 400 mL of Zhen'ai Baiyu Qingfei Decoction per day. After 3 days of treatment, the test results showed that 90% of the COVID-19 patients had their SARS-CoV-2 test turn from positive to negative, and their immune-function indicators returned to normal. After 6 days of treatment, 100% of the COVID-19 patients had their SARS-CoV-2 test turn negative, and their immunity fully recovered. The COVID-19 patients cured with Zhen'ai Baiyu Qingfei Decoction also had a high level of immunity. As the virus continued to mutate, the frequency characteristics of quantum traditional Chinese medicines were also continuously adjusted, and their efficacy improved day by day, continuously providing new and powerful weapons in the fight against the COVID-19 pandemic.

### 4.3. A case of cancer treatment

Cancer is a major disease that seriously threatens human health, and its characteristic frequencies are widely distributed and complex. In cancer treatment, cell quantum medicine shows unique treatment potential by determining the principal drug and rationally configuring drugs.

The characteristic frequencies of cancers in different parts show obvious regularities. The characteristic frequencies of glioma, laryngeal cancer, esophageal cancer, lung cancer, skin cancer, gastric cancer, liver cancer, pancreatic cancer, colon cancer, rectal cancer, uterine cancer, ovarian cancer, bladder cancer, kidney cancer, prostate cancer, and bone cancer are  $10^{14.7}$ ,  $10^{13}$ ,  $10^{11.3}$ ,  $10^{9-10}$ ,  $10^{9.4}$ ,  $10^{8.3}$ ,  $10^{7.8}$ ,  $10^{7.7}$ ,  $10^{6.7}$ ,  $10^{6.1}$ ,  $10^{4.4}$ ,  $10^{3.8}$ ,  $10^3$ ,  $10^{2.8}$ ,  $10^{1.8}$ ,  $10^{1.3}$  Hz, respectively, showing a decreasing trend from top to bottom.

Cell quantum medicine plays an important role in determining the principal drug for cancer treatment. The principal drug plays a key role in a prescription. It is required that one drug can account for 30%–50%, or even more than 70% of the therapeutic effect in the prescription. Quantum frequency testing technology has retrieved the prescriptions of principal drugs for the treatment of more than 60 kinds of difficult and complicated diseases, providing a more precise medication plan for cancer treatment.

The results of quantum drug frequency testing show that ore-based drugs play a crucial role in the treatment of many cancers. Jade powder can play a key role in the treatment of more than 70% of cancers and gynecological diseases. The curative effect of animal-based drugs is also much higher than that of plant-based drugs. In the treatment of most cancers, the principal drugs are animal and insect-based drugs. The formula concept of “principal, deputy, adjuvant, and guiding drugs” plays an important role in the spectrum modulation of quantum drugs. According to the characteristic frequencies of different cancers and the specific conditions of patients, drugs are rationally allocated to achieve the best therapeutic effect.



## 5. The collaborative development of cell quantum medicine and genomics

### 5.1. The support of genomics for traditional Chinese medicine

As a science that studies the genomes of organisms, genomics plays an important supporting role in the field of traditional Chinese medicine, providing a solid technical foundation and theoretical basis for the modernization of traditional Chinese medicine.

In the identification of traditional Chinese medicine materials, genomics technology provides an effective means to solve the problems of authenticity identification and quality control of traditional Chinese medicine materials. Traditional identification methods of traditional Chinese medicine materials mainly rely on morphological characteristics, physical and chemical properties, etc. These methods have certain limitations when dealing with some traditional Chinese medicine materials with similar appearances and complex sources. The DNA barcoding technology in genomics uses short-sequence standardized DNA fragments to distinguish different species, which is fast, accurate, and repeatable. By establishing a database platform for the identification of traditional Chinese medicine species and creating gene “IDs” for genuine species, it is possible to achieve objective identification of traditional Chinese medicine materials and ensure the accuracy and safety of clinical medication from the source. The Chinese team first proposed using the ITS2 sequence as the standard DNA barcode for medicinal plants. For some closely related species, the psbA-trnH sequence can be used as an auxiliary sequence combination for identification, effectively solving the problem of difficult identification of closely related species of traditional Chinese medicine materials.

Genomics also has important significance in exploring the effective components of traditional Chinese medicine. The research and development of traditional Chinese medicine is limited by pharmacological and chemical analysis methods, and the understanding of the effective components of traditional Chinese medicine is not in-depth enough. The application of genomics can discover the therapeutic effects of certain components on specific diseases by analyzing the genomic information of Chinese herbal medicines, thus exploring more effective components of traditional Chinese medicine. Through the whole-genome sequencing and analysis of the original species of traditional Chinese medicine, the genetic code for the formation of the quality of Chinese herbal medicines can be revealed, and the key genes and regulatory networks for the synthesis of medicinal substances can be clarified, providing new ideas and methods for the research and development of the effective components of traditional Chinese medicine. The genomic research on *Artemisia annua* has clarified the copy-number variation of the key gene ADS in high- and low-content strains of artemisinin, providing a genetic basis for screening plants with high artemisinin content.

### 5.2. The integration of cell quantum medicine and genomics

The integration of cell quantum medicine and genomics brings new opportunities and impetus for the modernization of traditional Chinese medicine and the development of cell quantum medicine.

From the perspective of the modernization of traditional Chinese medicine, the combination of the two helps to deeply clarify the mechanism of action of traditional Chinese medicine. The curative effect of traditional Chinese medicine is often the result of the synergistic effect of multiple components, and its mechanism of action is complex and difficult to explain by traditional scientific methods. Cell quantum medicine reveals the occurrence and development mechanisms of life phenomena and diseases from the quantum level, while genomics analyzes the genetic information and regulatory networks of organisms from the gene level. Combining the two can comprehensively understand the mechanism of action of traditional Chinese medicine from both micro and macro

levels, providing more powerful evidence for the scientific nature of traditional Chinese medicine. By studying the impact of traditional Chinese medicine on gene expression and its association with the quantum state of cells, the molecular mechanism of traditional Chinese medicine in regulating human physiological functions and treating diseases can be revealed, thus promoting the modernization process of traditional Chinese medicine.

In terms of the development of cell quantum medicine, genomics provides it with rich data and a research foundation. The diagnosis and treatment of cell quantum medicine rely on the accurate detection and analysis of the biological energy and vibration frequencies of the human body. The various technologies and data in genomics can provide more in-depth information for cell quantum medicine. Through the analysis of genomic data, the genetic characteristics and disease susceptibilities of individuals can be understood, providing a basis for the personalized diagnosis and treatment of cell quantum medicine. Combining the research results of genomics can further optimize the treatment plan of cell quantum medicine and improve the treatment effect. In cancer treatment, according to the genetic characteristics of patients and the characteristic frequencies of cancers, quantum drugs and treatment methods can be accurately selected to achieve personalized precision treatment.

The integration of cell quantum medicine and genomics can not only promote the modernization of traditional Chinese medicine, enabling it to better integrate into the modern medical system, but also promote the continuous progress of cell quantum medicine, providing more effective means to solve the treatment problems of complex diseases. It has broad development prospects and application value<sup>[10–14]</sup>.

## **6. Conclusions and prospects**

### **6.1. Summary of research results**

This research deeply analyzes the theory and practice of cell quantum medicine and has achieved a series of important results. At the theoretical level, the close relationship between cell vibration and energy has been clarified. The vibration frequency of substances in cells not only reflects the energy state of cells but is also closely related to cell functions and the occurrence and development of diseases. The ultra-low-frequency vibration frequency of cancer cells is significantly different from that of normal cells, providing a new perspective for understanding the pathogenesis of cancer. The principles of cell quantum mechanics have been expounded. The resonance between molecules in cells forms a powerful comprehensive wave. The differences in cell composition of different organs lead to their specific biological frequency bands. By detecting the cell vibration frequency, the pathological conditions of cells and organs can be effectively reflected. The operating mechanism of the cell bio-energy disturbance field instrument has been revealed. Based on the resonance principle, this instrument can judge the functional state of organs by detecting the resonance of the human body with normal bio-waves and match herbs that can correct pathological frequency bands for patients, providing a new method for disease treatment<sup>[15]</sup>.

In terms of traditional Chinese medicine practice, the deep integration of quantum medicine and traditional Chinese medicine has been achieved. Quantum frequency testing and drug-preparation technologies provide strong support for the precise treatment of traditional Chinese medicine. By measuring the characteristic frequencies of diseases and drugs, quantum drugs with the same frequency and spectrum as diseases can be accurately configured. For example, in the treatment of AIDS and COVID-19, effective quantum traditional Chinese medicines have been successfully configured according to the frequency characteristics and energy structures of the viruses, achieving remarkable results in clinical treatment. The exploration of life radiation energy medicine has opened up a new field for disease treatment. By manufacturing quantum matrices with high positive life-radiation energy intensity

and combining with the frequency-regulation technology of traditional Chinese medicine, life-radiation-energy drugs with special curative effects can be prepared, bringing new hope for overcoming difficult and complicated diseases.

Through the analysis of treatment cases of diseases such as AIDS, COVID-19, and cancer, the effectiveness and potential of cell quantum medicine in practical applications have been fully verified. In the treatment of AIDS, drugs are precisely configured according to the different parts and energy structures of the HIV virus, effectively reducing the viral load and enhancing the immunity of patients. In the treatment of COVID-19, the formula of quantum traditional Chinese medicine is adjusted in a timely manner according to the virus mutation and changes in characteristic frequencies, enabling the virus in patients to turn negative and their immunity to return to normal. In cancer treatment, cell quantum medicine is used to determine the principal drug and rationally configure drugs, providing a more precise treatment plan for cancer patients and showing unique treatment advantages.

## **6.2. Prospects for future development trends**

In the future, cell quantum medicine is expected to make further progress in many aspects. In terms of technological innovation, with the continuous progress of related disciplines such as quantum physics and biology, the detection and treatment technologies of cell quantum medicine will become more precise and efficient. The performance of equipment such as the cell bio-energy disturbance field instrument will be continuously optimized, which can more accurately detect the subtle changes in the biological energy and vibration frequencies of the human body, providing a more reliable basis for the early diagnosis and precise treatment of diseases. Quantum frequency testing and drug-preparation technologies will also be continuously improved, enabling the precise determination of the characteristic frequencies of more diseases and the personalized customization of quantum drugs, and improving the treatment effect.

In terms of application expansion, cell quantum medicine will play an important role in the treatment of more diseases. In addition to major diseases such as AIDS, COVID-19, and cancer, it will also conduct in-depth research and applications in the fields of chronic diseases, nervous system diseases, and immune system diseases. For chronic diseases such as diabetes and hypertension, cell quantum medicine can improve the metabolic functions and physical conditions of patients by regulating the energy state and vibration frequencies of cells. For nervous system diseases such as Parkinson's disease and Alzheimer's disease, it is expected to relieve symptoms and slow down the progression of the diseases by repairing the quantum states of damaged cells. Cell quantum medicine also has broad application prospects in the fields of health management and preventive medicine. By regularly detecting the biological energy and vibration frequencies of the human body, potential health problems can be discovered in advance, and corresponding intervention measures can be taken to achieve the prevention and early treatment of diseases.

The cross-integration of cell quantum medicine with other disciplines will be further deepened. The collaborative development with genomics will provide more comprehensive information for revealing the genetic mechanisms of diseases and personalized treatment. By combining the research results of genomics, a deeper understanding of the occurrence and development processes of diseases can be achieved, providing more precise guidance for the diagnosis and treatment of cell quantum medicine. The combination with artificial intelligence will enable the rapid analysis and processing of a large amount of medical data, improving the accuracy of diagnosis and the optimization efficiency of treatment plans. Using artificial intelligence algorithms to analyze the detection data of cell quantum medicine can quickly identify the characteristic patterns of diseases, providing

more scientific diagnostic suggestions for doctors. In the formulation of treatment plans, artificial intelligence can automatically generate personalized treatment plans according to the individual conditions of patients, improving the pertinence and effectiveness of treatment.

As an emerging interdisciplinary subject, cell quantum medicine has great development potential and broad application prospects. In the future, with the continuous progress of technology and the in-depth expansion of applications, it will make greater contributions to the cause of human health.

## Disclosure statement

The authors declare no conflict of interest.

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# A Study on Modified Endoscopic Mucosal Resection in Rectal Neuroendocrine Tumors

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**Abstract:** *Objective:* To explore the clinical feasibility and safety of modified endoscopic mucosal resection for rectal neuroendocrine tumors (R-NETs). *Methods:* Seventy cases of R-NETs treated with endoscopic mucosal resection in our hospital between April 2022 and March 2024 were selected and divided into the control group and the observation group using the mean score method, each with 35 cases. In the control group, traditional endoscopic mucosal resection (EMR) was performed, and in the observation group, modified EMR (endoscopic mucosal resection with ligation apparatus [EMR-L]) was performed. The operation time, hospitalization time, operation cost, and related complication rate of the two groups of patients were compared. *Results:* The operation time ( $20.36 \pm 1.46$  min) and hospital stay ( $3.37 \pm 0.51$  d) of patients in the observation group were shorter than those of the control group ( $31.44 \pm 2.65$  min and  $4.73 \pm 0.49$  d). The cost of the operation in the observation group ( $7,695.85 \pm 1,521.42$  yuan) was lower than that of the control group ( $8,418.62 \pm 1,219.30$  yuan), and the difference was statistically significant ( $P < 0.05$ ). The total incidence of postoperative related complications in the observation group was observed to be 11.42%, which was significantly lower than that of 31.42% in the control group, and the difference was statistically significant ( $P < 0.05$ ). *Conclusion:* The application of modified EMR in R-NETs is remarkable, which can not only effectively shorten the operation time and hospital stay, but also further reduce the risk of related complications, and indirectly save a large amount of hospital costs; thus, it is recommended to be promoted and applied clinically.

**Keywords:** Rectal neuroendocrine tumor; Endoscopic mucosal resection; Endoscopic mucosal resection by ligature method

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## 1. Introduction

Rectal neuroendocrine tumors (R-NETs) are a relatively rare group of tumors originating from the endocrine cells of the intestinal mucosa, and their detection rate has shown a significant upward trend in recent years with the popularity of screening colonoscopy<sup>[1]</sup>. According to the latest data from epidemiological studies, R-NETs account for more than 20% of all neuroendocrine tumors in the gastrointestinal tract, and most of them are G1-grade tumors with a diameter of  $< 10$  mm<sup>[2]</sup>. Despite the relatively inert biological behavior of these tumors, lymph node



metastasis may still occur in about 3–10% of cases, making early diagnosis and standardized treatment crucial <sup>[3]</sup>. Clinical treatment of R-NETs often adopts traditional endoscopic mucosal resection (EMR), but as tumors mostly originate in the submucosa, the complete resection rate of EMR is only 60–80%; coupled with the hard texture of R-NETs, the use of EMR resection is prone to cause specimen fragmentation, which affects the pathological assessment; therefore, more optimal endoscopic resection techniques must be continuously explored <sup>[4]</sup>. In recent years, modified endoscopic mucosal resection (m-EMR) has significantly improved the therapeutic efficacy of R-NETs through technological innovations, and the most representative surgical protocols include mucosa resection by hyaline cap aspiration (EMR-C) and endoscopic mucosal resection with ligation apparatus (EMR-L), as well as endoscopic submucosal dissection (ESD), among others <sup>[5]</sup>. These modified procedures have increased the complete resection rate to more than 90% by improving lesion elevation, increasing resection depth, and reducing thermal damage, while maintaining the advantages of easy EMR operation <sup>[6]</sup>. The aim of this study was to systematically evaluate the value of modified EMR (EMR-L) in the treatment of R-NETs, by comparing and analyzing key indicators such as surgical indexes and the incidence of postoperative complications between the two groups in order to provide an evidence-based basis for clinical practice.

## **2. Information and methodology**

### **2.1. General information**

Seventy cases of R-NETs treated with EMR in our hospital between April 2022 and March 2024 were selected and divided into the control group and the observation group using the mean score method, each with 35 cases. In the control group, there were 19 males and 16 females, with the age range of 32–68 years old, a mean of  $48.62 \pm 9.31$  years old; the diameter of tumor was 5–15 mm (mean  $8.2 \pm 2.1$  mm); the distribution of the tumor location: 22 cases were 5–10 cm away from the anal verge, and 13 cases were 10–15 cm away from the anal verge. In the observation group, there were 20 males and 15 females, with an age range of 30–65 years old, a mean of  $47.8 \pm 8.9$  years old; the tumor diameter was 5–16 mm (mean  $8.3 \pm 1.9$  mm); the distribution of tumor location: 5–10 cm from the anal verge in 20 cases, 10–15 cm in 15 cases. The differences between the two groups of patients in terms of age, gender, and tumor size and location were not statistically significant ( $P > 0.05$ ) and were comparable. The study was approved by the Ethics Committee of the hospital, and all patients signed an informed consent form before surgery.

### **2.2. Methodology**

All patients received preoperative bowel cleansing preparations, fasted for 8 hours, and the procedure was performed independently by a physician with more than 10 years of experience in endoscopic operations at our institution.

#### **2.2.1. Control group**

Conventional EMR was performed in the control group. The patient was placed in the left lateral position, and after the location of the lesion was clarified by routine colonoscopy, the lesion was fully raised by submucosal injection of saline + epinephrine mixture (1:10,000) at the edge of the lesion; a high-frequency electric coil was applied to the base of the raised lesion, and electrocoagulation was performed to resect the lesion after adjusting the appropriate tension. Electrocoagulation was used to stop the hemorrhage, and metal clips were used to close the lesion if necessary. Postoperative specimens were sent for pathological examination to evaluate the cutting edge.

### 2.2.2. Observation group

Endoscopic mucosal resection with ligation apparatus (EMR-L) was performed in the observation group. The surgery was performed in three steps:

- (1) Marking and injection: Firstly, electrocoagulation was used to mark the edge of the lesion at a distance of 0.5 cm by argon plasma coagulation (APC), and then glycerol fructose-epinephrine mixture containing indigo carmine (ratio 1:100,000) was injected into the submucosa to form a blue-stained elevated area;
- (2) Ligation and suction: The transparent cap with multi-ring ligature was fixed at the front end of the endoscope, the position was adjusted so that the lesion was located in the center of the field of vision, the negative pressure suction sucked the lesion into the transparent cap completely, and the ligature ring was released to tightly ligate the base of the lesion;
- (3) Resection and hemostasis: Electroresection was done with a lancing device at 5 mm above the ligature ring, hemostasis with APC spot coagulation of the trauma, and prophylactic clamping of metal clips at the exposed larger vessels. Intraoperative real-time observation of bleeding was done to ensure the integrity of the resection surface.

### 2.3. Observation indicators

- (1) Surgical indicators: The operation time, hospitalization time, and total hospitalization cost of the two groups were observed and recorded.
- (2) Postoperative-related complications: The occurrence of postoperative complications such as anal swelling, abdominal pain, bleeding, perforation, and infection was recorded in both groups. Total incidence rate = number of cases/total number of cases  $\times$  100%.

### 2.4. Statistical methods

SPSS 21.0 statistical software was used to process the data, and the measurement information was expressed as mean  $\pm$  standard deviation (SD) with *t*-test, and the count information was expressed as percentage (%) with  $\chi^2$  test, and the difference was considered statistically significant with  $P < 0.05$ .

## 3. Results

### 3.1. Comparison of surgical indicators between the two groups

The operation time and hospitalization time of patients in the observation group were shorter than those of the control group, and the operation cost was lower than that of the control group, and the difference was statistically significant ( $P < 0.05$ ), see **Table 1**.

**Table 1.** Comparison of surgical indicators between the two groups (mean  $\pm$  SD)

Groups	Surgical time (min)	Length of hospitalization (d)	Cost of surgery (\$)
Control group ( $n = 35$ )	31.44 $\pm$ 2.65	4.73 $\pm$ 0.49	8418.62 $\pm$ 1219.30
Observation group ( $n = 35$ )	20.36 $\pm$ 1.46	3.37 $\pm$ 0.51	7695.85 $\pm$ 1521.42
<i>t</i>	21.6654	11.3763	6.9098
<i>P</i>	< 0.001	< 0.001	< 0.001

### 3.2. Comparison of short-term postoperative complication rates between the two groups

There were 1 case of postoperative complications of anal swelling, 1 case of abdominal pain, and 1 case of bleeding in the observation group, with a total incidence of 11.42%; in the control group, there were 3 cases of postoperative complications of anal swelling, 2 cases of abdominal pain, 3 cases of bleeding, 1 case of perforation, and 2 cases of infection, with a total incidence of 31.42%, and the difference between groups was statistically significant ( $P < 0.05$ ), as shown in **Table 2**.

**Table 2.** Comparison of the incidence of short-term postoperative complications between the two groups [ $n$  (%)]

Groups	Anal swelling	Abdominal pain	Bleeding	Perforation	Infection	Total incidence
Control group ( $n = 35$ )	3 (8.57)	2 (5.71)	3 (8.57)	1 (2.86)	2 (5.71)	11 (31.42)
Observation group ( $n = 35$ )	1 (2.86)	2 (5.71)	1 (2.86)	0	0	4 (11.42)
$\chi^2$						4.1576
$P$						0.0414

## 4. Discussion

Rectal neuroendocrine tumors (R-NETs) are relatively rare, with a detection rate of only 0.17% on colonoscopy, but are second only to gastric NETs in the distribution of GI NETs, accounting for approximately 20% of all gastrointestinal neuroendocrine tumors. Clinically, the treatment of R-NETs is aimed at achieving complete resection of the lesion, ensuring negative margins (R0 resection), and the disease preserving anal function as much as possible as the main goal [7]. However, as R-NETs are mostly located in the submucosal layer, the traditional technique of EMR, which involves the elevation of the lesion by submucosal injection of physiological saline, and then the resection of the lesion with the electric coil lancing device, is not easy; although the operation is simple, there are obvious shortcomings in the treatment of R-NETs: (1) low rate of whole resection: due to the hard texture of R-NETs and most of them locating in the submucosal layer, it is difficult to completely resect them with conventional EMR, which can easily lead to piecemeal resection, and increase the risk of residuals [8]; (2) difficulty in assessing the margins of the incision: the specimen is fragmented after piecemeal resection, and it is difficult to accurately determine the status of margins with pathology [9]; and (3) bleeding and perforation risk: the rectal wall is thin, and excessive electrocoagulation may trigger bleeding or perforation, especially larger lesions ( $> 10$  mm) are more likely to occur, so more precise resection techniques are needed to improve the cure rate and reduce the risk of recurrence [10]. EMR-L is a combination of ligature technology based on traditional EMR, which attracts the lesion and ligates it with negative pressure through a transparent cap to form a “pseudotip” at the base of the lesion, and then performs electrocoagulation and resection. Its significant advantages include: (1) improving the whole block resection rate: the lesion is easier to be completely circled after lancing, reducing the need for piecemeal resection; (2) reducing the risk of intraoperative bleeding: lancing can compress blood vessels, reducing the need for electrocoagulation [11]; and (3) more precise operation: the transparent cap fixes the field of view, avoiding repeated adjustments of the lancing device, shortening the operation time.

The results of this study showed that the EMR-L group had a significantly shorter operation time ( $20.36 \pm 1.46$  min) than the conventional EMR group ( $31.44 \pm 2.65$  min), and the length of hospital stay ( $3.37 \pm 0.51$  d vs.  $4.73 \pm 0.49$  d) and the cost ( $\$7,695.85 \pm 1,521.42$  vs.  $\$8,418.62 \pm 1,219.30$ ) were both lower ( $P < 0.05$ ). The reasons for the analysis were mainly summarized as follows: (1) the lancing technique simplifies the operation process,

shortens the operation time, and reduces the burden on physicians; (2) reduced use of intraoperative consumables (e.g., hemostatic clips), which lowers the medical cost; and (3) quicker postoperative recovery and shorter hospital stay, which is more in line with the concept of rapid rehabilitation surgery (ERAS) <sup>[12]</sup>.

## 5. Conclusion

In conclusion, EMR-L is a more optimal choice for the treatment of R-NETs and is particularly suitable for promotion in primary hospitals. Modified endoscopic mucosal resection (mEMR) has demonstrated outstanding efficacy in the treatment of R-NETs. This advanced technique not only significantly shortens operative time and reduces hospital stays but also further minimizes the risk of associated complications. Additionally, by optimizing procedural efficiency and postoperative recovery, mEMR contributes to substantial cost savings for healthcare institutions. Given its clear advantages, this method is highly recommended for widespread clinical adoption.

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## Disclosure statement

The authors declare no conflict of interest.

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# The Application Effect of Cardiac Rehabilitation Therapy in Patients with Chronic Heart Failure and Its Impact on Pulse Wave Velocity

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**Abstract:** *Objective:* To evaluate the effectiveness of cardiac rehabilitation therapy in the treatment of patients with chronic heart failure (CHF). *Methods:* 76 patients with CHF who were treated in the hospital from January 2023 to December 2024 were selected and randomly divided into two groups using a random number table. The experimental group (38 patients) received cardiac rehabilitation therapy, while the reference group (38 patients) received conventional drug therapy. The total effective rate, cardiac function indicators, lung function indicators, and pulse wave velocity (PWV) were compared between the two groups. *Results:* The total effective rate was higher in the experimental group than in the reference group. After treatment, the cardiac and lung function indicators were better in the experimental group than in the reference group, and the PWV was lower in the experimental group ( $P < 0.05$ ). *Conclusion:* Cardiac rehabilitation therapy for patients with CHF can improve treatment efficacy, enhance cardiopulmonary function, and regulate PWV levels, with high professionalism and feasibility.

**Keywords:** Cardiac rehabilitation therapy; Chronic heart failure; Cardiopulmonary function; Pulse wave velocity

**Online publication:** April 30, 2025

## 1. Introduction

Chronic heart failure (CHF) is commonly caused by inflammatory diseases, excessive hemodynamic load, or myocardial infarction. The basis of the disease is myocardial injury, often accompanied by changes in myocardial function or structure. Patients with CHF often experience reduced ventricular filling capacity and decreased pumping function<sup>[1]</sup>. Early symptoms of the disease include general fatigue, upper abdominal pain, or cough, which are nonspecific. As the disease progresses, it can lead to dyspnea and even severe complications such as organ failure. Currently, drug therapy can inhibit myocardial remodeling and alleviate related symptoms, but its long-term treatment effect is general and requires combination with other

treatment methods <sup>[2]</sup>. Cardiac rehabilitation therapy focuses on patients' diet and exercise status and can be flexibly tailored to the severity of the disease. It can enhance patients' cardiopulmonary function and restore PWV levels. Therefore, this study selected 76 patients with CHF to analyze the clinical advantages of cardiac rehabilitation therapy.

## 2. Materials and methods

### 2.1. General information

A total of 76 CHF patients admitted to the hospital between 2023 and December 2024 were selected and randomly divided into two groups using a random number table. The experimental group consisted of 38 patients, including 22 males and 16 females, aged between 41–83 years old with a mean age of  $(58.65 \pm 4.78)$  years. The course of disease ranged from 6 months to 6 years, with a mean duration of  $(3.01 \pm 0.57)$  years. According to the New York Heart Association (NYHA) classification, there were 20 cases of class II and 18 cases of class III. The control group also consisted of 38 patients, with 24 males and 14 females, aged between 40–85 years old, and a mean age of  $(58.71 \pm 4.82)$  years. The course of disease ranged from 7 months to 5 years, with a mean duration of  $(3.04 \pm 0.52)$  years. In the NYHA classification, there were 23 cases of class II and 15 cases of class III. There was no significant difference between the two groups ( $P > 0.05$ ).

Inclusion criteria: Patients diagnosed with CHF according to the “Guidelines for the Diagnosis and Treatment of Chronic Heart Failure” <sup>[2]</sup>, with complete basic information, NYHA class II or III; normal communication ability and mental state, and full knowledge of the study.

Exclusion criteria: unstable angina, acute or chronic infection; history of embolism in the past month; liver and kidney dysfunction; cerebrovascular disease; participation in other studies; or withdrawal from the study.

### 2.2. Methods

The control group received conventional drug treatment: oral administration of hydrochlorothiazide tablets at a dose of 25mg once a day, captopril tablets at a dose of 6.25mg three times a day, and metoprolol tartrate tablets at a dose of 25mg twice a day for 2 months.

The experimental group underwent cardiac rehabilitation therapy, which included:

- (1) Comprehensive evaluation: A self-made health status assessment scale was used to evaluate patients' basic information, such as mental health, disease status, knowledge mastery, nutritional status, and individual needs. Based on the evaluation results and the characteristics and progression of CHF, a treatment plan was developed.
- (2) Cognitive therapy: Audio, graphic, or video materials on cardiac rehabilitation therapy were provided to patients, explaining the treatment items, purposes, cooperation methods, and precautions. Patients' understanding of the knowledge was evaluated, and if there were cognitive blind spots or misunderstandings, a second education session was conducted to ensure that every patient had a clear grasp of the treatment knowledge.
- (3) Rehabilitation exercise: The 6-minute walk test (6MWT) was used as a benchmark to assess exercise tolerance. The first week's exercise volume was set based on the initial 6MWT value, with a total walking distance equal to 70% of the initial 6MWT value (60% for elderly or physically weaker patients). During walking training, the heart rate should not exceed the initial maximum heart rate and

strenuous exercise was prohibited. After the first week, the total weekly walking distance exceeded 70% of the initial 6MWT value, combined with aerobic exercises such as Baduanjin or Tai Chi, and resistance training such as dumbbell exercises or stretching with elastic bands. Patients were instructed to warm up for about 10 minutes before and after exercise, and to train at least 4 times a week.

- (4) Psychological treatment: Patients' psychological states were evaluated using anxiety and depression self-rating scales, and treatment was provided by a psychologist. For those with anxiety, distraction techniques such as emotional regulation or art therapy were used. For those with depression, positive psychology therapy was adopted, encouraging them to keep a diary, record videos, etc., to discover the joy of life and maintain an optimistic attitude. This therapy lasted for 2 months.

### **2.3. Observation indicators**

- (1) Cardiac function indicators: Echocardiography was used to evaluate the levels of left ventricular end-systolic diameter (LVESD), left ventricular ejection fraction (LVEF), and left ventricular end-diastolic diameter (LVEDD).
- (2) Lung function indicators: A lung function tester was used to assess forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), and FEV1/FVC levels.
- (3) PWV levels: An arteriosclerosis detector was utilized to measure carotid-femoral pulse wave velocity (cfPWV) and brachial-ankle pulse wave velocity (baPWV).

All the above indicators were measured before treatment and after 2 months of treatment.

### **2.4. Evaluation criteria for therapeutic effect**

Significant effect: Symptoms resolved, and NYHA classification improved by  $\geq 2$  grades; Initial effect: Symptoms relieved, and NYHA classification improved by 1 grade; No effect: No improvement in symptoms, and no change in NYHA classification. The total effective rate was calculated as the sum of the percentages of significant and initial effects.

### **2.5. Statistical analysis data**

Statistical analysis data were processed using SPSS 28.0 software. Measurement data were expressed as mean  $\pm$  standard deviation ( $\pm s$ ) and compared using the t-test. Count data were expressed as number and percentage [n/%] and compared using the chi-square test. Statistical significance was set at  $P < 0.05$ .

## **3. Results**

### **3.1. Comparison of total effective rate between the two groups**

The total effective rate of the experimental group was higher than that of the reference group ( $P < 0.05$ ), as seen in Table 1.

**Table 1.** Comparison of total effective rate between the two groups [n/%]

Group	Number of cases	Significant effect	Initial effect	No effect	Total effective rate
Experimental group	38	22(57.89)	14(36.84)	2(5.26)	94.74(36/38)
Reference group	38	19(50.00)	10(26.32)	9(23.68)	76.32(29/38)
$\chi^2$					5.208
$P$					0.023

### 3.2. Comparison of cardiac function indicators between the two groups

Before treatment, there was no difference in cardiac function indicators between the two groups ( $P > 0.05$ ). After 2 months of treatment, the cardiac function indicators of the experimental group were better than those of the reference group ( $P < 0.05$ ), as seen in **Table 2**.

**Table 2.** Comparison of cardiac function indicators between the two groups [ $\bar{x} \pm s$ ]

Group	Number of cases	LVESD(mm)		LVEF(%)		LVEDD(mm)	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Experimental Group	38	32.28 $\pm$ 3.74	26.71 $\pm$ 3.12	40.56 $\pm$ 4.98	60.58 $\pm$ 7.43	60.11 $\pm$ 9.25	51.42 $\pm$ 5.48
Reference Group	38	32.24 $\pm$ 3.77	29.77 $\pm$ 3.19	40.51 $\pm$ 4.83	47.09 $\pm$ 6.42	60.04 $\pm$ 8.79	55.04 $\pm$ 5.56
$t$		0.046	4.227	0.044	8.469	0.034	2.858
$P$		0.963	< 0.001	0.965	< 0.001	0.973	0.006

### 3.3. Comparison of lung function indicators between the two groups

Before treatment, there was no difference in lung function indicators between the two groups ( $P > 0.05$ ). After 2 months of treatment, the lung function indicators of the experimental group were higher than those of the reference group ( $P < 0.05$ ), as shown in **Table 3**.

**Table 3.** Comparison of lung function indicators between the two groups [ $\bar{x} \pm s$ ]

Group	Number of cases	FVC(L)		FEV <sub>1</sub> (L)		FEV <sub>1</sub> /FVC(%)	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Experimental group	38	3.29 $\pm$ 0.51	5.54 $\pm$ 0.73	2.98 $\pm$ 0.44	5.38 $\pm$ 0.69	75.27 $\pm$ 7.12	90.11 $\pm$ 8.05
Reference group	38	3.31 $\pm$ 0.54	3.53 $\pm$ 0.66	2.96 $\pm$ 0.46	3.49 $\pm$ 0.61	75.22 $\pm$ 7.18	84.59 $\pm$ 8.01
$t$		0.166	12.590	0.194	12.650	0.030	2.996
$P$		0.869	< 0.001	0.847	< 0.001	0.976	0.004

### 3.4. Comparison of PWV levels between the two groups

Before treatment, there was no difference in PWV levels between the two groups ( $P > 0.05$ ). After 2 months of treatment, the PWV level of the experimental group was lower than that of the reference group ( $P < 0.05$ ), as shown in **Table 4**.

**Table 4.** Comparison of PWV levels between the two groups [ $\bar{x} \pm s$ , cm/s]

Group	Number of cases	cfPWV		baPWV	
		Before treatment	After treatment	Before treatment	After treatment
Experimental group	38	1052.98 $\pm$ 234.81	771.53 $\pm$ 92.41	1510.53 $\pm$ 208.35	1232.53 $\pm$ 84.17
Reference group	38	1058.22 $\pm$ 230.94	865.92 $\pm$ 94.05	1511.41 $\pm$ 210.55	1377.43 $\pm$ 85.09
<i>t</i>		0.098	4.413	0.018	7.463
<i>P</i>		0.922	< 0.001	0.985	< 0.001

## 4. Discussion

CHF progresses rapidly, often leading to multiple complications, posing significant treatment challenges. The long treatment cycle for patients with this disease focuses on alleviating symptoms, preventing related complications, and reducing mortality<sup>[3]</sup>. Medication serves as the foundational therapy, utilizing drugs such as cardiac stimulants and diuretics to improve heart function, relieve fluid retention, and mitigate disease severity. However, long-term drug therapy has side effects and generally limited long-term prognosis, highlighting its therapeutic limitations.

The decreased physiological function in CHF patients restricts their mobility, directly diminishing their exercise reserve, causing dyspnea or fatigue, and ultimately affecting their quality of life<sup>[4]</sup>. Based on this pathological process, cardiac rehabilitation therapy can be implemented for these patients. Measures such as cognitive therapy and gradual rehabilitation training can enhance the patients' physical fitness, restore cardiopulmonary function, and improve the efficacy of disease treatment<sup>[5]</sup>.

Results indicate that the total effective rate in the experimental group (94.74%) was higher than that of the control group (76.32%). After two months of treatment, the experimental group's cardiopulmonary function indicators were superior to those of the control group ( $P < 0.05$ ). This improvement can be attributed to cardiac rehabilitation therapy's ability to regulate the body's oxygen supply and consumption levels, thereby enhancing cardiopulmonary function and increasing exercise endurance<sup>[6]</sup>. Comprehensive assessments provide a holistic summary of the patient's physical state, identifying individualized needs for rehabilitation therapy. Combined with cognitive therapy, this approach corrects patients' misconceptions, raises awareness of the benefits of rehabilitation therapy, and improves compliance<sup>[7]</sup>. Psychological therapy deeply analyzes patients' current psychological issues and provides differentiated and humane psychological treatments, minimizing psychological stress and increasing treatment acceptance. Additionally, cardiac rehabilitation therapy tailors diverse training measures based on patients' current condition and exercise tolerance, gradually cultivating exercise habits and promoting regular exercise<sup>[8]</sup>. With gradual and incremental rehabilitation exercises, patients' lung capacity, ventilation, and gas exchange functions are improved, elevating lung function.

Decreased exercise endurance in CHF patients directly affects blood vessel elasticity, prolongs PWV, and exacerbates the disease. Therefore, this study included the PWV indicator. After two months of treatment, the experimental group's PWV level was lower than the control group's ( $P < 0.05$ ). This improvement is attributed to resistance training and aerobic exercise during cardiac rehabilitation, which enhances blood flow shear force and nitric oxide production by endothelial cells, relaxing blood vessels and preventing excessive arterial stiffness<sup>[9]</sup>. Cardiac rehabilitation also restores autonomic nerve balance, inhibits excessive catecholamine release, reduces blood vessel tension, and improves PWV. Furthermore, it prevents myocardial reverse



remodeling, improves heart function indicators like LVEF, and reduces vascular wall mechanical stress<sup>[10]</sup>. Rehabilitation exercise significantly improves arterial compliance, matching ventricular systolic function with blood vessel elasticity, lowering PWV levels.

## 5. Conclusion

In summary, cardiac rehabilitation therapy for CHF patients is highly effective, maximally restoring cardiopulmonary function, improving PWV levels, stabilizing the condition, preventing adverse events, and positively impacting treatment outcomes.

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# Study on the Immune Activity of Mice In Vitro and In Vivo with Nano-Material Adjuvant

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**Abstract:** This paper investigates the effects of graphene quantum dots and mesoporous silica as nanomaterial adjuvants on immune activity in mice both in vitro and in vivo. The two materials have distinct properties; graphene quantum dots possess unique optical and electrical characteristics, while mesoporous silica features a regular pore structure. In vitro experiments show differences in their effects on immune cell activation and cytokine secretion; in vivo experiments reveal varying performances in antibody production and immune cell function regulation. Their mechanisms of action and safety profiles also differ, offering distinct advantages in application prospects. These two nanomaterial adjuvants provide new directions for the development of immunology, warranting further exploration.

**Keywords:** Graphene quantum dots; Mesoporous silica; Nanomaterial adjuvant; Immune activity; Immune regulation

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## 1. Introduction

In modern biomedical research, the regulation of immune activity is of great significance for disease prevention and treatment. Adjuvants, as key components to enhance immune responses, have always been a hot topic in immunology. Although traditional adjuvants have some effect, they come with drawbacks such as significant side effects and limited immune enhancement. In recent years, with the rapid development of materials science, nanomaterials have shown great potential in the field of adjuvants due to their unique nanoscale effects, high specific surface area, and good modifiability. Graphene quantum dots and mesoporous silica have been research hotspots in recent years. Graphene quantum dots exhibit unique optical and electrical properties due to their distinctive physical and chemical characteristics, which are related to immune function. Mesoporous silica features regular pore structures, appropriate pore sizes, large specific surface areas, excellent surface chemical properties, and easy modification, making it a promising new method for immune regulation. This article provides an in-depth analysis of the effects of nanomaterial adjuvants on immune activity both inside and

outside mice.

## **2. Research progress on graphene quantum dots as adjuvants**

### **2.1. Characteristics of graphene quantum dots**

Graphene quantum dots range in size from 1 to 100 nanometers. Their extremely small particle size endows them with a large specific surface area, facilitating extensive interactions with the external environment. Common functional groups on their surfaces include carboxyl ( $-\text{COOH}$ ) and hydroxyl ( $-\text{OH}$ ) groups. These functional groups alter their charge characteristics in aqueous solutions, ensuring dispersion stability while serving as key sites for chemical modification. For example, carboxyl groups can be linked to amino-containing biomolecules through condensation reactions, enabling bio-functional modifications of<sup>[1]</sup>.

In terms of optics, graphene quantum dots exhibit excellent fluorescence performance. Their fluorescence emission wavelength can be altered through size control and surface modification, facilitating biological imaging and providing a visual approach to study their immune-regulating effects. In electrical properties, they have good conductivity, and their unique electronic structure features quantum confinement and edge effects. These electrical characteristics may interfere with the ion channels of immune cells, affecting intracellular signal transduction and thus regulating immune cell function.

### **2.2. Effects on in vitro immune activity of mice**

Macrophages, as the forefront of immunity, can take up graphene quantum dots through phagocytosis. Their surface scavenger receptors and Fc receptors play a crucial role in recognition and binding<sup>[2]</sup>. In terms of lymphocytes, T cell receptors (TCRs) of T lymphocytes interact with antigen-quantum dot complexes processed by antigen-presenting cells, triggering immune responses; B lymphocytes can directly recognize and bind to antigen-modified graphene quantum dots via their surface antigen receptors.

#### **2.2.1. Effects on the morphology and activity of immune cells**

After macrophages take up graphene quantum dots, their volume increases, pseudopodia become more numerous and elongated, significantly enhancing phagocytic capacity. For lymphocytes, graphene quantum dots can promote T lymphocyte proliferation, accelerate the cell cycle, and allow more cells to enter the S phase and G2/M phase; they also induce B lymphocytes to differentiate into plasma cells, enhancing antibody secretion capacity<sup>[3]</sup>.

As an important T-cell growth factor, the secretion of IL-2 is significantly increased under the influence of graphene quantum dots. This is due to its activation of the JAK-STAT signaling pathway within T lymphocytes, promoting the transcription and expression of the IL-2 gene. TNF- $\alpha$  has multiple biological activities; graphene quantum dots can stimulate macrophages and T lymphocytes by activating the NF- $\kappa$ B signaling pathway, enhancing the expression of the TNF- $\alpha$  gene and increasing its concentration in the cell culture supernatant<sup>[4]</sup>.

Chemokines are crucial for the migration and recruitment of immune cells. Studies have shown that graphene quantum dots can induce immune cells to secrete various chemokines, such as CXCL8 (i.e., IL-8), which attracts neutrophils and T lymphocytes to migrate towards inflammatory sites, enhancing immune defense. Additionally, graphene quantum dots influence the secretion of immune regulatory molecules like interferons (IFNs). Changes in IFN secretion can have profound effects on the body's immune state.

### 2.3. Effects on immune activity in mice

In animal models, combining graphene quantum dots with antigens can significantly enhance the production of specific antibodies. The primary mechanism involves activating B cell antibodies by improving antigen-presenting cells' uptake, processing, and presentation of antigens. Enzyme-linked immunosorbent assays show that compared to using only the antigen group, the antibody titer in the experimental group is notably increased, and it also exhibits a certain affinity for the produced antibodies <sup>[5]</sup>.

Research shows that graphene quantum dots can regulate the distribution and function of T lymphocyte subsets. Immune adjuvants can increase the number of CD4+ T cells, which secrete large amounts of cytokines such as interleukin-4 and interleukin-10. The function of CD8+ T cells is also enhanced, improving their ability to kill target cells, playing a crucial role in antiviral and anti-tumor activities. Fluorescence labeling tracking revealed that during the initial administration, graphene quantum dots primarily accumulate in the liver and spleen, where macrophages are abundant <sup>[6]</sup>. Over time, some gradually spread to other organs such as the lungs and kidneys. By imaging and quantitatively analyzing fluorescence at different time points in various organs, the dynamic distribution process within the body was clarified.

Currently, the metabolic pathways of graphene quantum dots in mice have not been fully elucidated. It is hypothesized that they may be phagocytosed by macrophages and enter lysosomes, where they are degraded by lysosomal enzymes. However, due to their high chemical stability, degradation is slow. Studies show that the clearance time in mice is relatively long, potentially taking several weeks or even months, which is crucial for evaluating their safety as an adjuvant and assessing long-term effects.

## 3. Research progress of mesoporous silica as an adjuvant

### 3.1. Characteristics of mesoporous silica

Mesoporous silica has a highly regular pore structure, with pore sizes mainly ranging from 2 to 50 nm. This precisely tunable pore structure makes it suitable for loading various types of biomacromolecules. The material boasts an excellent specific surface area (ranging from hundreds to thousands of square meters per gram), which not only effectively loads biomolecules but also enhances their interaction with the external environment. When loaded with antigens, a large number of antigen molecules can be adsorbed on the surface and inside the pores, forming stable complexes that provide a favorable environment for subsequent immune responses <sup>[7]</sup>.

Mesoporous silicene is rich in silanol groups (Si-OH), which endow it with excellent hydrophilicity, facilitating its dispersion within biological systems. Silanol is a crucial site for surface modification; through chemical methods such as silanization, different functional groups can be introduced into the material. These functional groups can be targeting ligands, such as antibody fragments or transmembrane peptides, enabling specific binding to the surface of immune cells. They can also be cytokines or immunomodulators that regulate immune responses, achieving precise modulation of immune activity.

### 3.2. Effects on the in vitro immune activity of mice

For process and mechanism of mesoporous silica being taken up by immune cells, immune cells primarily rely on endocytosis to take up mesoporous silica. Phagocytes, such as macrophages, engulf larger mesoporous silica particles through their phagocytic activity; whereas non-phagocytic cells, like lymphocytes, mostly complete the uptake via endocytosis mediated by gridiron proteins or caveolae proteins. In this process, the functional



groups on the surface of mesoporous silica play a crucial role. For example, positively charged groups can interact electrostatically with the negatively charged cell membranes of immune cells, enhancing uptake efficiency<sup>[8]</sup>.

At appropriate concentrations, mesoporous silica has a minimal effect on the survival of immune cells but can promote their proliferation. Taking lymphocytes as an example, it can facilitate their entry into the S phase and G2/M phases of the cell cycle, accelerating DNA synthesis and cell division. This promoting effect is closely related to the surface chemical properties of mesoporous silica and the immune modulatory molecules it carries. When loaded with proliferative cytokines, it significantly enhances the proliferation capacity of lymphocytes, thereby intensifying the immune response.

Mesoporous silica can influence multiple signaling pathways within immune cells. In macrophages, it can activate the NF- $\kappa$ B signaling pathway. After being taken up by macrophages, its surface components interact with pattern recognition receptors within the cell, thereby activating NF- $\kappa$ B and promoting the expression of inflammation-related genes such as TNF- $\alpha$  and IL-1 $\beta$ . In T lymphocytes, mesoporous silica can modulate the TCR signaling pathway, affecting the activation and function of T cells. Its surface-modified molecules can interact with TCR complexes, regulating the phosphorylation levels of downstream signaling molecules, thus controlling the immune activity of T cells<sup>[9]</sup>.

As immune signaling pathways are activated or inhibited, the expression and activity of a series of key signaling molecules change. In the NF- $\kappa$ B signaling pathway, I $\kappa$ B kinase (IKK) is phosphorylated and activated, which then phosphorylates and degrades I $\kappa$ B $\alpha$ , releasing the NF- $\kappa$ B dimer to enter the nucleus and regulate the transcription of related genes. In the TCR signaling pathway, the phosphorylation levels of key signaling molecules such as Src family kinases (Lck, Fyn) change, affecting the activity of downstream adapter proteins and kinases, ultimately impacting T-cell functions like cytokine secretion and cell proliferation.

### 3.3. Effects on immune activity in mice

Animal experiments have shown that combining mesoporous silica with antigens can significantly increase their immunogenicity. Its function is to assist antigen-presenting cells in the uptake, processing, and presentation of antigens, as well as to activate B cells to produce antibodies. Studies have indicated that compared to the control group, the treatment group showed a significant increase in serum antibody titers<sup>[10]</sup>. Additionally, mesoporous silica also plays a role in modulating the immune microenvironment, regulating antibody type conversion, inducing the generation of specific antibody subtypes, and enhancing the body's immune protection.

The study found that mesoporous silica gel had the effect of improving the activity of immune cells. It could improve the killing ability of CTL and the killing effect of NK cells, promote the proliferation of T and B lymphocytes, increase the total number of immune cells, and enhance the degree of cellular immune response of the body.

Research findings indicate that at conventional doses, silica has almost no significant inhibitory effect on vital organs such as the liver, kidneys, and heart. Experimental results show that the tissue structure of various organs in the model rats is basically normal, with no obvious pathological changes observed. This suggests that the material has good biocompatibility and does not cause severe tissue damage to animals.

Toxicity tests showed that for mice, long-term use of mesoporous silica had no significant weight abnormalities, no significant changes in hematological indicators, and no significant changes in organ coefficients. However, if exposed to high doses for a long time, there was a tendency for mild inflammatory response and tissue fibrosis<sup>[11]</sup>.

#### 4. Performance comparison of graphene quantum dots and mesoporous silica adjuvants

In terms of immune cell activation, graphene quantum dots, with their unique optical and electrical properties, can more efficiently stimulate T lymphocyte proliferation, accelerating their cell cycle into the S phase and G2/M phases at a higher ratio. Mesoporous silica, through surface modification, significantly enhances macrophage phagocytic activity, promoting the increase and elongation of pseudopodia. In cytokine secretion, graphene quantum dots significantly increase IL-2 production, while mesoporous silica more prominently promotes TNF- $\alpha$  secretion, stimulating macrophages and T lymphocytes to produce large amounts of <sup>[12]</sup>.

In terms of antibody production, graphene quantum dots can effectively enhance the affinity of specific antibodies, while mesoporous silica is more effective in increasing antibody titers. Regarding immune cell function regulation, graphene quantum dots significantly increase the proportion of CD4<sup>+</sup> T cells, whereas mesoporous silica performs better in enhancing the cytotoxic activity of CD8<sup>+</sup> T cells.

The binding of graphene quantum dots to immune cells mainly depends on the physical and chemical interaction between their unique electronic structure and cell surface molecules; mesoporous silica mainly binds to immune cells through chemical reaction and electrostatic interaction between the surface silanol groups and the receptors or membrane components on the surface of immune cells.

Using the unique optical and electrical properties of graphene quantum dots can more effectively stimulate the proliferation of T lymphocytes, promoting their entry into the S phase and G2/M phases. However, after surface modification, mesoporous silica significantly enhances its phagocytic activity against macrophages, promoting the increase and extension of pseudopodia. Studies show that graphene QDs can increase the secretion rate of IL-2, while mesoporous silica can enhance the secretion of TNF- $\alpha$ , stimulating the synthesis by macrophages and T lymphocytes.

Graphene quantum dots can effectively enhance the affinity of antibodies, and mesoporous silica has a better effect on the increase of antibody valence. Based on this, some studies have proposed to use graphene quantum dots to improve the ratio of CD4<sup>+</sup> T cells, and to improve the killing ability of CD8<sup>+</sup> T cells by using mesoporous silica <sup>[13]</sup>.

Graphene quantum dots primarily achieve the killing of immune cells through their unique electronic structure, interacting physically and chemically with substances on the cell surface. Mesoporous silica is a new type of nanomaterial that can adhere to immune cells via interactions between its silanol groups on the surface and receptors or membrane components on the immune cell surface, as well as electrostatic interactions.

Graphene quantum dots tend to interfere with ion channels within immune cells, affecting electrophysiological activities and thus modulating immune signaling pathways; mesoporous silica, on the other hand, regulates immune responses by activating or inhibiting specific immune signaling pathways such as NF- $\kappa$ B and TCR. The mechanism differences stem from the electrical properties of graphene quantum dots and the pore structure and surface chemical properties of mesoporous silica.

In terms of biological distribution, graphene quantum dots initially concentrate more in the liver, while mesoporous silica tends to cluster more in the spleen. Metabolically, graphene quantum dots degrade slowly and have a long clearance time; although mesoporous silica also has some stability, it metabolizes relatively faster<sup>[14]</sup>. Potential toxicity risks: at high doses, graphene quantum dots may cause mild inflammatory responses, whereas mesoporous silica may exhibit a slight tendency towards tissue fibrosis.

In vaccine development, graphene quantum dots are suitable for enhancing antigen-specific immune

responses, while mesoporous silica facilitates the overall immunogenicity of vaccines. In the field of immunotherapy, graphene quantum dots can precisely modulate immune cell functions due to their unique properties, whereas mesoporous silica can exert its effects by loading immune-regulating molecules<sup>[15]</sup>.

## 5. Conclusion

In the field of nanomaterial adjuvants, graphene quantum dots and mesoporous silica exhibit distinct properties. In terms of enhanced immune activity, in vitro, the former promotes T cell proliferation and increases IL-2, while the latter stimulates macrophages and promotes TNF- $\alpha$ ; in vivo, the former enhances antibody affinity and increases CD4<sup>+</sup> T cells, whereas the latter boosts antibody titers and strengthens CD8<sup>+</sup> T cell killing. In terms of mechanisms of action, their binding modes and signaling pathways differ. Regarding safety, they vary in distribution, metabolism, and toxicity. In terms of application prospects, vaccine development and immunotherapy each have their advantages. Both offer diverse possibilities for the advancement of immunology and warrant further research.

## Disclosure statement

The author declares no conflict of interest.

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# Transcatheter Embolization Combined with Surgical Resection for Traumatic Middle Meningeal Artery-vein Fistula: A Case Report

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**Abstract:** Traumatic carotid-cavernous arteriovenous fistula (TCCAVF) is a rare but severe cerebrovascular disorder, often resulting from head trauma with temporal bone fractures. The pathogenesis involves vessel wall injury due to traction, frequently associated with fractures near the middle meningeal artery. This case highlights the typical clinical presentation, diagnostic approaches, and therapeutic management of TCCAVF, emphasizing the challenges in treating this condition. Transcatheter embolization proved effective in occluding the fistula, underscoring its role as a key intervention for traumatic meningeal arteriovenous fistulas.

**Keywords:** Traumatic carotid-cavernous arteriovenous fistula; Transcatheter embolization; Traumatic meningeal arteriovenous fistula

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## 1. Introduction

Traumatic carotid-cavernous arteriovenous fistula (TCCAVF) is a rare but potentially life-threatening cerebrovascular disease, typically caused by head trauma, especially cases involving temporal bone fractures. It is speculated that traction injury to the vessel wall leads to the formation of arteriovenous fistulas, and its pathogenesis is mostly associated with fractures adjacent to the middle meningeal artery<sup>[1, 2]</sup>.

This case demonstrates the typical clinical manifestations, diagnostic methods, and treatment strategies of TCCAVF, while also reflecting the complexity and treatment challenges of this disease.



## 2. Case overview

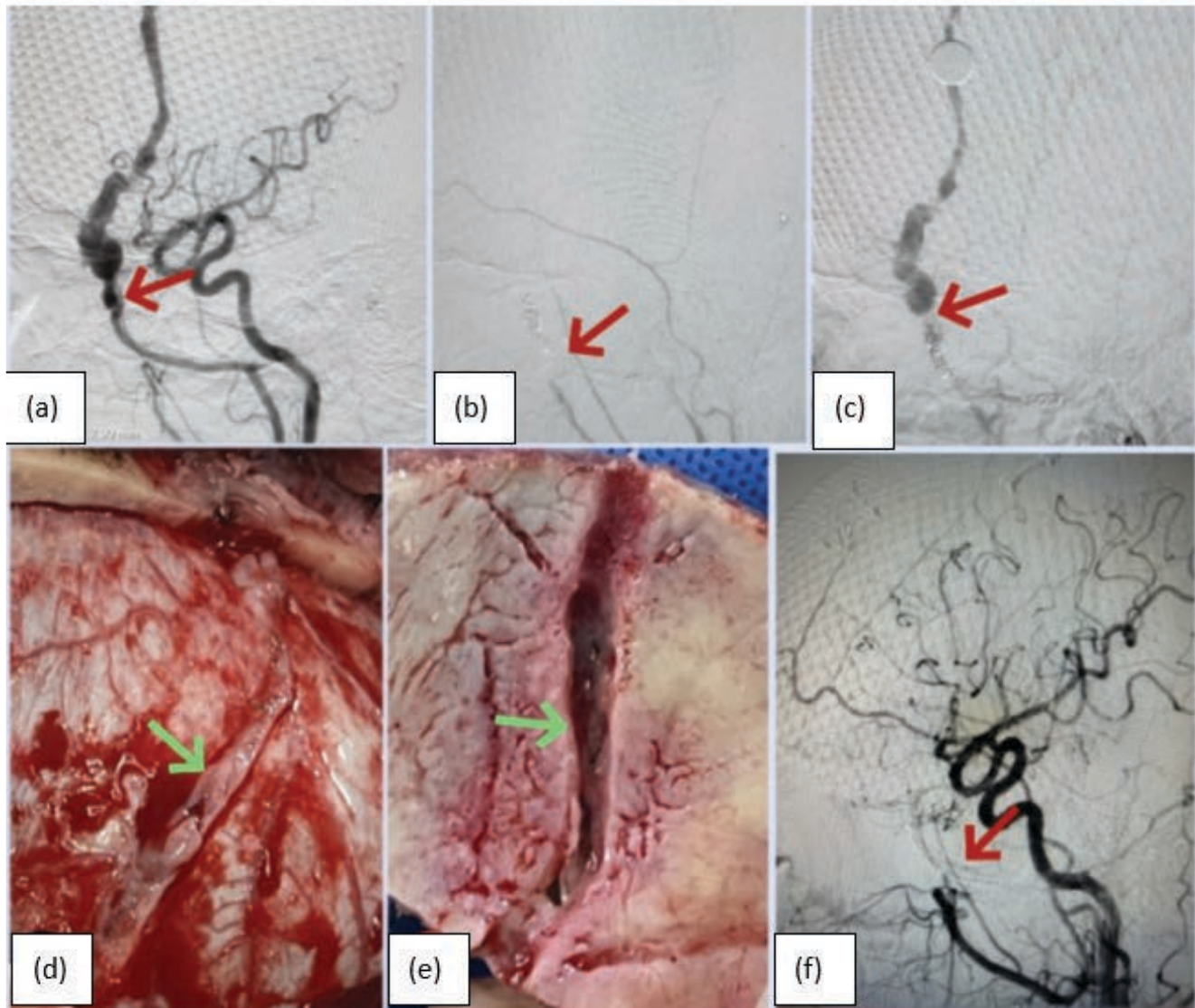
A 50-year-old female patient was admitted to the hospital due to “head trauma with unconsciousness for 2 hours caused by a car accident.” Physical examination on admission revealed coma, GCS score: 1 + 1 + 1 = 3, scalp hematoma on the right forehead, bilateral dilated and fixed pupils with a diameter of approximately 6mm, and absent pupillary light reflex. CT examination suggested acute subdural hematoma (left), subarachnoid hemorrhage, a small amount of intracranial air accumulation, skull fracture, skull base fracture (right), scalp hematoma; right middle ear mastoid hematoma; right zygomatic fracture; multiple rib fractures on the right side; right clavicle comminuted fracture. As the patient had cerebral hernia, preoperative preparations were completed after admission, and emergency left craniotomy hematoma removal, and decompressive craniectomy were performed. The operation was successful, and the patient recovered well, with clear consciousness and no functional disability. Approximately 60 days after the injury, a titanium mesh cranioplasty was performed, and the operation was smooth. About 75 days after the injury, the patient developed pulsatile tinnitus. No special conditions were found after consultation with otolaryngology. Auscultation of the temporal and parietal regions of the head revealed a blowing murmur consistent with the pulse on the right temporal and parietal regions.

**Figure 1** shows the cerebrovascular DSA examination of the patient. **Figure 1(a)** revealed a right dural arteriovenous fistula. During the operation, a spring coil combined with ONYX glue embolization was immediately applied, and the dural arteriovenous fistula was satisfactorily occluded (**Figure 1(b)**). The patient’s tinnitus symptoms disappeared. About 120 days after the injury, the patient again developed pulsatile tinnitus. Cerebrovascular angiography showed recurrence of the dural arteriovenous fistula (**Figure 1(c)**). Preoperative preparations were completed, and craniotomy for dural arteriovenous fistula resection was performed under general anesthesia. During the operation, the accompanying veins of the dural arteries were dilated and the wall was thickened (**Figure 1(d)**), showing arterialization, and the surrounding skull was compressed into a groove-like indentation (**Figure 1(e)**). An arcuate incision was made around the arterialized vein to open the dura mater, block the blood flow, and the artificial dura mater was sutured to repair the dura mater. The bone flap was repositioned, and the subcutaneous tissue and skin were sutured in layers. The operation was successful. The patient did not experience tinnitus symptoms after the operation. More than 180 days after the operation, cerebrovascular angiography showed no recurrence of the dural arteriovenous fistula (**Figure 1(f)**).

## 3. Pathogenesis and pathophysiology

The formation of TCCAVF is a result of the combined effects of trauma, vascular injury, and imbalance in local repair mechanisms. During craniocerebral trauma, the mechanical stress of temporal bone fractures can directly tear the vessel walls of the middle meningeal artery and its accompanying veins, forming an arteriovenous shunt. Under normal circumstances, there is a vessel wall between the middle meningeal artery and vein, but in TCCAVF, this vessel wall is destroyed, leading to the formation of an abnormal direct connection between the artery and vein. The formation of TCCAVF is mainly related to trauma-induced vessel wall damage, especially direct tearing or traction injury of the middle meningeal artery and its accompanying veins.

Arterial blood bypasses the normal blood flow pathway, directly flows into the veins and reaches the venous sinuses, leading to increased overall venous pressure in the brain tissue, impeded blood flow, and potentially causing cerebral edema, intracranial hemorrhage, or neurological deficits <sup>[1, 2]</sup>. In this case, the patient’s temporal bone fracture was located in the region of the middle meningeal artery, and it is speculated



**Figure 1.** Cerebrovascular DSA examination of the patient; **(a)** The arrow indicates the location of the dural arteriovenous fistula. Above the arrow is the dural vein draining into the sagittal sinus, and below the arrow is the thickened dural artery; **(b)** The arrow indicates no blood flow after embolization surgery combining a spring coil with ONYX glue; **(c)** The arrow indicates recurrence of the dural arteriovenous fistula, and the dot above is a spherical marker for the location of the draining vein; **(d)** The arrow indicates thickening of the dural vein and thickening of the blood vessel wall; **(e)** The arrow indicates the impression of the arterialized vein on the skull flap; **(f)** The arrow indicates the disappearance of the dural artery and dural arteriovenous fistula, with no blood flow.

that fracture fragments or shear forces during trauma caused damage to the vessel wall, resulting in the formation of an arteriovenous fistula. Additionally, local inflammatory responses and vascular remodeling after trauma may further promote the formation and expansion of the fistula <sup>[3]</sup>. It should be noted that the hemodynamic changes in TCCAVF are bidirectional. On one hand, arterial blood directly enters the venous system, causing local venous hypertension, which may lead to cortical venous dilation and, in severe cases, rupture and bleeding. On the other hand, the brain tissue distal to the fistula is affected by the “steal phenomenon”, resulting in hypoperfusion, neurological dysfunction, or epileptic seizures. The recurrence of the

fistula in this case after initial embolization may be related to neovascularization around the fistula.

#### **4. Diagnosis and imaging evaluation**

The diagnosis of TCCAVF combines clinical features and multimodal imaging examinations. Apart from typical pulsatile tinnitus, approximately 30% of cases can be affected by cortical venous hypertension, presenting with focal neurological deficits such as limb weakness and language disorders. Other symptoms of TCCAVF include headache, epileptic seizures, and visual changes. In this case, the patient presented with tinnitus as the initial symptom, but had no other neurological abnormalities, possibly due to the location of the fistula being away from functional venous sinuses.

Digital subtraction angiography (DSA) is the gold standard for diagnosing TCCAVF, as it can clearly show the location of the fistula, feeding arteries, and draining veins, and evaluate hemodynamic changes <sup>[4]</sup>. DSA was performed in this patient, confirming the location of the fistula in a distal branch of the middle meningeal artery and revealing the characteristic “early-appearing vein” sign, which helped doctors determine the nature and severity of the fistula and provided a strong basis for formulating later treatment strategies. Additionally, computed tomography angiography (CTA) and magnetic resonance angiography (MRA) can serve as screening tools, but they have lower sensitivity for detecting small fistulas <sup>[5]</sup>. CTA can rapidly screen for fractures and hematomas, but its sensitivity for low-flow fistulas is inadequate. The initial CTA examination in this case did not reveal abnormalities, possibly due to the incomplete formation of the fistula. Magnetic resonance venography (MRV) can clearly show venous sinus dilation and cortical venous tortuosity, but its ability to display the feeding arteries of the fistula is limited. In this case, the patient had a temporal bone fracture located in the region of the middle meningeal artery, and the formation of TCCAVF was related to direct injury of the vessel wall.

Based on the history of trauma and the presence of a clear blowing-like bruit on auscultation over the temporoparietal region, the diagnosis of TCCAVF was suspected and confirmed by DSA, which revealed a dural arteriovenous fistula located in the right middle meningeal artery region. In recent years, clinical applications of high-resolution three-dimensional rotational DSA technology have enabled stereoscopic localization of fistulas, combined with hemodynamic parameters such as pressure gradient measurements, to further optimize the placement of embolization materials. Additionally, intraoperative indocyanine green fluorescence angiography (ICG) allows real-time evaluation of fistula occlusion effects, thereby reducing the risk of postoperative recurrence.

#### **5. Treatment strategy and efficacy analysis**

Traumatic carotid-cavernous arteriovenous fistulas have been shown to progressively grow in repeated cerebrovascular angiography, and they are one of the causes of delayed intracranial hemorrhage <sup>[3]</sup>. Furthermore, pulsatile intracranial noise significantly affects patients' rest. Therefore, most patients require active treatment. The treatment goal of TCCAVF is to completely occlude the fistula and restore normal hemodynamics. Currently, the main treatment methods include interventional embolization and surgical resection, or a combination of both <sup>[6]</sup>. Interventional embolization is non-invasive, involving the insertion of guidewires and catheters into the fistula to apply embolization materials that block abnormal blood vessels and occlude the fistula.



In this case, the initial treatment employed a combination of coils and Onyx glue for embolization, which achieved significant short-term results. However, factors such as rapid blood flow through the fistula, incomplete embolization, and neovascularization may increase the risk of subsequent recurrence. Studies have shown that simple embolization treatment has a higher recurrence rate, especially for high-flow fistulas <sup>[7]</sup>. Therefore, considering alternative treatment methods for recurrent or complex cases is necessary.

Surgical resection of the fistula and involved dura mater is a more thorough treatment approach. In this case, successful surgical resection of the arterialized vein was performed, and no recurrence was observed during long-term follow-up, confirming the reliability of surgical treatment <sup>[8]</sup>. Apart from interventional embolization and surgical resection, other treatment strategies can be considered, such as radiotherapy for patients who cannot tolerate surgery or interventional treatment, and drug therapy (e.g., platelet inhibitors and anticoagulants) to reduce the risk of intravascular embolization. However, the effectiveness and safety of these treatment strategies require further research and clinical validation.

## **6. Treatment selection and individualized approach**

The treatment of TCCAVF should be tailored to the specific circumstances of each patient: interventional therapy is suitable for patients with deep-seated fistulas or high surgical risk, but recurrence should be vigilantly monitored. Surgical treatment is more appropriate for cases with superficial fistulas, failed interventional therapy, or concomitant intracranial hematomas <sup>[9]</sup>. The treatment process in this case suggests that surgical treatment may be a better option for high-flow, superficial fistulas <sup>[10]</sup>. When deciding on a treatment plan, the patient's overall condition, severity of the disease, and treatment risks should be fully considered. Simultaneously, open communication with the patient is essential, providing detailed information about the benefits and risks of treatment and involving them in the final decision-making process. Surgical treatment offers the advantage of directly addressing the fistula, ensuring complete removal and thereby reducing the risk of recurrence. Before surgery, a detailed surgical plan should be developed, covering aspects such as surgical timing, steps, and potential complications.

Comprehensive preoperative evaluation and preparation are crucial, including neuroimaging assessments like magnetic resonance imaging (MRI) and angiography to determine the specific details of the fistula (location, size, feeding arteries, etc.) and assess for any complications (e.g., intracranial hematoma). The patient's general health status, including the cardiovascular system, liver function, and coagulation profile, should also be thoroughly evaluated. During the surgical procedure, close monitoring of blood pressure and cerebral hemodynamics is essential to prevent intraoperative bleeding or other complications. Following surgery, the patient's condition, including neurological status and wound healing, should be closely monitored to avoid complications. The patient may require a period of rehabilitation, including physical therapy and rehabilitation training, to facilitate functional recovery. Tailoring an individualized treatment plan for each patient can maximize their needs and improve overall treatment efficacy.

## **7. Long-term follow-up and prognosis**

Patients with TCCAVF require long-term follow-up, with regular monitoring for recurrence through DSA or CTA. These imaging examinations can clearly demonstrate the presence of abnormal vessels and blood flow,

enabling doctors to accurately evaluate treatment effectiveness and recurrence risk. Establishing a regular follow-up schedule is crucial to ensure patient safety. Besides imaging, patients' symptoms are also important indicators for assessing treatment efficacy. The disappearance of pulsatile tinnitus, a common symptom in TCCAVF patients, suggests improvement in hemodynamic abnormalities. However, it should be noted that the absence of pulsatile tinnitus does not necessarily indicate complete resolution of the lesion but rather indicates a certain degree of treatment success.

Therefore, long-term follow-up should also assess other neurological functions to better manage the patient's condition<sup>[11]</sup>. During follow-up, attention should also be paid to the patient's quality of life and mental health. Treating TCCAVF is a long-term process, and patients may experience adverse emotions such as anxiety, fear, and depression. Hence, it is essential to provide individualized psychological support and health education based on the patient's specific situation, aiming to improve their mental state and enhance treatment compliance. Additionally, helping patients develop healthy lifestyles, including controlling blood pressure and blood sugar levels, is important. In this case, no recurrence was observed during the 180-day postoperative follow-up.

## 8. Conclusion

Reviewing the treatment process of this case, for the treatment of traumatic middle meningeal arteriovenous fistulas, accurate localization through DSA angiography, selection of a small incision in the localized area, and amputation of the draining vein under local or general anesthesia constitute an effective and minimally invasive treatment approach. This treatment method offers advantages such as minimal trauma and low cost, making it suitable for most patients. However, for some complex cases, a more comprehensive treatment plan may be required, such as a combination of interventional therapy and surgical treatment, to ensure effective control of the disease. In clinical practice, doctors need to select the most appropriate treatment plan based on the specific conditions and lesion characteristics of the patient to achieve the best treatment effect. Simultaneously, treatment experience and long-term follow-up observations of similar cases have important guiding significance, helping to improve treatment plans and increase the success rate of treatment.

## Disclosure statement

The authors declare no conflict of interest.

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# Clinical Application of Imaging Navigation Technology in the Treatment of Pulmonary Tuberculosis

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**Abstract:** *Objective:* To observe the guiding role of image navigation technology in the treatment of patients with tuberculosis. *Methods:* A total of 188 patients with multidrug-resistant tuberculosis (MDR-TB) and rifampin-resistant tuberculosis (RR-TB) who were hospitalized in the hospital from September 2023 to September 2024 were included. After random equal division, 94 patients were included in the control group and received systemic anti-tuberculosis chemotherapy; 94 patients were included in the treatment group. Based on systemic anti-tuberculosis treatment, digital subtraction angiography (DSA) technology was used to inject targeted drugs into the bronchial lumen through bronchoscopy to complete anti-tuberculosis treatment. The changes in sputum bacteria and imaging were observed in the two groups. *Results:* The sputum negative conversion rate in the treatment group was significantly higher than that in the control group (86.2%; 70.2%) ( $u=2.74$ ,  $P<0.01$ ). The absorption rate of CT imaging lesions (significant absorption) was significantly higher than that of the control group (83.0%; 50%) ( $u=2.45$ ,  $P<0.05$ ). The closure rate of chest CT cavities was significantly higher than that of the control group (74.2%; 39.1%) ( $u=2.20$ ,  $P<0.05$ ). During the treatment process, the improvement of clinical symptoms was significantly higher than that of the control group, and the difference was statistically significant. There was no statistically significant difference in the incidence of adverse reactions between the two groups ( $\chi^2=0.434$ ,  $P>0.05$ ). *Conclusion:* Based on DSA, targeted drug infusion within the bronchoscope can significantly improve the efficacy of the disease, with mild adverse reactions that patients can tolerate. It is worthy of promotion and application.

**Keywords:** Image navigation; DSA; Bronchoscopy; Targeted infusion therapy; MDR-TB; RR-TB

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## 1. Introduction

MDR-TB/RR-TB is a type of tuberculosis disease that is more complex and difficult to treat. This disease is relatively contagious, poses a higher risk of death for patients, and has a poor long-term prognosis, with cavitary

tuberculosis being the most critical condition <sup>[1]</sup>. According to statistics from the World Health Organization (WHO), there were 400,000 cases of multidrug-resistant and rifampicin-resistant tuberculosis (MDR/RR-TB) globally in 2023, accounting for an estimated 44% of MDR-TB/RR-TB incidence, but the treatment success rate reached 68% <sup>[2]</sup>. However, based on clinical data from China in 2020, the success rate of second-line anti-tuberculosis treatment for MDR-TB/RR-TB was 51%, which is lower than the global level <sup>[3]</sup>.

Currently, systemic anti-tuberculosis treatment remains the common chemotherapy for patients with MDR-TB/RR-TB, which can prevent the spread of tuberculosis lesions, but its treatment specificity is general. Bronchoscopy is a new type of equipment with a high application rate. Local infusion therapy using this instrument is the latest treatment for MDR-TB/RR-TB, which can improve the absorption rate of lesions and achieve better long-term efficacy. To ensure the accuracy of infusion therapy, guiding techniques such as DSA are often used, which can leverage the treatment advantages of high-precision equipment. Therefore, this study selected 188 patients with MDR-TB/RR-TB to evaluate the specific efficacy of continuous infusion of targeted drugs into the bronchoscopic cavity under the premise of DSA.

2. Materials and methods

2.1. Selection criteria

Inclusion criteria: (1) Determined by relevant standards such as “Diagnosis of Pulmonary Tuberculosis (WS+288-2017)”;

(2) Drug sensitivity testing can confirm MDR-TB/RR-TB;

(3) Meet multiple examination indications for bronchoscopy and can tolerate this operation throughout the process.

Exclusion criteria: (1) Significant other types of lung lesions;

(2) Multiple important organs with abnormal functions;

(3) Immune diseases;

(4) Critical underlying diseases with a survival period of less than 6 months;

(5) Accompanied by other serious infections;

(6) Have a history of allergy to the drugs involved in the study;

(7) Withdraw voluntarily in the middle of the study.

2.2. General information

One hundred and eighty-eight patients with MDR-TB/RR-TB who received inpatient treatment between September 2023 and September 2024 were selected. Randomly divided equally, the basic information between groups is as follows:

Table 1. Comparison of basic data between the two groups of patients (n/%, X+S)

Group	Number of Cases	Gender		Ages(years)		Duration of Disease (years)	
		Male	Female	Range	Mean	Range	Mean
Treatment group	94	45(47.9)	49(52.1)	16-61	31.28±4.17	1-5	4.39±1.48
Control group	94	52(55.3)	42(44.7)	17-55	31.60±4.25	1-6	4.80±1.41
<i>x<sup>2</sup>/t</i>		1.044		0.521		1.945	
<i>P</i>		0.307		0.603		0.053	

2.3. Treatment methods

The control group underwent systemic anti-tuberculosis chemotherapy. Based on the patient’s medication history and drug sensitivity test results, drug resistance was confirmed using tuberculosis mycobacterium

identification and drug resistance gene testing (tNGS) based on ultra-multiple PCR and next-generation sequencing technology. This project can identify five species of *Mycobacterium tuberculosis* complex. With full coverage of first and second-line anti-tuberculosis drugs, there are 16 types of treatment drugs to choose from. Following the “Guidelines for Chemotherapy of Drug-Resistant Tuberculosis,” the ABC group anti-treatment plan was selected to rationalize the types of medications used. Patients underwent intensive chemotherapy for 6 months, with a total treatment course of 18–20 months.

The treatment group, based on DSA technology, received bronchial infusion of targeted drugs through bronchoscopy. Patients completed various pre-surgical examinations and were positioned in a supine position, with local anesthesia applied to the throat. The specific location and scope of the cavity lesion were identified based on chest CT and other results. Guided by an X-ray system, a bronchoscope was slowly inserted, and the position of the scope was evaluated using catheter navigation technology. A catheter was gently inserted through the working channel, and when small bronchi (levels 6 to 8) were visible, a mixed contrast solution (povidone-iodine combined with lidocaine) was administered in a dose of 5 to 10 ml for local angiography of the lesion area. The contrast agent flowed smoothly into the lesion site or cavity, allowing multi-dimensional and multi-level evaluation of the lesion. Then, 4–6 ml of a combination agent containing levofloxacin, isoniazid, and amikacin (all conventionally used drugs in our hospital) was injected (calculated based on the size of the lesion and cavity) <sup>[4, 5]</sup>. The catheter was gently removed, and the bronchoscope was withdrawn. Patients were required to maintain an anti-reflux position and were observed for 30 minutes, during which violent coughing was prohibited to prevent medication reflux. This therapy was administered once a week, with one cycle consisting of 4 weeks.

## 2.4. Observation items

- (1) Sputum negative conversion rate: Observed at 3/6/12/18 months after treatment. After molecular biological detection or culture of sputum bacteria, two consecutive negative results without reversion to positive indicate a negative conversion.
- (2) Lesion absorption rate: Evaluated after 18 months of treatment. Significant absorption is defined as the absorption of the existing lesion compared to the original lesion being no less than 1/2; absorption refers to the specific absorption of the lesion not reaching 1/2; unchanged indicates no change in the lesion scope; deterioration signifies lesion dissemination or area expansion.
- (3) Cavity changes: Evaluation will be conducted during the same time period. Closure is defined as the absence of a cavity; reduction is defined as a decrease in cavity diameter by no less than 1/2; no change is defined as a cavity diameter decrease or increase of less than 1/2; and enlargement is defined as an increase in cavity size by more than 1/2.
- (4) Improvement of clinical symptoms: Observation of improvement rates of symptoms such as fever, cough, and expectoration.
- (5) Adverse reaction rate: Observation of the occurrence probability of fever, minor hemoptysis, tracheal dissemination, and pneumothorax.

## 2.5. Efficacy evaluation

Efficacy is judged based on the revised efficacy evaluation criteria from the 1982 National Tuberculosis Prevention and Control Work Conference, with the main indicator being the negative conversion of tuberculosis bacteria <sup>[6]</sup>. Changes in tuberculosis imaging can be evaluated based on sputum bacteria, lesions, and cavities.

## 2.6. Statistical processing

Statistical methods employed SPSS 19.0 statistical software for data processing. Measurement data were expressed as (4-S) and analyzed using two independent sample t-tests. Count data were analyzed using the chi-square test, and ordinal data were examined using the rank sum test. A *P*-value less than 0.05 was considered statistically significant.

## 3. Results

### 3.1. Sputum negative conversion rate in both groups

The sputum negative conversion rate at 18 months was higher in the treatment group than in the control group (*P* < 0.05).

**Table 1.** Sputum negative conversion rate in both groups (n/%)

Group	Number of cases	3 months	6 months	12 months	18 months
Treatment group	94	54(57.4)	62(66.0)	72(76.6)	81(86.2)
Control group	94	43(45.7)	53(56.4)	61(64.9)	66(70.2)
$\chi^2$		2.577	1.814	3.110	7.018
<i>P</i>		0.108	0.178	0.078	0.008

### 3.2. Lesion absorption rate in two groups

The significant lesion absorption rate in the treatment group at 18 months was higher than that in the control group (*P* < 0.05).

**Table 2.** Lesion absorption rate in two groups (n/%)

Group	Number of cases	Significant absorption	Absorption	No absorption	Deterioration
Treatment group	94	78(83.0)	8(8.5)	7(7.4)	1(1.1)
Control group	94	47(50.0)	36(38.3)	7(7.4)	4(4.3)
$\chi^2$		22.942	23.263	0.000	1.849
<i>P</i>		0.000	0.000	1.000	0.174

### 3.3. Changes in cavity status between the two groups

The cavity closure rate in the treatment group at 18 months was higher than that in the control group (*P* < 0.05).

**Table 3.** Changes in cavity status between the two groups (n/%)

Group	Number of cases	Closure	Reduction	No change	Deterioration
Treatment group	31	23(74.2)	4(12.9)	3(9.7)	1(3.2)
Control group	23	9(39.1)	5(21.7)	6(26.1)	3(13.0)
$\chi^2$		6.724	0.742	2.560	1.856
<i>P</i>		0.010	0.389	0.110	0.173



### 3.4. Improvement of clinical symptoms in both groups

The improvement of clinical symptoms in the treatment group was better than that in the control group ( $P < 0.05$ ).

**Table 4.** Improvement of clinical symptoms in both groups (n/%)

Group	Improvement in fever	Improvement in cough	Improvement in expectoration	Improvement in chest pain	Improvement in dyspnea
Treatment group	100. 0(35/35)	85. 9(73/85)	87. 3(69/79)	83.9(26/31)	95. 2(40/42)
Control group	71. 1(37/52)	56. 2(50/89)	57. 1(48/84)	53. 1(17/32)	70. 0(21/30)
$\chi^2$	12.200	18.513	18.329	6.870	8.612
$P$	0.001	0.000	0.000	0.009	0.003

### 3.5. Adverse reaction rates in both groups

The adverse reaction rate in the treatment group was lower than that in the control group ( $P < 0.05$ ).

**Table 5.** Adverse reaction rates in both groups (n/%)

Group	Number of cases	Fever	Minor hemoptysis	Tracheobronchial dissemination	Pneumothorax	Incidence rate
Treatment group	94	4(4.3)	2(2.1)	2(2.1)	0	8.5(8/94)
Control group	94	7(7.4)	5(5.3)	5(5.3)	1(1.1)	19.1(18/94)
$\chi^2$						4.463
$P$						0.035

## 4. Discussion

Currently, there are many types of anti-tuberculosis drugs, and their indications and clinical efficacy vary, making improper medication usage prone to occur, thereby increasing the risk of MDR-TB/RR-TB. Additionally, as the course of tuberculosis prolongs, the treatment regimens required by patients become increasingly complex, which can also lead to drug resistance, further increasing the difficulty of treating the disease [7]. Various reasons have led to a gradual increase in the proportion of drug-resistant tuberculosis, which has a low cure rate. Patients often experience recurrent infections. If accompanied by severe tissue damage, it can also lead to significant fibrous tissue hyperplasia, reducing the blood vessel content in the affected area, thereby affecting the blood circulation state, reducing the absorption rate of therapeutic drugs, and significantly reducing their efficacy [8, 9]. Coupled with the emergence of multidrug resistance in patients, it can cause excessive reproduction of pathogenic bacteria in the cavitory lesion area, resulting in a large amount of liquefied caseous necrosis-like material adhering to the cavity wall, causing the number of mycobacteria to rise rapidly and present a highly active reproductive state [10].

Within the cavitory lesion, the drug concentration is relatively low, making it impossible to achieve a bacteriostatic effect, and various administration routes, such as intravenous infusion or oral administration, cannot achieve optimal efficacy. Typically, systemic chemotherapy combined with bronchoscopic local interventional therapy can provide targeted treatment for lesions. Specific analysis: Bronchoscopy can accurately remove the accumulated purulent secretions in the trachea, completely suck away the caseous

necrosis, and accurately remove the hyperplastic tissue in the area, thereby cleaning the pathogenic bacteria and relieving symptoms such as airway obstruction. With the help of drainage, bronchoscopy can reduce the degree of mucosal swelling, relieve airway stenosis, and close cavitary lesions. Continuous drainage can promote the conversion of sputum bacteria to negative. Slow infusion of drugs can significantly increase the blood drug concentration in the lesion area, allowing the drug components to fully contact the pathogenic bacteria, thereby blocking their growth process. Bronchoscopy treatment can precisely infuse drugs into the lesion site using this method, increasing the drug concentration at the lesion site and enhancing the treatment effect.

In recent years, interventional therapy utilizing bronchofiberscopy has emerged as a novel treatment approach for MDR-TB/RR-TB. This method accurately delivers therapeutic drugs, enhancing drug concentration in the lesion area, thereby achieving efficient bactericidal effect and controlling the patient's condition. However, bronchoscopy insertion bears a certain degree of blindness, which may hinder precise positioning, leading to issues such as positioning deviation or repeated positioning. Image-guided bronchoscopy for precise infusion therapy of pulmonary tuberculosis lesions offers a new treatment option for drug-resistant tuberculosis. After injecting a contrast agent into the bronchi for comparison, the lesions can be observed from multiple angles using imaging navigation technology. This allows dynamic observation of the entire interventional process under direct vision, guiding precise positioning of the bronchoscope and enabling precise infusion therapy of the lesions. This significantly increases the local drug concentration in pulmonary lesions, enhancing the direct contact between anti-tuberculosis drugs and drug-resistant *Mycobacterium tuberculosis*, effectively inhibiting its growth. When combined with systemic medication, it provides a more effective treatment for drug-resistant tuberculosis.

In the future, this approach may offer new therapeutic options for patients with long-term bacteria excretion and persistent MDR-TB/RR-TB, especially those with cavitary tuberculosis. In this study, under the premise of DSA, multiple targeted drugs such as levofloxacin or isoniazid were infused into the bronchoscope cavity, enabling precise distribution of the drugs to the lesion area. After 18 months of treatment, the sputum conversion rate reached 86.2%, and the lesion absorption rate was as high as 91.5%. CT scans showed a cavity closure rate of 74.2% after 18 months, with significant improvement in all symptoms. There were no serious adverse reactions during the entire treatment process. Comparing multiple data points between groups,  $P < 0.05$ . Thus, this therapy demonstrates significant advantages in the treatment of MDR-TB/RR-TB, stabilizing patients' conditions and achieving ideal disease outcomes.

## 5. Conclusion

In summary, under the premise of DSA, infusion of multiple targeted drugs into the bronchoscope can enhance the overall efficacy of MDR-TB/RR-TB patients. This interventional therapy is highly feasible, favoring lesion absorption and cavity closure, with a low likelihood of causing significant adverse reactions. Patients have good tolerance for the entire treatment process.

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## Disclosure statement

The authors declare no conflict of interest.

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# To Explore the Application Effect of Bird's Nest Nursing in Neonatal Nursing

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**Abstract:** *Objective:* To observe and study the practical value of adopting nest nursing in neonatal nursing. *Methods:* From January 2023 to January 2024, a total of 382 newborns that were admitted to the hospital were selected to carry out this study. They were divided into two groups, the routine group and the observation group, with 191 cases in each group. Newborns in the routine group were given basic nursing intervention, while those in the observation group were given bird's nest nursing intervention. The growth and development indexes, the occurrence of adverse reactions, the improvement of gastrointestinal function, and the nursing satisfaction rate of their families were analyzed and studied. *Results:* The growth and development indexes of newborns in the observation group were significantly better than those in the routine group ( $P < 0.05$ ). The incidence of adverse neonatal reactions in the observation group was significantly lower than that in the routine group ( $P < 0.05$ ). The improvement of gastrointestinal function of newborns in the observation group was significantly better than that in the routine group ( $P < 0.05$ ). The nursing satisfaction rate of newborns' families in the observation group was significantly higher than that in the routine group ( $P < 0.05$ ). *Conclusion:* As for the key points of clinical newborn care, the actual effect of adopting the bird's nest nursing intervention is more prominent, and its main function is to promote the growth and development of newborns. It can not only avoid the risk of adverse reactions in many aspects but also improve the gastrointestinal function of newborns, so that the nursing satisfaction rate of family members is obviously improved. It is recommended to be applied and popularized in clinical practice.

**Keywords:** Neonatal care; Bird's nest nursing; Application effect

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## 1. Introduction

For most newborns, because they are separated from their mothers, their immune function is reduced and their resistance is poor, which makes them more likely to suffer from infectious diseases. Based on this, it is necessary to carry out targeted nursing intervention for newborns in clinic. Bird's nest nursing is a comprehensive and meticulous nursing intervention method, which is mainly based on the use of warm boxes and soft cloth rolls, so that it has a sense of boundary and security, simulates the living environment in the womb for newborns,

significantly improves their fear and anxiety, and can also meet various nursing needs to some extent, and promote the healthy growth and development of newborns<sup>[1]</sup>. In this study, basic nursing intervention was given to the newborns in the routine group, and the newborns in the observation group were given bird's nest nursing intervention<sup>[2]</sup>. The growth and development indexes, the occurrence of adverse reactions, the improvement of gastrointestinal function as well as the nursing satisfaction rate of family members of the two groups were analyzed and studied.

## 2. Data and methods

### 2.1. General information

From January 2023 to January 2024, a total of 382 newborns admitted to the hospital were selected to carry out this study. They were divided into two groups, the routine group and the observation group, with 191 cases in each group. In the routine group, there were 100 males and 91 females, aged from 1 to 10 days, with an average age of  $(4.36 \pm 0.39)$  d and a weight of  $(3,216.48 \pm 146.42)$  g. In the observation group, there were 101 males and 90 females, aged from 1 to 9 days, with an average age of  $(4.71 \pm 0.55)$  d and a weight of  $(3,216.04 \pm 146.89)$  g. There was no significant difference in the baseline data of newborns between the two groups, which was comparable ( $P > 0.05$ ).

Inclusion criteria: (1) Full-term delivery of newborns; (2) Apgar score of newborn is over 9; (3) The clinical data of newborns are complete, and (4) The family members have a high degree of cooperation with this study.

Exclusion criteria: (1) Neonates with congenital diseases; (2) Combined with immune system disorder; (3) Combined with coagulation dysfunction; (4) The family members of the children had poor nursing compliance and withdrew from this study halfway.

### 2.2. Methods

In the routine group, the newborns were given basic nursing intervention. The nurses needed to put the newborns in the incubator, monitor their vital signs, insist on daily cleaning, and create a comfortable and clean environment. In the observation group, the newborns were given bird's nest nursing intervention:

#### (1) Health guidance

Nurses should pay attention to health guidance in the process of neonatal care and need to inform the family members of newborns in detail about the key of bird's nest nursing, so as to alleviate their anxiety<sup>[3]</sup>. Through patient explanation, family members can understand the positive influence of bird's nest nursing on the healthy development of newborns, thus enhancing their trust in nursing work. At the same time, nurses should actively communicate with the newborn's family members, help them adapt to the role change as soon as possible, change from bystander to participant, guide the family members to touch and care for the newborn, and enhance the parent-child relationship. On this basis, nurses can also encourage family members to ask questions, answer their doubts in time, and jointly create good conditions for the healthy growth of newborns.

#### (2) Build a nest environment

In constructing a bird's nest environment, the principles of environmental engineering can be effectively applied. To ensure safety and hygiene, nurses should use thoroughly disinfected cotton sleeping bags as nesting material. After putting the cotton sleeping bag into the incubator, according to the actual needs of the newborn, the environmental factors such as temperature and light in the incubator are adjusted by using the



principle of environmental engineering to simulate the intrauterine environment. When adjusting the light, special attention should be paid to avoid the injury to the newborn's eyes caused by strong light <sup>[4]</sup>. Next, the nursing staff should construct a nest-like environment to help the newborn stay in the lateral position and slightly bend its limbs to make the posture of the newborn more comfortable. At the same time, roll up the edge of the sleeping bag and cling to the back of the newborn to simulate the feeling of wrapping in the uterus and give the newborn enough security and comfort.

(3) Daily care

Adjust the suitable water temperature for newborns, and pay attention to the eyes and ears of newborns when cleaning them. Immediately after completion, clean the newborn's body and apply physiological saline to wipe the eyes before wiping touch oil or talcum powder on the skin folds. In addition, after the defecation of the newborn, the diaper should be changed immediately, and the perineal position should be cleaned to avoid red buttocks in the newborn.

(4) Adjust the sleeping position

In adjusting sleeping posture, nurses should use physiological principles to provide the best sleeping posture for newborns. That is, placing a soft pillow 2cm behind the neck of the newborn can help it open the airway and keep breathing unobstructed. At the same time, help newborns adjust their sleeping posture regularly to avoid the oppression on bones and muscles caused by keeping the same posture for a long time. Before touching newborns, nurses need to disinfect their hands to prevent cross infection.

## 2.3. Observation indicators

- (1) Analyze and study the growth and development indicators of the two groups of newborns: The specific indicators include sleep time, weight gain, and temperature fluctuation.
- (2) Analyze and study the adverse reactions of newborns in the two groups: The specific indicators include crying, fever and infection.
- (3) Analyze and study the improvement of gastrointestinal function of newborns in the two groups: The specific selection indicators include the time of first defecation, the time of yellow defecation, and the increase of milk intake volume.
- (4) Analyze and study the nursing satisfaction rate of family members of two groups of newborns: Based on the self-made questionnaire of family members' nursing satisfaction in our hospital, the actual items include nursing technology, nursing attitude, nurse-patient communication, and so on. The score is 0–100, with over 85 being completely satisfied, 60–84 being basically satisfied, and below 60 being dissatisfied.

## 2.4. Statistical analysis

SPSS 25.0 software was used for data processing, and the measurement data were represented by " $(\bar{x} \pm s)$ ", with t test; The counting data is represented by "n/%" and tested by  $\chi^2$ . When  $P < 0.05$ , it is statistically significant.

## 3. Results

### 3.1. Analyze and study the growth and development indicators of the two groups of newborns

The specific data are shown in **Table 1**. The growth and development indexes of newborns in the observation group are obviously better than those in the routine group ( $P < 0.05$ ).

**Table 1.** Comparison of growth and development indexes of newborns between routine group and observation group ( $\bar{x} \pm s$ )

Group	Number of cases	Sleep time (h/d)	Weight gain (g)	Fluctuation range of body temperature (°C)
Observation group Conventional group	191	21.45 ± 1.44	16.52 ± 0.36	0.51 ± 0.15
Observation group Conventional group	191	14.79 ± 1.38	11.56 ± 0.28	0.96 ± 0.23
<i>t</i>	—	21.381	69.637	10.493
<i>P</i>	—	0.000	0.000	0.000

### 3.2. Analyze and study the adverse reactions of newborns in two groups

The specific data are shown in **Table 2**. The incidence of adverse reactions of newborns in the observation group was significantly lower, which was significantly better than that in the routine group ( $P < 0.05$ ).

**Table 2.** Comparison of neonatal adverse reactions between routine group and observation group

Group	Number of cases	Crying	Generate heat	Infect	Incidence rate of adverse reactions (n,%)
Observation group Conventional group	191	5(2.62)	4(2.10)	0(0.00)	9(4.72)
Observation group Conventional group	191	10(5.24)	10(5.24)	5(2.61)	25(13.09)
$\chi^2$	—	—	—	—	8.265
<i>P</i>	—	—	—	—	0.004

### 3.3. Analyze and study the improvement of gastrointestinal function in two groups of newborns

The specific data are shown in **Table 3**. The improvement of gastrointestinal function of newborns in the observation group is better than that in the routine group ( $P < 0.05$ ).

**Table 3.** Comparison of the improvement of gastrointestinal function between the routine group and the observation group ( $\bar{x} \pm s$ )

Group	Number of cases	Time of first defecation (h)	Time when meconium turns yellow (h)	The volume of increased milk consumption of newborns (mL)
Observation group Conventional group	191	18.56 ± 1.39	46.55 ± 2.68	6.28 ± 0.63
Observation group Conventional group	191	25.64 ± 1.25	64.27 ± 2.81	3.42 ± 0.25
<i>t</i>		24.251	29.220	27.019
<i>P</i>		0.000	0.000	0.000

### 3.4. Analyze and study the satisfaction rate of family nursing of newborns in two groups

The specific data are shown in **Table 4**. The nursing satisfaction rate of newborns' families in the observation

group is significantly higher than that in the routine group ( $P < 0.05$ ).

**Table 4.** Comparison of nursing satisfaction rate of family members of newborns between the two groups

Group	Number of cases	Very satisfied (n,%)	Basic satisfaction (n,%)	Dissatisfied (n,%)	Patient satisfaction (n,%)
Observation group Conventional group	191	119(62.30)	69(36.13)	3(1.57)	188(98.43)
Observation group Conventional group	191	100(52.36)	70(36.65)	21(10.99)	170(89.02)
$\chi^2$		—	—	—	14.405
$P$		—	—	—	0.000

## 4. Discussion

The name of nest nursing mainly comes from the nest built by birds for hatching eggs. Nest nursing is also a kind of neonatal nursing mode <sup>[5]</sup>. The core of this nursing mode is to make newborns feel the environment similar to that in the mother's body and ensure that they can develop healthily and gradually adapt to the external environment. The results of this study showed that the growth and development indexes of newborns in the observation group were significantly better than those in the routine group ( $P < 0.05$ ). The incidence of adverse neonatal reactions in the observation group was significantly lower than that in the routine group ( $P < 0.05$ ). The improvement of gastrointestinal function of newborns in the observation group was significantly better than that in the routine group ( $P < 0.05$ ). The nursing satisfaction rate of newborns' families in the observation group was significantly higher than that in the routine group ( $P < 0.05$ ). It is not difficult to understand that the nest nursing creates a good healthy growth environment for newborns by creating a uterus-like environment for them.

In the bird's nest nursing intervention, parents are encouraged to form good emotional communication and contact with newborns, and parents can try to have skin contact with newborns, which can effectively enhance their sense of security. In the field of neonatal care, bird's nest nursing, a widely concerned nursing model, has been recognized by more and more medical institutions and families <sup>[6]</sup>. This nursing method not only attaches importance to the warmth and comfort of newborns but also emphasizes the active participation of family members. Bird's nest nursing can create an external nursing environment similar to the uterus for newborns, which has many advantages for newborns.

- (1) It can promote the emotional connection between parents and newborns. In this nursing, parents will have frequent skin contact with newborns. This kind of intimate contact not only helps to establish emotional bonds between parents and babies, but also makes babies feel the care from their parents, thus enhancing the sense of security of newborns, which is of great significance to the future psychological development of newborns.
- (2) It provides a warm and comfortable environment for newborns <sup>[7, 8]</sup>. By using the special bird's nest cotton pad, nurses can create a small environment for newborns to maintain a suitable temperature. In this environment, newborns can maintain normal body temperature and avoid overheating or overheating. This is very important for the physical health of newborns because the stability of body temperature is the basis for the normal growth and development of newborns.
- (3) Imitate the fetus in the maternal environment <sup>[9]</sup>. This nursing method can make the newborn seem to be

still in the mother's body by providing feelings similar to the intrauterine environment, such as intimate skin contact, warm and slightly compact space, etc. This feeling of familiarity and safety is helpful to alleviate the discomfort caused by leaving the mother's body and promote the healthy development of the newborn<sup>[10]</sup>.

- (4) It can promote the healthy development of newborns. By providing a warm and comfortable environment for newborns, this nursing mode helps to establish a healthy immune system. In such an environment, the newborn's body can better resist the invasion of external pathogens and then maintain a healthy state.
- (5) Bird's nest nursing emphasizes the active participation of family members. In this nursing process, parents can participate in the daily care of newborns, such as feeding, changing diapers, bathing, and other activities. This participation can not only strengthen the parent-child relationship between parents and newborns but also give parents more sense of accomplishment in the process of caring for newborns.

## 5. Conclusion

To sum up, for the key points of clinical neonatal care, the actual effect of adopting the bird's nest nursing intervention is more prominent, and its main function is to promote the growth and development of newborns. It can not only avoid the risk of adverse reactions in many aspects, but also improve the gastrointestinal function of newborns, so that the nursing satisfaction rate of family members is obviously improved. It is recommended to be applied and popularized in clinical practice.

## Disclosure statement

The author declares no conflict of interest.

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