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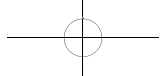
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## Journal of Clinical and Nursing Research

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*Fan Li*



# Operative Cooperation of One Case of Extracorporeal Membrane Oxygenation (ECMO)-Assisted Hybrid Sleeve Left Pneumonectomy

Jing Wang, Jing Li, Yanshu Wei\*, Xiaoli Liu, Xuejing Li

Peking University People's Hospital operating room, Beijing 100044, China

\*Corresponding author: Yanshu Wei, [wys99\\_20001@163.com](mailto:wys99_20001@163.com)

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**Abstract:** A case of surgical nursing cooperation during extracorporeal membrane oxygenation (ECMO)-assisted hybrid sleeve left pneumonectomy, which included a right open carinal resection, tracheal bronchial anastomosis, and thoracoscopic left pneumonectomy, has been documented. A thorough nursing intervention focused on patient safety and proactive measures to address potential complications was implemented throughout the surgical process. The procedure was completed without incident, and no postoperative complications were reported.

**Keywords:** Extracorporeal membrane oxygenation (ECMO); Hybrid; Tracheal adenoid cystic carcinoma (TACC); Operative cooperation

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## 1. Introduction

Tracheal adenoid cystic carcinoma (TACC) is a rare malignant tumor originating from the submucosal glands of the trachea <sup>[1]</sup>. Its invasion can cause pulmonary atelectasis and hypoxemia, requiring prompt treatment. Currently, surgical excision remains the mainstay of treatment for TACC <sup>[2]</sup>. Given the challenges associated with maintaining adequate intraoperative oxygenation during carinal resection under one-lung ventilation, which poses risks to patient safety, this procedure should be conducted in collaboration with cardiothoracic surgeons and supported by extracorporeal membrane oxygenation (ECMO). ECMO is a medical technique that temporarily reroutes the patient's blood for oxygenation and circulation, requiring careful monitoring and management by the operating room nursing team to ensure the safety of the patient's tubes and circulatory system <sup>[3]</sup>. In October 2024, the hospital successfully performed an ECMO-assisted tracheal bronchial anastomosis and thoracoscopic left pneumonectomy, termed hybrid sleeve left pneumonectomy <sup>[4]</sup>. The procedure was executed without complications, and the patient expressed satisfaction with the nursing care provided. The details of the perioperative nursing collaboration are



outlined below.

## **2. Case study**

A 53-year-old male underwent a chest computed tomography (CT) scan that revealed atelectasis in the lower lobe of the left lung, with an elevated body temperature but no indications of shortness of breath, chest tightness, or sputum production. A subsequent contrast CT suggested central lung cancer, obstructive pneumonia, and atelectasis in the lower lobe of the left lung. A positron emission tomography-computed tomography (PET-CT) scan indicated a possible TACC diagnosis. An electronic bronchoscopy was performed under general anesthesia, which demonstrated that the lesion affected the left main bronchus, predominantly bronchioles, the left wall of the lower trachea, and tracheal bifurcation, with partial infiltration of the proximal part of the right main bronchus. Biopsy results indicated a high likelihood of adenoid cystic carcinoma.

Following a thorough examination, ECMO-assisted hybrid sleeve left pneumonectomy was performed under general anesthesia. First, cardiothoracic surgeons established ECMO using esophageal cardiac ultrasound. With ECMO support, the procedure began with the right carinal resection, followed by the right main trachea-lower trachea end-to-end anastomosis. Post-anastomosis, mechanical ventilation of the right lung was utilized alongside ECMO, gradually decreasing the level of ECMO assistance to transition to reliance solely on ventilator support. ECMO was maintained without an oxygen supply for diversion purposes. Subsequently, a thoracoscopic left pneumonectomy was performed with ECMO assistance. During this phase, anesthesiologists methodically adjusted the respiratory settings of the anesthesia machine, while cardiothoracic surgeons reduced the ECMO flow to its minimum to prevent thrombus formation.

Ultimately, the patient was positioned supine, tracheal alignment was verified, followed by clamping of the left chest tube and suturing of the subcutaneous tissues between the mandible and anterior chest wall to ensure a cervical anteriorly flexed position post-surgery. The anesthesia team and cardiac and thoracic surgeons confirmed that the patient's respiratory function was normal and oxygenation was satisfactory before discontinuing ECMO. After ECMO withdrawal, the patient's vital signs were stable, and spontaneous respiration was restored. An antagonist was administered, and once the patient was fully awake, the tracheal tube was removed, and the patient was subsequently transferred to the intensive care unit.

## **3. Comprehensive nursing intervention based on patient safety**

### **3.1. Multidisciplinary cooperation in the development of surgical and coordination plans**

The cardiothoracic nurses involved in the surgery participated in the preoperative case discussion with the multidisciplinary cooperation team, fully understood the patient's condition, were well-acquainted with the surgical procedures beforehand, and organized the collaboration plan for potential scenarios during the operation.

### **3.2. Preoperative preparation**

#### **3.2.1. Environment management**

The surgery was set in a hundred-level laminar flow operating room. Before the surgery, the participant list and entry sequence were confirmed. The team entered the operating room according to the three phases of ECMO setup, right carinal resection, and left pneumonectomy. Scrub nurses coordinated the team to maintain order within

the operating room, while also ensuring that the number of visitors remained below 12, to minimize the risk of infection due to personnel movement <sup>[5]</sup>.

### **3.2.2. Device preparation and management**

This surgical procedure was divided into three sub-surgeries, with surgical instruments categorized into three groups based on the specific requirements of each sub-surgery. Instruments from each group were utilized exclusively within their designated sub-surgery, ensuring no cross-use occurred. The instrument preparation included the ECMO extracorporeal circulation package, the open chest basic instrument package, and the thoracoscope instrument package.

### **3.2.3. Rescue medication management**

Before the surgery, it is ensured that all medications and supplies in the ambulance were ready <sup>[6]</sup>. Following the doctor's instructions, dopamine was diluted to 50 mL with normal saline at a ratio of 3 mg/kg body weight, and norepinephrine was diluted to 50 mL with normal saline at 0.3 mg/kg body weight. Additionally, 50 µg/mL phenylephrine was prepared as a backup for stable hemodynamics. During the administration process, the oral instructions were implemented according to the specified guidelines, and the verification and administration protocols were duly observed <sup>[7]</sup>.

### **3.2.4. Instrument preparation and management**

This procedure required a thoracoscope, a high-frequency electrosurgical knife, an ultrasonic knife for intrathoracic tissue dissection, and an ECMO machine and transesophageal ultrasound machine for ECMO setup. Tracheoscopy was used to confirm anastomosis closure in the tracheal lumen during the surgery. In addition, a defibrillator was on standby for emergency resuscitation, and care was taken to keep circulating tubes, gas lines, and power cords clear of walkways to prevent entanglement <sup>[8]</sup>.

## **3.3. Perioperative cooperation**

### **3.3.1. Cooperation by perioperative nurses**

#### **(1) Operational cooperation of key processes**

- (i) Cooperation in ECMO procedures: Perioperative nurses provided the puncture instruments in the sequence required, assisted the surgeon in stabilizing and securing the guidewire, and simultaneously handed over the extracorporeal circulatory cannula. After successful cannulation, nurses held the distal end of the tubes and collaborated with the surgeon to complete the tube connection, ensuring the intubated section was elevated and flat to prevent dislodgment.
- (ii) Cooperation for carinal resection and left pneumonectomy: The extensive infiltration of the left main bronchial tumor resulted in significant adhesion of the surrounding tissues to the tracheal prominence. To facilitate the blunt dissection of these tissues, a peanut with barium thread was prepared. Emergency instruments, including blocking forceps and hemostasis sutures, were readily available. The principles of asepsis and tumor-free techniques were strictly implemented throughout the procedure. Instruments and dressings that came into contact with the airway and tumor were placed in the designated contaminated area to prevent reuse. Two scrub nurses verified and accurately recorded the specimen names during the procedure. After surgery, a stringent specimen management protocol

was strictly implemented, ensuring the specimen was transferred to the surgeon with the appropriate signature.

(2) Item verification and device replacement

After the establishment of ECMO tubing, tracheal anastomosis post-carinal resection counted the surgical items correctly according to the surgical items counting protocol. Surgical instruments utilized in each sub-surgery were packed and documented, while those needed for the subsequent sub-surgery were prepared.

### **3.3.2. Cooperation by scrub nurses**

(1) Nursing cooperation in specific areas

(i) Record of surgical inventory: The inventory of each sub-surgical item was recorded separately.

(ii) Disposal of dressings and medical waste: After each sub-surgery, the dressings and medical waste used in the current sub-surgery were packed and sealed separately and then placed in the operating room.

(2) ECMO tubing and positional care

After establishing ECMO tubing with the patient in a supine position, two physicians protected the internal jugular vein and femoral vein cannulas. Then, anesthesiologists, scrub nurses, and thoracic surgeons collaborated to reposition the patient to the left lateral position for tracheal anastomosis post-carinal resection. The venous cannulas were extended to the posterior side of the bed and connected to the ECMO machine. The femoral vein cannula was secured to the edge of the lower limb position pad, while the proximal end of the internal jugular vein cannula was anchored to the side of the patient's head, with continuous monitoring of the ECMO circulatory flow. The patient was then placed in the right lateral position for left pneumonectomy.

In this position, the femoral vein tubes were straightened on the patient's ventral side, extending down the right lower limb to the caudal side of the bed, where they were properly secured. The proximal end of the right internal jugular vein tubes was secured behind the patient's right shoulder, wrapped around the underside of the upper arm, extended along the edge of the bed to the caudal side of the bed, and properly secured. Additionally, the proximal end of the right-hand support plate was slightly lowered to create a gap between the arms, preventing any compression of the tubes. Cardiothoracic surgeons confirmed the ECMO tubing's proper function after each position.

## **4. Proactive nursing intervention for complications**

The anticipated duration of surgery and anesthesia time for this patient was projected to exceed 8 h. The extent of the open chest trauma was significant, increasing the risk of hypothermia. Additionally, the use of ECMO throughout the procedure contributed to hemodynamic changes and blood components, increasing the risk of thrombus formation<sup>[9]</sup>. To mitigate these risks, the following preventive measures should be implemented.

### **4.1. Prevention of medical device-related stress injury**

A memory sponge mattress, gel pad, and soft cloth sheet should be utilized before the surgery. A small pad should be used to separate the patient's skin from the infusion tube. After repositioning, the chest drain, urinary catheter, ECG electrode wire, and ECMO tubing should be inspected to ensure they are not under pressure. Additionally,

any tubing that may be compressed on either side of the body should be straightened and secured appropriately to prevent medical device-related pressure injuries. It is also important to ensure that the patient's exposed skin does not come into contact with metallic objects, including the operating table, positioning frame, and tube fixation forceps<sup>[10]</sup>.

## 4.2. Prevention of hypothermia

The room temperature should be set to 26°C before the patient's admission, and the heating blanket should be pre-warmed to 37°C<sup>[11]</sup>. The non-surgical area should be covered with a cloth sheet during a significant volume of fluid administration using a heated infusion device<sup>[12]</sup>. The rinsing fluid should be stored in a thermostat at 37°C for easy access<sup>[13, 14]</sup>. A temperature probe was used to monitor the patient's nasal temperature, which was kept at 36.5°C throughout the procedure.

## 4.3. Prevention of deep vein thrombosis (DVT)

Gradient medical elastic socks should be used before surgery<sup>[15]</sup>. It is essential to implement intraoperative warming measures to prevent hypothermia and DVT<sup>[16]</sup>. Additionally, protective constraints should be adjusted to accommodate one finger, to prevent excessive pressure and blood stagnation in the limb<sup>[17]</sup>. When positioning the patient laterally, avoid compressing the popliteal fossa and femoral vein. In the supine position, elevate the lower extremities without obstructing the surgical field<sup>[18]</sup>. Anesthesiologists must monitor oxygen saturation levels between 90% and 100% to prevent hypoxemia and DVT<sup>[19]</sup>. Adequate fluid replacement is necessary to prevent increased blood viscosity due to insufficient blood volume<sup>[19]</sup>.

## 5. Conclusions

In clinical practice, the application of ECMO-assisted hybrid sleeve left pneumonectomy is relatively rare because it is a complex operation, involves many departments, and requires highly qualified operating room nurses. The present case has the following important clinical insights: (1) nurses participating in the multidisciplinary operation team provide suggestions regarding nursing care plans for patients post-surgery; (2) The present case highlights the need for connection plans for the various sub-surgeries in complex surgeries to shorten the operation duration; (3) Clinicians should conduct patient safety management through an operative cooperation approach. Nevertheless, further studies are needed to improve this procedure and optimize its application.

## Disclosure statement

The authors declare no conflict of interest.

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# Evaluating the Impact of Different Electrocardiogram Methods on Detecting Pacemaker Dysfunction and Cardiac Function Changes in Pacemaker Patients

Yan Li<sup>1,2,3</sup>, Chun Zhou<sup>4</sup>, Ying Li<sup>1,2,3</sup>, Binlin Chen<sup>1,2,3</sup>

<sup>1</sup>The First College of Clinical Medical Science, China Three Gorges University, Yichang 443003, Hubei, China

<sup>2</sup>Electrocardiogram Diagnosis Department, Yichang Central People's Hospital, Yichang 443003, Hubei, China

<sup>3</sup>Hubei Provincial Clinical Research Center for Ischemic Cardiovascular Disease, Yichang 443003, Hubei, China

<sup>4</sup>Arrhythmia Department, The First Affiliated Hospital of Dalian Medical University, Dalian 116011, Liaoning, China

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**Abstract:** *Objective:* To investigate the effect of 12-lead electrocardiogram and 24-hour dynamic electrocardiogram in detecting pacemaker dysfunction and changes in cardiac function indexes in patients with pacemaker implantation. *Methods:* A total of 136 patients with pacemaker implantation in the First Clinical Medical College of Three Gorges University, Institute of Cardiovascular Disease of Three Gorges University and Yichang Central People's Hospital from January 2023 to December 2024 were selected as the research objects. All patients received 12-lead electrocardiogram and 24-hour holter 3–14 days after implantation. *Results:* The overall detection rate of various types of pacemaker dysfunction by Holter was significantly higher than that by conventional ECG (27.21% vs. 5.15%,  $\chi^2=24.402$ ,  $P < 0.001$ ). The overall arrhythmia detection rate of Holter was significantly higher than that of conventional electrocardiogram (57.35% vs. 10.29%,  $\chi^2=67.277$ ,  $P < 0.001$ ). The time domain indexes of heart rate variability obtained by 24-hour continuous monitoring of Holter were significantly improved compared with those of conventional electrocardiogram ( $P < 0.05$ ). *Conclusions:* Compared with 12-lead electrocardiogram, 24-hour holter monitoring can more accurately detect pacemaker dysfunction and arrhythmia in patients with pacemaker implantation, and provide more comprehensive data of heart rate variability, which is helpful for clinicians to better evaluate the cardiac function of patients and adjust treatment plans.

**Keywords:** Pacemaker implantation; Electrocardiogram; Abnormal pacemaker function; Cardiac arrhythmia; Heart rate variability

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## 1. Introduction

Pacemaker implantation is a key treatment to correct severe bradyarrhythmia and heart block, and its postoperative management directly affects the quality of life and long-term prognosis of patients. With the popularization of

implantation technology and the upgrading of device functions, the requirements for monitoring the working state of pacemakers are increasingly refined, especially the timely identification of intermittent dysfunction and potential imbalance of cardiac electrical activity<sup>[1]</sup>. As a basic screening tool, routine 12-lead electrocardiogram is widely used in clinical practice because of its convenient operation and instant results, but its short recording time may lead to missed diagnosis of paroxysmal abnormalities<sup>[2]</sup>. While a 24-hour Holter provides a more complete perspective to capture incidental events by continuously monitoring cardiac electrophysiological activity, but its cost and efficiency limitations also need to be weighed<sup>[3]</sup>. At present, there is no unified standard for the joint evaluation of pacemaker dysfunction, such as sensing threshold drift, pacing signal loss, and secondary arrhythmia in clinical practice. If such abnormalities are not detected in time, they may lead to decreased cardiac output or even syncope in pacing-dependent patients. Based on this, this study selected 136 patients with pacemaker implantation to systematically compare the detection efficiency of routine electrocardiogram and dynamic electrocardiogram in different types of dysfunction, spontaneous conduction arrhythmia, and heart rate variability, in order to provide scientific support for optimizing the postoperative monitoring scheme and improving the risk early warning ability.

## **2. Materials and methods**

### **2.1. General information**

A total of 136 patients with pacemaker implantation who were admitted to the First Clinical Medical College of China Three Gorges University, Institute of Cardiovascular Disease of China Three Gorges University and Yicang Central People's Hospital from January 2023 to December 2024 were selected as the research objects. All patients completed the standardized follow-up, including 79 males (58.09%) and 57 females (41.91%). The average age was  $65.38 \pm 8.74$  years (range, 48–82 years). There were 62 cases (45.59%) with single-chamber pacemaker and 74 cases (54.41%) with dual-chamber pacemaker. Fifty-eight cases (42.65%) had atrioventricular block, 71 cases (52.21%) had sick sinus syndrome, and 7 cases (5.15%) had congenital heart disease. There were 89 cases (65.44%) of hypertension, 47 cases (34.56%) of type 2 diabetes, and 62 cases (45.59%) of coronary heart disease.

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

#### **2.2.1. Inclusion criteria**

- (1) Meeting the indications for permanent pacemaker implantation in 2021 ESC Guidelines for Cardiac Pacing and Cardiac Resynchronization Therapy<sup>[4]</sup>.
- (2) Regular follow-up  $\geq 6$  months.
- (3) Complete clinical data, including preoperative cardiac function evaluation, pacemaker parameter records, and follow-up data.
- (4) Signed informed consent and volunteered to participate in the study.

#### **2.2.2. Exclusion criteria**

- (1) Acute myocardial infarction, uncontrolled heart failure or malignant arrhythmia.
- (2) Severe electrolyte disturbance.
- (3) Complicated with tumor, severe liver and kidney dysfunction or active infection.
- (4) Mental disorder or physical activity limitation.

(5) Pacemaker implantation time less than 3 months or postoperative infection and other complications.

## **2.3. Methods**

### **2.3.1. Routine 12-lead ECG**

All patients underwent each 12-lead ECG assessment from 3 to 14 days after surgery. The resting state ECG activity was recorded by Japan Optoelectronic ECG-9130P synchronous ECG acquisition device combined with ECGLAB-A-A wired ECG workstation (Meigao Medical). The patient was placed in the supine position, guided to maintain calm breathing, the limb leads were adhered to the international standard position (RA/LA/RL/LL), and the chest leads (V1-V6) were strictly positioned along the intercostal space. The acquisition parameters were set as gain 10 mm/mV and paper speed 25 mm/s, and the electrophysiological signals were continuously monitored for 60 seconds. The effective map was defined as noise amplitude < 0.1 mV. Daily data were baseline calibrated and noise filtered by LabChart 10.0 software to eliminate the artifacts of electromyography and respiratory motion.

### **2.3.2. 24-hour ambulatory electrocardiogram**

The 12-channel Holter monitoring system of DMS was used for 24 hours continuous multilead electrophysiological signal acquisition from 3 to 14 days after operation. Technical points: (1) Stop  $\beta$ -blockers and class I/III antiarrhythmic drugs 72 hours before the examination; (2) The electrodes were placed according to Einthoven triangle and the anatomical marks of chest leads, and anti-allergic conductive cream was used to reduce skin impedance; (3) During the acquisition period, symptom events (such as palpitations and syncope) and exercise intensity levels were marked in real time through the human-computer interaction module. The raw data were processed by BioWin analysis system: the wavelet transform algorithm was used to eliminate the high-frequency interference, the R wave recognition threshold was set as 0.5 mV, and the ST segment offset was quantified based on 80 ms after J point. The standard of valid data was that the false error rate was less than 5% and the continuous recording time was more than 22 hours; those who did not meet the standard needed to be reexamined within 48 hours.

## **2.4. Observation indicators**

### **2.4.1. Abnormal pacemaker function**

The specific detection content included: (1) Abnormal pacing function, such as pacing signal failed to effectively drive myocardial depolarization; (2) Ventricular and atrial oversensing, that is, excessive sensing of unexpected signals; (3) Ventricular and atrial poor sensing, that is, insufficient perception of normal signals; And (4) Pacing syndrome, which may be characterized by a range of uncomfortable symptoms such as dizziness and fatigue.

### **2.4.2. Cardiac function**

- (1) Arrhythmia: The types of arrhythmia included: premature ventricular beats, which are early contractions originating in the ventricles; atrial premature beats, or early atrial contractions; atrial tachycardia, characterized by a rapid atrial rhythm; sinus pause, a temporary cessation of impulse generation by the sinus node; pacemaker-mediated tachycardia, a form of tachycardia involving pacemaker activity; ventricular spontaneous rhythm, a rhythm originating spontaneously from the ventricles; pacemaker frequency unburst, referring to abnormal acceleration of the pacemaker's pacing rate; and atrioventricular block, a disruption in electrical conduction between the atria and ventricles. The total detection rate of



arrhythmias was calculated.

- (2) Time domain of heart rate variability: It includes the standard deviation of all RR intervals (SDNN) within 24 hours, which reflects the overall degree of heart rate variability. The root mean square difference of successive normal R-R intervals (r-MSDD) within 24 hours was used to reflect the short-term variability of heart rate. The standard deviation of normal R-R interval (SDANN-index) for the whole continuous 5 minutes was used to evaluate the short-term stability of heart rate. The standard deviation of the mean R-R interval (SDANN) in every 5 minutes can reflect the long-term variation of heart rate.

## 2.5. Statistical methods

All the collected data were input into SPSS26.0 software for statistical analysis. The counting data were recorded as the number of cases and percentage (n(%)), analyzed by  $\chi^2$  test and other methods, and the measurement data were recorded as the mean and standard deviation ( $\bar{x} \pm s$ ), analyzed by t test, and  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Comparison of abnormal pacemaker function

The results showed that the overall detection rate of various types of pacemaker dysfunction by Holter was significantly higher than that by conventional electrocardiogram (27.21% vs. 5.15%,  $\chi^2=24.402$ ,  $P < 0.001$ ), as shown in **Table 1**.

**Table 1.** Comparison of pacemaker dysfunction [n (%)]

Group of groups	Routine electrocardiogram	Dynamic electrocardiogram	$\chi^2$	$P$
Number of cases	136	136		
The pacing function was abnormal	0(0.00)	7(5.15)	/	/
Ventricular and atrial oversensing	5(3.68)	17(12.50)	/	/
Poor sensing of the ventricle and atrium	2(1.47)	13(9.56)	/	/
The pacing syndrome	0(0.00)	0(0.00)	/	/
Sum up	7(5.15)	37(27.21)	24.402	0.000

### 3.2. Comparison of arrhythmia

The results showed that the overall arrhythmia detection rate of Holter was significantly higher than that of conventional electrocardiogram (57.35% vs. 10.29%,  $\chi^2=67.277$ ,  $P < 0.001$ ), as shown in **Table 2**.

### 3.3. Time domain comparison of heart rate variability

The results showed that the time domain indexes of heart rate variability obtained by 24-hour continuous monitoring of Holter were significantly improved compared with those of conventional electrocardiogram ( $P < 0.05$ ), as shown in **Table 3**.

**Table 2.** Comparison of arrhythmia [n (%)]

Group of groups	Routine electrocardiogram	Dynamic electrocardiogram	$\chi^2$	$P$
Number of cases	136	136		
Atrial tachycardia was present	0(0.00)	3(2.21)	/	/
Premature ventricular contractions	6(4.41)	27(19.85)	/	/
Atrial premature beats	7(5.15)	15(11.03)	/	/
Sinus pauses	0(0.00)	8(5.88)	/	/
Ventricular spontaneous rhythm	0(0.00)	6(4.41)	/	/
The pacemaker is running at a high rate	0(0.00)	7(5.15)	/	/
Pacemaker-mediated tachycardia	0(0.00)	5(3.68)	/	/
Atrioventricular block	1(0.74)	7(5.15)	/	/
Sum up	14(10.29)	78(57.35)	67.277	0.000

**Table 3.** Time-domain comparison of heart rate variability ( $\bar{x} \pm s$ )

Group of groups	Routine electrocardiogram	Dynamic electrocardiogram	$T$	$P$
Number of cases	136	136		
SDNN	98.62 $\pm$ 20.74	142.35 $\pm$ 28.58	14.778	0.000
SDANN-index	85.27 $\pm$ 18.96	121.73 $\pm$ 24.35	13.778	0.000
SDANN	122.18 $\pm$ 9.56	53.62 $\pm$ 12.47	50.884	0.000
r-MSDD	21.47 $\pm$ 6.84	38.95 $\pm$ 10.28	16.509	0.000

## 4. Discussion

The core goal of postoperative monitoring of cardiac pacemaker is to detect device dysfunction and secondary arrhythmia in time, so as to prevent hemodynamic disorders and malignant cardiovascular events. Recent studies have pointed out that the incidence of pacemaker dysfunction such as insufficient sensing and pacing threshold drift in the early stage of implantation is 5–15%, but it is easy to be missed by traditional examination methods due to concealed clinical manifestations [5].

This study found that the overall detection rate of pacemaker dysfunction by Holter was 27.21%, which was significantly higher than that by conventional ECG (5.15%). This difference was highly consistent with the previous research results of Li *et al.* [6]. Taking poor ventricular sensing as an example, the detection rate of dynamic electrocardiogram (9.56%) was higher than that of conventional electrocardiogram (1.47%), and its mechanism was closely related to the dynamic change of the impedance of the lead-myocardial interface. In the early postoperative period, electrode micro-dislocation or local myocardial edema can lead to the fluctuation of sensing threshold, which is easily triggered when the patient's position changes or respiratory movement. Conventional electrocardiogram is difficult to capture such time-discrete events because the single sampling time is less than 10 seconds. He *et al.* pointed out that postural changes can cause electrode contact impedance to fluctuate by 30%–50%, leading to intermittent sensing abnormalities. The long-term characteristics of Holter can just cover such physiological dynamic changes, thus significantly improving the detection sensitivity [7].

In addition, the detection rate of ventricular and atrial oversensing Holter (12.50%) was much higher than that of conventional electrocardiogram (3.68%). The mechanism involved the complexity of atrioventricular pacing timing. By continuously recording atrioventricular interval changes, Holter can identify the false trigger caused by atrial electrode missensing electromyogram signal or T wave, while conventional electrocardiogram is isolated due to sampling fragments. Such temporal dependency exceptions are difficult to resolve.

The advantage of Holter monitoring with respect to arrhythmia detection is the complete capture of sequence-dependent events. The detection rate of pacemaker-mediated tachycardia (PMT) in Holter monitoring (3.68%) was significantly higher than that in conventional monitoring (0%). The mechanism of PMT is closely related to the triggering conditions of PMT: PMT is often induced by premature atrial contraction through the reverse atrioventricular pathway. Holter can clearly show the coupling relationship between the reverse P wave and ventricular pacing signal after premature atrial contraction by continuously tracking the atrioventricular conduction sequence. Li *et al.* also confirmed that the detection rate of Holter in the diagnosis of PMT was 2.7%, which was significantly better than that of conventional 12-lead ECG<sup>[8]</sup>. In addition, the difference in detection of atrial premature beats (11.03% on Holter vs. 5.15% on conventional electrocardiogram) suggests that pacemaker implantation may cause mechanical stretch or an inflammatory response of the atrial muscle. Dynamic monitoring can early identify such electrical remodeling tendency and provide a basis for anticoagulation therapy. Heart rate variability analysis further revealed the essential differences between the two methods. The mean SDNN of the Holter group was higher than that of the conventional group, and the difference was due to the complete coverage of the circadian rhythm of the autonomic nerve by Holter data. The circadian fluctuation of HRV, such as increased vagal tone at night, can reflect the autonomic nervous regulation ability of the heart, while the conventional ECG can only reflect the transient state at the detection time, which may mask the true degree of autonomic nervous imbalance.

## 5. Conclusion

In conclusion, compared with 12-lead electrocardiogram, 24-hour holter monitoring can more accurately detect pacemaker dysfunction and arrhythmia in patients with pacemaker implantation, and provide more comprehensive heart rate variability data, which is helpful for clinicians to better evaluate the cardiac function of patients and adjust the treatment plan.

## Disclosure statement

The authors declare no conflict of interest.

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# Clinical Study on the Treatment of Diabetic Retinopathy (Qi-Yin Deficiency Type) with the Method of Soothing the Liver, Harmonizing the Spleen, and Opening the Orifices

Yu Jiang<sup>1</sup>, Ling Li<sup>2</sup>, Guang Han<sup>1\*</sup>

<sup>1</sup>Department of Ophthalmology, Changchun Hospital of Traditional Chinese Medicine, Changchun 130022, Jilin, China

<sup>2</sup>Graduate School, Changchun University of Chinese Medicine, Changchun 130117, Jilin, China

*\*Author to whom correspondence should be addressed.*

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**Abstract:** *Objective:* To observe the clinical efficacy of the method of softening the liver, harmonizing the spleen, and unblocking the orifices in the treatment of Xiaoke Neizhang with Qi and Yin deficiency type. *Methods:* Seventy-two patients with Xiaoke Neizhang of qi and yin deficiency type were selected from March 2024 to May 2025 and divided into a treatment group and a control group with 36 cases each according to the random number table method. The treatment group was treated with the method of softening the liver, harmonizing the spleen, and unblocking the orifices, which included oral administration of Softening the Liver and Harmonizing the Spleen Pills combined with iontophoresis of Xuesaitong Injection. The control group was treated with oral administration of calcium dobesilate capsules. Both groups were treated for 2 courses, and multiple indicators such as visual acuity, fundus condition, and TCM syndrome scores were compared between the two groups. *Results:* The total effective rate of the treatment group was higher than that of the control group. There were significant differences in visual acuity, fundus condition, and TCM syndrome scores between and within the groups ( $P < 0.05$ ). *Conclusion:* The method of softening the liver, harmonizing the spleen, and unblocking the orifices has a definite clinical effect in the treatment of Xiaoke Neizhang with Qi and Yin deficiency type. It has a direct effect, is painless, easy for patients to accept, and has high clinical application value.

**Keywords:** Softening the Liver and Harmonizing the Spleen Pills; Xuesaitong injection; Iontophoresis; Xiaoke Neizhang; Qi and Yin deficiency type

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# 1. Introduction

Diabetic retinopathy, known as “Xiaohe Neizhang” in Chinese medicine, is considered one of the most common complications of diabetes. The longer the duration of diabetes and the more significant fluctuations in blood sugar levels, the higher the risk of developing this disease. It has become one of the leading causes of blindness in China and has severely impacted people’s learning and quality of life. Currently, Western medicine offers various treatments for this condition, such as oral medications, drug injections, vitrectomy, or laser surgery. The clinical efficacy of different treatment methods varies. In contrast, traditional Chinese medicine (TCM) takes a holistic approach, emphasizing syndrome differentiation and treatment, and adopts a combination of internal and external therapies. This approach leverages the strengths of TCM to effectively delay the progression of the disease. This article observes the clinical efficacy of the “soft liver and spleen-opening therapy” for Xiaohe Neizhang with deficiency of both qi and yin. The research results are reported below:

## 2. Materials and methods

### 2.1. General Information

This study selected 72 patients diagnosed with Xiaohe Neizhang (deficiency of both qi and yin) at the ophthalmology clinic and inpatient department of our hospital from March 2024 to May 2025. The patients were randomly divided into a treatment group and a control group using a random number table method, with 36 patients in each group. The treatment group consisted of 20 males and 16 females, aged between 31 and 65 years (mean age:  $54.00 \pm 9.02$  years), with a disease duration of  $10.56 \pm 6.70$  years. The control group consisted of 22 males and 14 females, aged between 33 and 65 years (mean age:  $53.28 \pm 8.13$  years), with a disease duration of  $10.61 \pm 7.45$  years. There was no statistically significant difference in general information between the two groups ( $P > 0.05$ ). This study was approved by the hospital’s medical ethics committee (Changzhonglunshen [2023] No. 003), and all subjects were informed of the study content and signed informed consent forms before treatment.

### 2.2. Inclusion criteria

- (1) Diagnosis of diabetic retinopathy with Qi and Yin deficiency syndrome, referring to “National Higher Education ‘14th Five-Year Plan’ Textbook for the Traditional Chinese Medicine Industry” edited by Peng Qinghua<sup>[2]</sup>.
- (2) Age between 30 and 65 years old.
- (3) No severe cardiac, cerebral, or psychiatric diseases.
- (4) Signed “informed consent” can be included in the observation cases.

### 2.3. Exclusion criteria

- (1) Age below 30 or above 65 years old.
- (2) Severe cardiac, cerebral, or psychiatric diseases.
- (3) Occurrence of serious adverse events.
- (4) Development of severe comorbidities during the trial.
- (5) Failure to meet the inclusion criteria or inability to follow prescribed treatment that affects efficacy evaluation.



## 2.4. Methods

### 2.4.1. Treatment methods

Both groups of patients received conventional hypoglycemic therapy.

- (1) Treatment group: Adopting the method of softening the liver, harmonizing the spleen, and clearing the orifices, specifically using Softening Liver and Harmonizing Spleen Pills (Changchun Traditional Chinese Medicine Hospital, production batch number 230501), 1 pill per day taken orally; combined with Xuesaitong Injection (Heilongjiang Zhenbaodao Pharmaceutical Co., Ltd., production batch number A07220708079) for iontophoresis: 4ml of the medicinal solution was used to soak a gauze pad, which was then wrapped around the electrodes and placed on both eyes, connected to the cathode; the auxiliary electrode was wrapped in a saline-soaked gauze and placed on the wrist, connected to the anode. The current intensity was controlled at 10-15mA, with each treatment session lasting 20 minutes, once per day.
- (2) Control group: Administered with Calcium Dobesilate Capsules (0.5g/capsule, Shanghai Zhaohui Pharmaceutical Co., Ltd.), 1 capsule taken three times per day orally.
- (3) Observation period: Continuous treatment for 2 courses, with each course lasting 10 days, totaling 20 days.

### 2.4.2. Observation indicators

- (1) Vision loss: 3 points for corrected vision decreasing to below 0.1, 2 points for decreasing to 0.1–0.25, and 1 point for decreasing to 0.3–0.6.
- (2) Retinal hemorrhage: 3 points if hemorrhage is present in all four quadrants of the retina, 2 points if hemorrhage is seen in two to three quadrants, and 1 point if hemorrhage is only present in one quadrant.
- (3) Visual field obstruction: 3 points for complete visual field obstruction, 2 points for 1/2 visual field obstruction, and 1 point for 1/4 visual field obstruction.

### 2.4.3. Therapeutic effect evaluation

Referring to the “Guiding Principles for Clinical Research of New Chinese Medicines” from 2002 the below are as follow <sup>[1]</sup>:

- (1) Markedly effective: Vision improves by more than 4 rows, with vision no less than 1.0. Fundus examination shows a reduction or disappearance of microaneurysms; the amount of fundus hemorrhage decreases by one grade or disappears completely; and exudation also decreases by one grade or disappears. If two of these three criteria are met, it is considered markedly effective.
- (2) Effective: Vision improves by 2 to 3 rows, and the number of microaneurysms decreases by one grade; both the amount of fundus hemorrhage and the amount of exudation decrease by one grade. If one of these three criteria is met, it is considered effective.
- (3) Ineffective: None of the three criteria are met.

### 2.4.4. Statistical methods

Data analysis was performed using SPSS (26.0) statistical software. Measurement data were expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ), and comparisons between and within groups were performed using the t-test. Count data were expressed as rates, and a *P*-value  $< 0.05$  was considered statistically significant.

### 3. Results

#### 3.1. Comparison of overall therapeutic effect between the two groups

The total effective rate of the treatment group was higher than that of the control group. After  $\chi^2$  test,  $P < 0.05$ , indicating a statistically significant difference (Table 1).

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

Group	Cases (n)	Markedly Effective n (%)	Effective n (%)	Ineffective n (%)	Total Efficacy (%)	$\chi^2$	P-value
Treatment	36	13	20 (55.6)	3	91.7	6.651	0.036
Control	36	5	22	9	75.0		

#### 3.2. Comparison of visual acuity between the two groups

After treatment, the visual acuity of both groups was higher than before treatment, and the visual acuity of the treatment group was higher than that of the control group. After t-test,  $p < 0.05$ , indicating a statistically significant difference (Table 2).

**Table 2.** Comparison of visual acuity between the two groups

Group	n	Pre-treatment	Post-treatment	p-value
Treatment	36	0.44 ± 0.03	0.68 ± 0.03	< 0.01
Control	36	0.45 ± 0.03	0.54 ± 0.03	< 0.01
t-value	-	-0.16	2.84	-
p-value	-	0.89	0.006	-

#### 3.3. Comparison of fundus conditions between the two groups

After treatment, the values of various indicators of fundus conditions in both groups were lower than before treatment, and the treatment group was lower than the control group.  $P < 0.05$ , indicating a statistically significant difference (Table 3).

**Table 3.** Comparison of fundus conditions between the two groups

Group	n	Microaneurysms (count)		Hemorrhage (mm <sup>2</sup> )		Exudates (mm <sup>2</sup> )	
		Pre- treatment	Post- treatment	Pre- treatment	Post- treatment	Pre- treatment	Post- treatment
Treatment	36	11.2 ± 4.1	8.7 ± 2.6	0.14 ± 0.05	0.11 ± 0.03	0.06 ± 0.04	0.04 ± 0.02
Control	36	11.0 ± 3.9	9.6 ± 3.1	0.19 ± 0.03	0.17 ± 0.02	0.06 ± 0.04	0.05 ± 0.03
t-value	-	0.164	3.032	0.164	3.561	0.014	2.957
p-value	-	0.763	0.004	0.735	< 0.01	0.927	0.007

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

After treatment, the scores of traditional Chinese medicine (TCM) syndromes in both groups were lower than before treatment, and the scores of TCM syndromes in the treatment group were lower than those in the control group, with  $p < 0.05$  indicating a statistically significant difference (Table 4).



**Table 4.** Comparison of TCM syndrome scores between the two groups

Group	n	Baseline	Post-treatment	<i>t</i> -value	<i>p</i> -value
Treatment	36	8.78 ± 2.34	4.39 ± 1.84	16.94	< 0.001
Control	36	8.64 ± 2.90	8.36 ± 2.96	9.94	0.006
<i>t</i> -value	-	0.22	-6.84	-	-
<i>p</i> -value	-	0.82	< 0.001	-	-

## 4. Discussion

Diabetes mellitus is a metabolic disease characterized by chronic hyperglycemia caused by multiple etiologies. Long-term carbohydrate, fat, and protein metabolism disorders in diabetes can cause multisystem damage, such as chronic progressive damage, functional decline, and failure of tissues and organs like eyes, kidneys, nerves, heart, and blood vessels [3]. In traditional Chinese medicine, diabetes is categorized as “Xiaoke” (wasting-thirst syndrome). Retinopathy is a common complication of this disease, with symptoms such as decreased vision, visual obstruction, or visual distortion. In severe cases, it can lead to vision loss. Western medicine refers to it as diabetic retinopathy. The prevalence of this disease is as high as 54% among patients with a history of diabetes ranging from 5 to 15 years. It is gradually becoming younger and is the leading cause of blindness among the working population. In traditional Chinese medicine, diabetic retinopathy is known as “Xiaoke Neizhang” or “Xiaoke Mubing”. Based on etiology and pathogenesis, it is clinically classified into other syndromes such as Qi and Yin deficiency, spleen and kidney deficiency, Yin deficiency with stagnation, and phlegm and blood stasis obstruction [1]. This study focuses on patients with Qi and Yin deficiency type of Xiaoke Neizhang.

In Western medicine, the early treatment of diabetic retinopathy mainly involves oral medication. In the middle and late stages, retinal laser photocoagulation, vitrectomy, and other methods are used based on the condition of the ocular fundus. However, the recovery of retinal function after surgery is often unsatisfactory. For patients with macular edema or retinal neovascularization, anti-VEGF therapy is commonly used, which requires long-term and multiple treatments. Due to the high cost of treatment, it is difficult for patients to adhere to it, thus affecting the clinical efficacy.

The treatment of this disease in traditional Chinese medicine starts from the “holistic concept and syndrome differentiation and treatment”, and there are many treatment methods, such as traditional Chinese medicine decoction, external treatment methods such as iontophoresis or acupuncture, combined Chinese and Western medicine treatment, and combined traditional Chinese medicine and laser treatment. Especially after retinal laser surgery or vitrectomy combined with traditional Chinese medicine therapy, it can consolidate the clinical efficacy and reduce the recurrence rate of the disease.

The method of softening the liver, harmonizing the spleen, and opening the orifices is a treatment approach established based on the basic theories of traditional Chinese medicine and the five-wheel theory of ophthalmology in traditional Chinese medicine. This method connects the eyes with the internal organs, focusing on analyzing local symptoms and combining them with systemic disorders for dialectical treatment. This study involves both internal and external treatment, specifically oral administration of Softening Liver and Harmonizing Spleen Pills combined with iontophoresis using Xuesaitong injection.

Softening Liver and Harmonizing Spleen Pills are a preparation made in our hospital and have been used for

more than 60 years. It has the effect of strengthening the spleen and stomach, dispersing liver Qi, and regulating Qi. The formula consists of Chai Hu (Bupleurum), Bai Shao (White Peony), Chao Bai Zhu (Fried Atractylodes), Chao San Xian (Fried Three Immortals), and other medicinal herbs. Chai Hu has the effect of dispersing liver Qi stagnation and elevating Yang Qi. It contains multiple components, such as saikosaponin, which have strong anti-inflammatory effects, can reduce the secretion of various inflammatory mediators, reduce the degree of retinal inflammation, protect the existing barrier function of the blood-retinal barrier, thereby effectively improving blood vessel permeability and preventing retinal edema or obvious exudation. Bai Shao nourishes the liver and blood, relieves pain, and contains components such as paeoniflorin, which have a protective effect on the optic nerve.

At the same time, it has a good effect on the expansion of eye blood vessels, can significantly reduce the blood viscosity in the area, improve microcirculation, deliver nutrients to various retinal cells, and thereby improve retinal metabolism. Chai Hu and Bai Shao are the most classic herbal pair for dispersing liver Qi stagnation and regulating emotions. They are used frequently in classical prescriptions. The combination of the two can not only disperse liver Qi stagnation but also nourish the liver and blood, possessing both dispersing and converging functions, and can nourish the liver and nourish Yin <sup>[4]</sup>. Baizhu (*Atractylodes macrocephala*) has a bitter, sweet, and warm taste, attributed to the spleen and stomach meridians. It has the effect of strengthening the spleen, nourishing Qi, drying dampness, and promoting urination. Baizhu can be used raw or fried. The selection of fried Baizhu can reduce its drying property, decrease gastrointestinal irritation, and enhance its spleen-strengthening effect. “Fried Sanxian” includes fried Shenqu (fermented mass of wheat, etc.), fried malt, and fried hawthorn. “Fried Sanxian” is chosen instead of “Jiao Sanxian” because frying is more suitable for strengthening the spleen and promoting digestion. Considering the meridian attributes of all the herbs in the formula, it can be attributed to the liver, spleen, and stomach meridians.

External treatment is based on internal treatment and combined with the iontophoresis of Chinese herbal medicines. Iontophoresis has a long history of application. It utilizes the characteristics of direct current to rapidly and fully introduce drug ions into the tissue. Simultaneously, combined with external electric field driving, it can precisely introduce drug ions into specific areas. Xuesaitong injection, which mainly contains Panax notoginseng saponins, is selected for its excellent hemostatic effect, as well as its ability to resolve blood stasis and reduce swelling. In this study, Xuesaitong injection is used externally directly on the eyes to enhance the local drug concentration. This method has the advantages of direct action and fast onset. It allows the drug to act directly on the eyes without passing through the bloodstream, resulting in higher safety benefits after administration. Effective stimulation of multiple acupoints around the eyes can regulate blood circulation in the area, enabling the full absorption of nutrients. Therefore, it can improve visual function and is well-accepted by patients.

## 5. Conclusion

In summary, this study adopts a method that treats both the liver and spleen simultaneously, addressing both the symptoms and root causes. This approach fully demonstrates the advantages of combined therapy targeting both qi and blood, as well as the organs. Through clinical observation of 72 patients with diabetic retinopathy, it was found that compared to simply taking calcium dobesilate capsules orally, the combined therapy can improve patients' vision and ameliorate retinal hemorrhage and macular edema. During follow-up visits at 1, 3, and 6 months after treatment, it was observed that patients' vision and retinal conditions remained stable, effectively controlling the further progression of the disease. For patients who have undergone vitrectomy or retinal photocoagulation

surgery, traditional Chinese medicine therapy can alleviate post-surgical retinal edema symptoms and consolidate the surgical effect. For patients receiving anti-VEGF therapy for macular edema, this therapy can prolong the duration of intraocular injection treatment and reduce the burden on patients. Traditional Chinese medicine therapy plays an irreplaceable role in improving vision, retinal conditions, and optic nerve protection. It can also improve retinal microcirculation, promote the absorption of retinal hemorrhage and macular edema, and reduce the blindness rate. This therapy serves as a complement to Western medical treatments, and the combination of Chinese and Western medicine effectively delays disease progression.

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## Disclosure statement

The authors declare no conflict of interest.

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# The Efficacy of Tongxinluo Capsules in Treating Coronary Heart Disease with Angina Pectoris and Its Impact on Cardiac Function

Ruxin Ji

Mianzhu Center for Disease Control and Prevention, Mianzhu 618200, Sichuan, China

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**Abstract:** *Objective:* To analyze the efficacy of Tongxinluo Capsules in treating coronary heart disease (CHD) with angina pectoris. *Methods:* A total of 98 patients with CHD and angina pectoris admitted between May 2022 and May 2025 were enrolled and randomly divided into a control group and an experimental group, with 49 cases each. The control group was treated with atorvastatin + clopidogrel, while the experimental group received atorvastatin + clopidogrel + Tongxinluo Capsules. Clinical efficacy, cardiac function, angina attack frequency and duration, and adverse reactions were compared between the two groups. *Results:* The experimental group showed higher clinical efficacy than the control group ( $P < 0.05$ ). Cardiac function in the experimental group was superior to that of the control group ( $P < 0.05$ ). The duration and frequency of angina attacks in the experimental group were lower than those in the control group ( $P < 0.05$ ). There was no significant difference in the incidence of adverse reactions between the two groups ( $P > 0.05$ ). *Conclusion:* The use of Tongxinluo Capsules in the clinical treatment of CHD with angina pectoris can improve various clinical indicators, enhance therapeutic efficacy, and promote faster patient recovery.

**Keywords:** Tongxinluo Capsules; Coronary heart disease; Angina pectoris; Cardiac function

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## 1. Introduction

Coronary heart disease (CHD) with angina pectoris, as a common condition in the field of cardiovascular diseases, can significantly impair patients' quality of life and even threaten their lives. The pathogenesis of this disease is complex, often associated with coronary atherosclerosis, necessitating early intervention to reduce the risk of cardiovascular events<sup>[1]</sup>. Currently, conventional Western medications such as atorvastatin and clopidogrel are widely used in clinical treatment. While these drugs can regulate blood lipid levels and alleviate clinical symptoms, they may also lead to adverse reactions<sup>[2]</sup>. With the advancement of traditional Chinese medicine (TCM), Tongxinluo Capsules have emerged as a therapeutic option for CHD with angina pectoris. This compound herbal preparation is believed to promote Qi circulation, activate blood flow, and relieve pain

by unblocking collaterals. To explore the clinical value of Tongxinluo Capsules in treating CHD with angina pectoris, this study administered the drug to patients and analyzed its therapeutic efficacy and impact on cardiac function, aiming to provide a reference for clinical practice.

## **2. Materials and methods**

### **2.1. General information**

A total of 98 patients with coronary heart disease and angina pectoris admitted from May 2022 to May 2025 were included and randomly divided into a control group and an experimental group, with 49 patients in each group. The control group consisted of patients aged 45–74 years, with an average age of  $(63.49 \pm 4.17)$  years; 26 males and 23 females; and a disease duration of 1–5 years, with an average of  $(3.98 \pm 0.53)$  years. The experimental group consisted of patients aged 43–73 years, with an average age of  $(64.01 \pm 4.23)$  years; 25 males and 24 females; and a disease duration of 1–6 years, with an average of  $(4.08 \pm 0.61)$  years. The general information was not statistically significant ( $P > 0.05$ ).

#### **2.1.1. Inclusion criteria**

- (1) Meet the clinical diagnostic criteria for angina pectoris of coronary heart disease, and confirmed by coronary angiography.
- (2) Complete and available clinical data.
- (3) Patients and their families have sound cognitive and communication abilities.
- (4) High level of cooperation throughout the study.

#### **2.1.2. Exclusion criteria**

- (1) Malignant tumors
- (2) Immune disorders
- (3) Congenital heart disease
- (4) Severe dysfunction of other important organs
- (5) History of heart surgery
- (6) Systemic infectious diseases
- (7) Infectious diseases
- (8) Contraindications to study medication, etc.

### **2.2. Methods**

The control group was treated with atorvastatin combined with clopidogrel. Atorvastatin (Pfizer Pharmaceutical Co., Ltd.; National Medicine Approval No. H20051408) was administered orally once a day, 20mg per time, after meals. Clopidogrel (Lepu Pharmaceutical Co., Ltd.; National Medicine Approval No. H20123115) was administered orally once a day, 75mg per time, after meals. The experimental group was treated with Tongxinluo Capsule based on the control group's regimen. The treatment methods of atorvastatin and clopidogrel were the same as those in the control group. Tongxinluo Capsule (Shijiazhuang Yiling Pharmaceutical Co., Ltd., National Medicine Approval No. Z19980015, specification: 0.26g/capsule) was administered orally, 3 capsules each time, 3 times a day. Both groups were treated continuously for 4 weeks. During the medication period, patients

were instructed to maintain good sleep and emphasize a low-salt and low-fat diet.

## 2.3. Observation indicators

- (1) Clinical efficacy: (a) Markedly effective: The incidence of angina pectoris is reduced by more than 80%, and electrocardiogram examination reveals that ST-T has returned to the isoelectric line.; (b) Effective: The incidence of angina pectoris is reduced by 50%–80%, and electrocardiogram examination reveals that the T wave is upright and the ST segment depression has recovered by more than 1.5mm; (c) Ineffective: The above criteria are not met, and no changes are found in the electrocardiogram examination; Effective rate = (markedly effective + effective) / total number of cases × 100%.
- (2) Cardiac function: Echocardiography was used to measure the left ventricular end-diastolic diameter (LVEDD), left ventricular ejection fraction (LVEF), and left ventricular end-systolic diameter (LVESD) in both groups.
- (3) Angina pectoris attacks: The duration and frequency of angina pectoris attacks in both groups were observed and recorded.
- (4) Adverse reactions: The occurrence of adverse reactions such as headache, rash, nausea, vomiting, and diarrhea in both groups was observed and recorded.

## 2.4. Statistical methods

Data were processed using SPSS 22.0 software. Measurement data were expressed as mean ± standard deviation ( $\bar{x} \pm s$ ) and analyzed using the t-test. Count data were expressed as frequencies and percentages [n(%)] and analyzed using  $\chi^2$  test. A  $P$ -value < 0.05 was considered statistically significant.

## 3. Results

### 3.1. Comparison of clinical efficacy

The clinical efficacy of the experimental group was higher than that of the control group ( $P < 0.05$ ), as shown in **Table 1**.

**Table 1.** Comparison of clinical efficacy (n,%)

Group	<i>n</i>	Markedly Effective n (%)	Effective n (%)	Ineffective n (%)	Total effective rate (%)
Study	49	21 (42.86)	24 (48.98)	4 (8.16)	45 (91.84)
Control	49	17 (34.69)	20 (40.82)	12 (24.49)	37 (75.51)
$\chi^2$					4.781
<i>p</i> -value					0.028

### 3.2. Comparison of cardiac function

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



**Table 2.** Comparison of cardiac function (n,  $\bar{x} \pm s$ )

Group	n	LVEDD (cm)		LVESD (cm)		LVEF (%)	
		Pre	Post	Pre	Post	Pre	Post
Study	49	6.41 $\pm$ 0.42	5.01 $\pm$ 0.32	4.63 $\pm$ 0.42	3.27 $\pm$ 0.25	45.61 $\pm$ 5.29	57.44 $\pm$ 4.97
Control	49	6.46 $\pm$ 0.43	5.73 $\pm$ 0.36	4.65 $\pm$ 0.44	3.66 $\pm$ 0.38	46.03 $\pm$ 5.21	52.86 $\pm$ 4.02
t-value		0.582	10.464	0.230	6.002	0.396	3.204
p-value		0.562	< 0.001	0.819	< 0.001	0.693	0.003

### 3.3. Comparison of angina pectoris attacks

Prior to treatment, the two groups showed no significant difference in the duration or frequency of angina pectoris episodes ( $P > 0.05$ ). However, following treatment, the experimental group exhibited a reduction in both the duration and frequency of angina attacks compared to the control group ( $P < 0.05$ ), as detailed in **Table 3**.

**Table 3.** Comparison of angina pectoris attacks (n,  $\bar{x} \pm s$ )

Group	n	Episode duration (minutes)		Episode frequency (times/week)	
		Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Study	49	6.37 $\pm$ 1.23	2.67 $\pm$ 0.31	4.71 $\pm$ 0.14	1.19 $\pm$ 0.27
Control	49	6.34 $\pm$ 1.25	4.46 $\pm$ 0.29	4.69 $\pm$ 0.11	2.63 $\pm$ 0.25
t-value		0.077	29.517	0.786	27.394
p-value		0.939	< 0.001	0.434	< 0.001

### 3.4. Comparison of the occurrence of adverse reactions

The adverse reaction rate in the experimental group was 20.4% (10 out of 49 cases), showing no significant difference compared to the control group's rate of 22.45% (11 out of 49 cases) ( $P > 0.05$ ). For further details, refer to **Table 4**.

**Table 4.** Comparison of the occurrence of adverse reactions (n,%)

Group	n	Headache n (%)	Rash n (%)	Nausea/Vomiting n (%)	Diarrhea n (%)	Total Incidence n (%)
Study	49	1 (2.04)	3 (6.12)	4 (8.16)	2 (4.08)	10 (20.41)
Control	49	3 (6.12)	2 (4.08)	4 (8.16)	2 (4.08)	11 (22.45)
$\chi^2$						0.061
p-value						0.806

## 4. Discussion

Coronary heart disease (CHD) is a clinically common condition typically caused by atherosclerosis. Once diagnosed, prompt treatment is essential, as the disease can easily lead to chronic heart failure, impairing respiratory function and causing symptoms such as fatigue and limited mobility. As the condition progresses, it may threaten the patient's life <sup>[3]</sup>. Among CHD patients, angina pectoris is a frequent symptom, often

accompanied by tachycardia, elevated blood pressure, pallor, and cold sweats. If angina persists, it may trigger heart failure or even myocardial infarction, significantly endangering the patient's life<sup>[4]</sup>. Clinically, it is crucial to prioritize intervention for this disease, adhering to the principles of early diagnosis and treatment to alleviate symptoms, relieve pain, and promote recovery.

Currently, the clinical treatment of CHD patients with angina pectoris primarily involves medication. A variety of drugs are available, including lipid-regulating and antiplatelet therapies such as atorvastatin, clopidogrel, and aspirin. While these drugs can improve symptoms and have certain therapeutic value—for instance, atorvastatin helps stabilize plaques and regulate lipids, thereby alleviating clinical symptoms<sup>[5]</sup>—long-term use may lead to adverse reactions. Therefore, safer and more effective treatments are needed to curb the progression of CHD and angina. Current clinical approaches mainly involve antiplatelet drugs, nitrates, or surgical interventions to control the frequency of angina attacks and prevent adverse cardiovascular events caused by prolonged angina<sup>[6]</sup>.

Traditional Chinese medicine (TCM) posits that CHD is often influenced by factors such as deficiency of heart qi, impaired organ function, and chronic illness, leading to weakened blood circulation due to heart deficiency, blood stasis, and prolonged fluid retention. These factors collectively contribute to the disease. Therefore, treatment should follow the principles of replenishing Qi, warming Yang, improving microcirculation, protecting vascular endothelium, reducing inflammation, and promoting blood circulation and diuresis. Tongxinluo Capsule, a key TCM compound formulation for treating CHD and angina, is composed of ginseng, leech, scorpion, ground beetle, centipede, red peony root, frankincense, rosewood, sandalwood, spiny jujube seed, and borneol. These ingredients work synergistically to improve blood circulation, unblock blood vessels, enhance myocardial oxygen supply, regulate cardiac function, reduce myocardial ischemic damage, and strengthen myocardial contractility, thereby effectively treating CHD and angina<sup>[7]</sup>.

The results showed that the clinical efficacy of the experimental group was higher than that of the control group ( $P < 0.05$ ). The experimental group also demonstrated superior cardiac function and reduced angina attacks compared to the control group ( $P < 0.05$ ), with no statistically significant difference in adverse reactions ( $P > 0.05$ ). This can be attributed to Tongxinluo Capsule's ability to dilate coronary arteries, regulate vascular endothelial function, exert anti-inflammatory effects, and improve myocardial blood supply and cardiac function. Additionally, the study's rigorous control of biases and potential individual sensitivity to the drug may have contributed to the capsule's pronounced efficacy.

## 5. Conclusion

In conclusion, Tongxinluo Capsule can be clinically used to treat CHD patients with angina pectoris. This treatment regimen effectively alleviates clinical symptoms, reduces the duration and frequency of angina attacks, and improves cardiac function.

## Disclosure statement

The author declares no conflict of interest.



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# Study on the Value of Bedside Brain Ultrasound Examination in Early Diagnosis of Brain Tissue Injury in Neonates with Intrauterine Distress

Dan Yang, Qionglan Li, Xiaoqing Xiang

Yichang Central People's Hospital, Yichang 443505, Hubei, China

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**Abstract:** *Objective:* To analyze the value of bedside cranial ultrasonography in the early diagnosis of neonatal brain tissue injury in intrauterine distress. *Methods:* 128 neonates with suspected intrauterine distress admitted to the Yichang Central People's Hospital from January 2023 to December 2024 were selected as study subjects based on the inclusion and exclusion criteria, and all subjects underwent bedside craniocerebral ultrasonography and MRI, and the results of MRI were used as the gold standard to divide the infants into the brain-injury group ( $n = 31$ ) and the no-brain-injury group ( $n = 97$ ), and the value of bedside cranial ultrasonography for early diagnosis of brain tissue injury in neonates with intrauterine distress was analyzed. *Results:* (1) Among the 128 cases of intrauterine distress neonates, 31 cases were examined for abnormal signs, including 22 cases (70.97%) examined by bedside craniocerebral ultrasonography and 28 cases (90.32%) examined by MRI. (2) Bedside cranial ultrasound detected hypoxic-ischemic encephalopathy in 6 cases, accounting for 4.69%, ventricular widening in 2 cases, accounting for 1.56%, intracranial hemorrhage in 8 cases, accounting for 6.25%, periventricular softening of white matter in 5 cases, accounting for 3.91%, and cerebral edema in 1 case, accounting for 0.78%, while MRI detected hypoxic-ischemic encephalopathy in 9 cases, accounting for 7.03%. 3 cases of ventricular widening, accounting for 2.34%, 4 cases of intracranial hemorrhage, accounting for 3.13%, 9 cases of periventricular-intraventricular white matter softening, accounting for 7.03%, and 3 cases of cerebral edema, accounting for 2.34% were examined. Among them, the detection rate of periventricular-intraventricular hemorrhage by bedside cranial ultrasound was significantly higher than that of MRI ( $P < 0.05$ ). *Conclusion:* The diagnostic value of bedside cranial ultrasound in periventricular-intraventricular hemorrhage is high, but the diagnostic value is not as good as that of MRI in other brain tissue injuries, and clinically appropriate examination protocols can be selected according to the specific types of craniocerebral injuries.

**Keywords:** Bedside cranial ultrasound; Diagnosis of intrauterine distress; Neonate; Brain tissue injury

**Online publication:** September 4, 2025

# 1. Introduction

The neonate is the early stage of a child's life and the life stage with the highest child mortality rate. With the development of intensive care and therapeutic techniques, the survival rate of critically ill neonates and very preterm infants has increased significantly, but at the same time the incidence of neurologic injury in the neonatal population is on the rise. Neonatal brain injury refers to non-progressive brain injury, including congenital brain underdevelopment and central nervous system dysfunction left by trauma, which can be manifested as behavioral neurodevelopmental abnormalities, central movement disorders, mental retardation, etc., and brain injury in preterm infants is most commonly seen in the clinic <sup>[1]</sup>. When neonates suffer from brain injury, they may have serious clinical symptoms, such as frequent spitting up, poor sleep, abnormal crying, and even convulsions, which may affect their intellectual and physical development in severe cases, which not only seriously affects the quality of life of the affected children, but also brings a heavy burden to the families and the society, therefore, early identification and timely intervention are crucial for the poor prognosis of neonatal brain injury <sup>[2]</sup>. There are many causes of neonatal brain injury, including birth injury, intracranial infection, and gestational hypertension, among which intrauterine distress is one of the more common causes. Intrauterine distress triggers neonatal brain tissue injury, mainly from fetal hypoxia and ischemia in utero. In utero, conditions such as abnormal placental function, umbilical cord prolapse, and tightening of the umbilical cord around the neck can impede the delivery of oxygen and nutrients from the mother to the fetus <sup>[3]</sup>. When the fetal blood oxygen supply is insufficient, it will prioritize the blood supply to vital organs such as the heart and brain to maintain basic life activities. However, prolonged and severe hypoxia will break this compensatory mechanism and lead to insufficient cerebral blood perfusion <sup>[4]</sup>. At the same time, hypoxia will lead to enhanced anaerobic fermentation and lactic acid accumulation, causing metabolic acidosis and further aggravating brain tissue injury. In addition, the reperfusion phase after hypoxia-ischemia will produce a large number of oxygen free radicals, which attack cell membranes, proteins, and nucleic acids, triggering oxidative stress and damaging the blood-brain barrier, leading to serious pathological changes such as cerebral edema and intracranial hemorrhage, and ultimately resulting in irreversible damage to the neonatal brain tissues and affecting neurological development <sup>[5]</sup>. Therefore, timely bedside cranial ultrasound examination of neonates with intrauterine distress is crucial.

As a practical medical diagnostic technology, bedside cranial ultrasound diagnosis of neonatal brain tissue injury has obvious advantages, it is easy to operate, without the need to transfer the child to a special examination room, can be carried out at the bedside, especially for the critical condition of neonates in intensive care wards, not suitable for moving, and can obtain the diagnostic information in a timely manner <sup>[6]</sup>. Moreover, cranial ultrasound takes the unclosed fontanel of newborns and infants as the acoustic window, and applies ultrasound imaging technology to scan intracranial structures, which is able to obtain diagnostic information on cranial and cerebral anatomy and pathology, as well as blood flow, and clearly display common injuries such as intraventricular hemorrhage, ventricular dilatation, and parenchymal lesions, which can help to intervene in a timely manner, and gain valuable time for clinical diagnosis and treatment, and play an irreplaceable role in the early screening, diagnosis, and subsequent monitoring of neonatal brain tissue injuries. It plays an irreplaceable and important role in the early screening, diagnosis, and follow-up monitoring of neonatal brain tissue injury <sup>[7]</sup>.

In view of this, this study selected 128 cases of neonates with suspected intrauterine distress admitted to the Yichang Central People's Hospital from January 2023 to December 2024 as the study subjects, aiming to analyze the value of bedside cranial ultrasonography for the early diagnosis of intrauterine distress neonatal brain tissue injury.

## 2. Data and methods

### 2.1. Clinical data

According to the inclusion and exclusion criteria, 128 cases of neonates with suspected intrauterine distress admitted to the Yichang Central People's Hospital from January 2023 to December 2024 were selected as the study subjects. According to the diagnostic results, they were divided into brain injury group (n=31) and no brain injury group (n=97), and there was no significant correlation between the baseline data of the two groups of children ( $P > 0.05$ ), as shown in **Table 1**. The study was approved by the Ethics Committee of the hospital.

**Table 1.** Comparison of baseline data of children in two groups

Group	Number of cases	Male/female	Mean gestational age (weeks)	Average birth weight (kg)
Brain injury group	31	14/17	37.78 inju	3.048 inj
No brain damage group	97	45/52	38.12ain d	3.422ain
$\chi^2/t$ value		0.014	0.406	1.878
$P$ -value		0.905	0.686	0.065

### 2.2. Inclusion and exclusion criteria

#### 2.2.1. Inclusion criteria

- (1) Meeting the diagnostic criteria of intrauterine distress in Obstetrics and Gynecology <sup>[8]</sup>.
- (2) Perfect clinical data of the child.
- (3) Single fetus.
- (4) Gestational age of 37–42 weeks.
- (5) Informed consent of the family of the child.

#### 2.2.2. Exclusion criteria

- (1) Combined congenital disabilities.
- (2) The presence of genetic diseases in the mother.
- (3) Brain damage caused by trauma.
- (4) The child can not cooperate with the completion of MRI examination.
- (5) The presence of congenital neurological malformations.

### 2.3. Examination methods

All newborns underwent bedside cranial ultrasonography and MRI examination. Bedside cranial ultrasonography: In the supine position under the quiet or sleep state, the doctor used a high-frequency ultrasonic probe to scan the cranium and brain through the fontanels of the anterior fontanel, posterior fontanel and lateral fontanel of the newborns, including the sagittal, coronal and transverse planes, to observe the brain parenchyma, the brain ventricular system, the brain midline structure and so on, and to detect the existence of brain tissue injuries.

#### 2.3.1. MRI examination

- (1) Before the examination, make sure that the newborn is free of metal implants.
- (2) During the examination, lie supine in the supine position.
- (3) Use the Philips 1.5T MRI scanner to perform various sequences of scanning, such as T1WI, T2WI, etc.,

and observe the transverse axial T<sub>1</sub>WI, transverse axial T<sub>2</sub>WI, sagittal T<sub>1</sub>WI, transverse axial FLAIR from different perspectives and levels.

## 2.4. Observation indexes

- (1) Diagnostic results of brain tissue injury in neonates with intrauterine distress by different examination methods.
- (2) Specific types of brain tissue injury diagnosed by different examination methods.

## 2.5. Statistical analysis

Data were analyzed using SPSS26.0 software, and for count data, they were expressed in the form of %, and the correlation between groups was explored with the help of the  $\chi^2$  test or Fisher's exact probability method; for the metrological data that conformed to the normal distribution, this study presented them in the form of  $(\bar{x} \pm s)$ , and the significance of the differences was assessed by t-tests, and the threshold value of  $P < 0.05$  as a criterion for determination, indicating that significant differences are meaningful in statistical tests.

## 3. Results

### 3.1. Comparison of the diagnostic results of different examination methods for brain tissue damage in neonates with intrauterine distress

The results showed that among 128 cases of intrauterine distress neonates, 31 cases were examined with abnormal signs, among which 22 cases were examined with abnormal signs by bedside cranial ultrasound, accounting for 70.97%, and 28 cases were examined with abnormal signs by MRI, accounting for 90.32%, as shown in **Table 2**.

**Table 2.** Comparison of the diagnostic results of different examination methods for brain tissue injury in neonates with intrauterine distress

Inspection methods	Examination of abnormalities [n (%)]
Bedside cranial ultrasound	22 (70.97)
MRI	28 (90.32)

### 3.2. Specific types of brain tissue injury diagnosed by different examination methods

The results showed that bedside cranial ultrasound detected hypoxic-ischemic encephalopathy in 6 cases, accounting for 4.69%, ventricular widening in 2 cases, accounting for 1.56%, intracranial hemorrhage in 8 cases, accounting for 6.25%, periventricular white matter softness in 5 cases, accounting for 3.91%, and cerebral edema in 1 case, accounting for 0.78%; MRI detected hypoxic-ischemic encephalopathy in 9 cases, accounting for 7.03%, and ventricular widening in 3 cases, accounting for 2.34%. In MRI, 3 cases of ventricular widening were detected, accounting for 2.34%, 4 cases of intracranial hemorrhage were detected, accounting for 3.13%, 9 cases of periventricular-intraventricular white matter softening were detected, accounting for 7.03%, and 3 cases of cerebral edema were detected, accounting for 2.34%. Among them, the detection rate of periventricular-intraventricular hemorrhage by bedside cranial ultrasound was significantly higher than that of MRI ( $P < 0.05$ ), as shown in **Table 3**.



**Table 3.** Specific types of brain tissue injury diagnosed by different examination methods

Examination methods	Hypoxic-ischemic encephalopathy	Ventricular widening	Periventricular-intraventricular hemorrhage	Periventricular white matter softening	Cerebral edema
Bedside cranial ultrasound (n = 128)	6 (4.69)	2 (1.56)	8 (6.25)	5 (3.91)	1 (0.78)
MRI (n = 128)	9 (7.03)	3 (2.34)	4 (3.13)	9 (7.03)	3 (2.34)
$\chi^2$ Value	2.306	0.706	13.000	1.132	0.001
<i>P</i> -value	0.129	0.401	0.000	0.287	0.970

## 4. Discussion

Fetal intrauterine distress refers to acute or chronic hypoxia of the fetus in the uterus due to various factors, and symptoms that jeopardize the health or even the life of the fetus. It is also divided into acute fetal distress and chronic fetal distress. Acute fetal distress mainly occurs during labor and delivery, and once the signs of acute fetal distress are found, measures should be taken decisively to improve fetal hypoxia. Chronic fetal distress mainly occurs in the late stage of gestation, and is mostly attributed to hypertensive disorders of pregnancy, chronic nephritis, and diabetes mellitus, etc.<sup>[9]</sup>

The pathophysiology of intrauterine fetal distress is based on a series of changes caused by ischemia and hypoxia. In the initial stage of ischemia and hypoxia, due to the accumulation of carbon dioxide in the fetal body, respiratory acidosis occurs, sympathetic nerve excitation, increased secretion of adrenal catecholamines and cortisol, resulting in increased blood pressure, increased heart rate, and redistribution of blood in the fetal body<sup>[10]</sup>. At this time, the heart, brain, and adrenal gland vasodilatation, blood flow increases, and other organs vasoconstriction, blood flow decreases. When hypoxia is aggravated, myocardial inhibition is obvious, and cardiac function is not compensated, leading to brain cell damage, which in turn causes brain tissue damage, mental retardation, and many other neonatal complications. Therefore, how to detect and correctly diagnose fetal distress at an early stage is an important topic in perinatal medicine and an eternal topic in obstetrics.

Bedside cranial ultrasound uses the unclosed fontanel of newborns and infants as an acoustic window, and applies ultrasound imaging technology to scan intracranial structures, obtaining diagnostic information on cranio-cerebral anatomy and pathoanatomy, as well as blood flow<sup>[11]</sup>. Its ability to suggest the location, type, and extent of intracranial lesions has made it the modality of choice for neonatal brain tissue injury. At present, regarding the diagnosis of neonatal brain tissue injury, or internal and external has been carried out in a number of hospitals bedside craniocerebral ultrasound examination, its examination mode and operation practice has become a recognized standard of judgment. The value of bedside cranial ultrasonography in the diagnosis of neonatal brain tissue injury in intrauterine distress in this study is summarized below.

This study found that the detection rate of MRI for the diagnosis of hypoxic-ischemic encephalopathy, ventricular widening, periventricular white matter softening, and cerebral edema was higher than that of bedside cranial ultrasound; and the detection rate of bedside cranial ultrasound for periventricular-intraventricular hemorrhage was significantly higher than that of MRI ( $P < 0.05$ ). The reason may be that ultrasound has higher sensitivity to hyperechoic hemorrhagic lesions. The acute phase of hemorrhage in PIVH manifests as a strong echogenic mass within the ventricles, and ultrasound can directly observe the location, extent, and echogenic features of the hemorrhage through the fontanelle transillumination window, which is especially advantageous for

identifying small hemorrhages of grade I-II<sup>[12, 13]</sup>. In contrast, MRI is not sensitive to the display of small amount of bleeding in the acute stage (bleeding ular widening, periventricular white matter softening, and cerebral edema was higher than that of bedside cranial ultrasound; and the detection rate examined in real time at the bedside, which is especially suitable for emergency evaluation of critically ill neonates, and can detect the lesion in time at the early stage of hemorrhage. Whereas MRI examination requires the transfer of the child and is often delayed in neonates due to sedation and life support, which may miss the optimal observation window in the acute stage of hemorrhage<sup>[14]</sup>. In addition, high-frequency ultrasound probe has higher resolution for small intracerebral hematomas and blood clots, while MRI is more advantageous in displaying ferritin deposits in the late stage of hemorrhage or chronic phase changes, but is not as good as ultrasound in detecting small amounts of hemorrhage in the acute phase, especially in preterm infants with unclosed fontanelles, and it is easier to detect subtle hemorrhagic foci with the real-time dynamic scanning of ultrasound<sup>[15]</sup>.

## 5. Conclusion

In conclusion, bedside cranial ultrasound has a high diagnostic value in periventricular-intraventricular hemorrhage, but its diagnostic value in other brain tissue injuries is not as good as that of MRI, and clinically appropriate examination protocols can be selected according to the specific type of cranial brain injury.

## Disclosure statement

The authors declare no conflict of interest.

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# Research Progress on the Application of Mobile Health Technology in Self-Management of Patients with Chronic Obstructive Pulmonary Disease

Yingzi Yuan, Xuan Shen, Mingyue Yang, Na Gao, Ying Zhang\*

School of Public Health and Nursing, Hangzhou Normal University, Hangzhou 311121, Zhejiang, China

*\*Author to whom correspondence should be addressed.*

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**Abstract:** Self-management interventions for chronic obstructive pulmonary disease (COPD) patients using mobile health technology are beneficial for relieving disease symptoms, improving patients' adherence to rehabilitation self-management, and improving quality of life. This paper reviews the application of mobile health technology in self-management of patients with chronic obstructive pulmonary disease, introduces the application form of mobile health technology in self-management of patients with chronic obstructive pulmonary disease, summarizes its application effect in self-management of patients with chronic obstructive pulmonary disease, analyzes the problems and proposes solutions in the process of research and implementation at this stage, with a view to providing a theory for the application of mobile health technology in pulmonary rehabilitation and management of patients with chronic obstructive pulmonary disease. This study summarizes the effect of its application in the self-management of patients with chronic obstructive pulmonary disease.

**Keywords:** Mobile health; Chronic obstructive pulmonary disease; Self-management; Pulmonary rehabilitation; Review

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## 1. Introduction

Chronic obstructive pulmonary disease (COPD) is one of the most common diseases in respiratory medicine. Its main characteristic is persistent incomplete airflow limitation, characterized by gradually worsening dyspnoea. Patients often experience worsening of their condition due to ventilatory impairment or dyspnoea <sup>[1]</sup>. Currently, approximately 300 million people worldwide are affected by COPD <sup>[2]</sup>. As a chronic respiratory disease, COPD can be better managed through self-care, enabling patients to recognize symptoms early and seek medical attention promptly, thereby slowing disease progression. While traditional pulmonary rehabilitation exercises, as a non-pharmacological treatment, can improve related symptoms, few patients participate in or adhere to these

exercises. Patients often have low levels of disease knowledge and self-management behavior, resulting in poor rehabilitation compliance. This increases the risk of disease exacerbation and rapid decline in lung function <sup>[3–5]</sup>. Therefore, it is particularly important for patients to learn how to monitor their own conditions and enhance their self-management capabilities. In recent years, mobile health technology has emerged as a new technology and has gradually been applied to patient rehabilitation and management. Mobile health technology aims to utilize mobile devices (smartphones, telephones, computer systems, and other electronic devices) to enhance healthcare services <sup>[6]</sup>. Mobile health technology, as a new technology that is not limited by time and space, can more effectively provide self-management and rehabilitation programs for patients with COPD. This study reviews the application of mHealth technology in the self-management of patients with COPD at home and abroad, aiming to provide theoretical references for the development of the application of mHealth technology in the field of COPD.

## **2. The concept of mobile health**

Mobile health(mHealth), also known as mobile medicine, was first coined by Istepanian in 2003, who defined it as mobile computing, medical sensors, and communication technologies used in healthcare <sup>[7]</sup>. With the rapid development of smart mobile technology and the widespread adoption of smartphones, their application in the healthcare sector has become increasingly widespread and in-depth. The World Health Organization defines mHealth as the use of mobile devices, including smartphones, tablets, or wearable monitoring devices, to deliver healthcare services <sup>[8]</sup>. This definition has now been expanded to include mobile applications, social media, and location tracking technologies to obtain data related to the monitoring, diagnosis, and management of chronic diseases <sup>[9]</sup>. MHealth, with its portability, intelligence, and visualization advantages, can monitor the health data of chronic disease patients anytime, anywhere, providing technical support for patient health management.

## **3. Forms of mHealth technology in the self-management of patients with chronic obstructive pulmonary disease**

### **3.1. Smart wearables**

With the advancement of Internet technology, the application rate of wearable devices is increasing rapidly. Smart wearable devices, especially smart bracelets, are lightweight and compact, easy to wear, and mounted on the limb with less impact on user comfort. Smart bracelets monitor vital signs such as heart rate and oxygen saturation through optical sensors, providing effective monitoring indicators for patients with COPD, which can promote patients' rehabilitation and exercise, and enhance adherence to health-promoting behaviors and self-management capabilities. Hataji *et al.* used Apple smartwatches to monitor patients with COPD, and the smartwatches were able to accurately record the amount of daily activity (steps, exercise time, calories burned) of the patients, which helped doctors to assess the patients' exercise capacity and rehabilitation progress, and the data from the smartwatches were highly correlated compared with traditional medical devices, which made them highly reliable for clinical applications <sup>[10]</sup>. A study by Lu *et al.* found that a wearable device-based pulmonary rehabilitation training model can effectively improve dyspnoea symptoms in patients with chronic obstructive pulmonary disease, and that the difference between the test group's own 6-minute walking distance, respiratory rate, heart rate, and oxygen saturation before and after the intervention was statistically significant compared to that of the control group <sup>[11]</sup>.

The application of wearable devices can facilitate the immediate transmission of clinical information, which is expected to enable early intervention in COPD and improve disease prognosis.

### 3.2. Mobile applications (APP)

More and more technology is being used in healthcare, with smartphones playing an important role, especially with the advent of the 5G era making the use of smartphone apps more common, and these apps are also being used in the rehabilitation of homebound patients with COPD. Naranjo *et al.* used the “AppO<sub>2</sub>” mobile application in conjunction with home visits by healthcare professionals to intervene with patients undergoing home oxygen therapy for COPD <sup>[12]</sup>. After three months, the patients’ dyspnoea had improved, and their sense of responsibility and confidence in managing their disease had increased. The “ChestCare” app developed by Gabhen *et al.* includes not only a basic symptom assessment module, but also other related modules such as lung capacity tracking, 6-minute walk test, risk factor monitoring, and education <sup>[13]</sup>. These modules not only provide effective interventions for patients, but also guide them in self-health management. Marc *et al.* used the “Kaia COPD” app to provide a comprehensive training intervention of respiratory exercise, breathing exercises, and health education to patients with stage II-IV COPD, and the patients’ dyspnoea and fatigue improved significantly after the intervention <sup>[14]</sup>. The use of smartphone apps improves adherence to rehabilitation exercises and exercise awareness, and makes it easier to provide pulmonary rehabilitation exercises to patients with COPD, with unrestricted access to needed medical information at anytime, anywhere.

### 3.3. Remote monitoring systems

Remote monitoring systems for COPD have been widely researched and applied both at home and abroad. The remote monitoring system can provide personalized rehabilitation intervention plans for patients with COPD through real-time data tracking, and improve the self-management ability of patients with COPD through online doctor-patient collaboration. Kaimakamis *et al.* utilized the “WELCOME” remote monitoring system to provide continuous monitoring for patients with chronic obstructive pulmonary disease <sup>[15]</sup>. The system uses a sensor undershirt to transmit collected real-time signals (including heart rate, respiratory rate, body position, oxygen saturation, multilead electrocardiogram, and electrical impedance tomography) via a tablet computer and wireless connection to a medical decision support system, which allows physicians to analyze the disease state and then develop a personalized treatment plan for the patient. Tsai *et al.* implemented home-based tele-rehabilitation exercise training via real-time videoconferencing for patients with stable chronic obstructive pulmonary disease, and the patients’ endurance exercise capacity and self-efficacy tended to improve after tele-rehabilitation, as well as their health-related quality of life <sup>[16]</sup>. Naranjo *et al.* developed an intelligent monitoring vest for COPD respiratory rate based on non-contact capacitive sensing <sup>[17]</sup>. This smart vest transmits the data generated by capacitive sensors to family members, clinicians, etc., providing low-cost and comfortable respiratory monitoring for home pulmonary rehabilitation exercises of COPD patients. Flynn *et al.* used a proprietary software platform to remotely monitor patients with COPD using virtual VR, which allowed patients with COPD to perform at-home rehabilitation exercises while clinicians remotely monitored the patient’s progress using a web-based dashboard and modified the patient’s pulmonary rehabilitation program in real time through follow-up phone calls <sup>[18]</sup>. The results showed that the completion rate of rehabilitation exercises was effectively increased, which is especially suitable for home patients who cannot participate in offline rehabilitation exercises compared with traditional rehabilitation.

### 3.4. Social media platforms

The rapid development of Internet technology has made social media platforms an important place to obtain and exchange information. Social media platforms provide social support for the self-management of patients with COPD through their extensive connectivity, interactivity, and information dissemination capabilities. Zhang *et al.* integrated the WeChat platform with traditional Chinese medicine continuity of care to establish an online platform for COPD continuity of care <sup>[19]</sup>. A continuity of care team comprising eight clinical healthcare professionals was formed. COPD patients logged into the WeChat platform to participate in rehabilitation exercises. The results showed that after intervention via the WeChat platform, patients' lung function improved, and compliance with pulmonary rehabilitation training significantly increased. Dixit *et al.* created eight exercise videos for patients and uploaded them to a social media platform <sup>[20]</sup>. Patients accessed these videos weekly through a social media group and received daily exercise reminder messages. After three months of exercise training, patients experienced relief in chest tightness, coughing, and shortness of breath during exertion, as well as improved sleep quality. Research has shown that on the "COPD360social" social platform, COPD patients share their stories through blogs, pictures, and videos, greatly expanding COPD patient education and self-management resources and improving communication between patients and healthcare professionals <sup>[21]</sup>. Compared with the traditional face-to-face communication mode, the advantages of social media platforms are more prominent, easier to maintain real-time communication and feedback, more convenient access to information, and high user engagement.

## 4. Effectiveness of mHealth technology in self-management of patients with chronic obstructive pulmonary disease

### 4.1. Improving lung function and quality of life

Implementing effective pulmonary rehabilitation training for patients with COPD is an important means of improving patients' lung function status and quality of life. The use of mHealth technology to remotely monitor patients' conditions, behaviors, and symptoms can help in the early detection and treatment of chronic obstructive pulmonary disease COPD, and improve lung function in time to prevent deterioration of the disease <sup>[22]</sup>. Studies have shown that patients who receive mobile application-based pulmonary rehabilitation therapy demonstrate better exercise capacity, quality of life, and hospital outcomes, as well as reduced dyspnoea, compared to patients who receive conventional pulmonary rehabilitation therapy <sup>[23]</sup>. Wang *et al.* intervened in patients with chronic obstructive pulmonary disease based on the COPD mobile Internet platform, giving the control group conventional nursing interventions, while the observation group was diagnosed through the platform and consultation with specialists on the basis of conventional nursing interventions to discuss the condition and treatment methods, and at the same time, the platform regularly pushed voice, picture, video and other health education materials to the patients, and the lung function indexes of the patients in the observation group were superior to those of the conventional control group in the 6-month period after the intervention <sup>[24]</sup>. The difference between the observation group and the control group was statistically significant, indicating that after the intervention with the mobile Internet platform, the patients' pulmonary function status was improved and their quality of life was enhanced.

### 4.2. Enhancing self-management skills

Self-management skills are one of the factors that determine the long-term prognosis of patients with COPD. Lenferink *et al.* showed that patients with COPD experienced a reduction in respiratory-related mortality with



rational self-management interventions <sup>[25]</sup>. Traditional self-management interventions for chronic obstructive pulmonary disease have largely ignored patient spontaneity and initiative, and the rehabilitation effects do not last long due to the low intensity of self-management concepts established by patients <sup>[26]</sup>. The use of mHealth technology can provide patients with knowledge and skills, make it more convenient and efficient for medical staff to manage and educate patients, help patients develop good living habits, and guide them to carry out correct pulmonary rehabilitation exercises in order to improve patients' self-management initiative. In Glynn *et al.*'s study, patients in the intervention group implemented a comprehensive self-management plan via a smartphone app, synchronizing physical activity and lung function-related data to the app via Bluetooth <sup>[27]</sup>. The app also provided communication channels with healthcare professionals, goal-setting, and incentive features, enabling patients to promptly address questions arising during self-management, enhance disease management awareness, and thereby more proactively implement self-management behaviors. Research has shown that with the assistance of mobile devices, patients perceive that their condition is being closely monitored, enabling them to participate more effectively in their own health management <sup>[28]</sup>. MHealth technology provides a more convenient communication channel between patients with COPD and healthcare professionals, and patients' self-awareness of supervised rehabilitation and exercise is increased, which helps patients develop self-management skills and improves disease prognosis.

#### **4.3 Improving disease awareness and increasing compliance with pulmonary rehabilitation**

MHealth technology has played a positive role in improving medication management, respiratory training, and exercise compliance among patients with COPD. By providing rehabilitation exercises with remote supervision, patients may be more inclined to participate in pulmonary rehabilitation exercises even without on-site support from healthcare professionals <sup>[29]</sup>. Yonchuk *et al.* developed an application called "Respercise", which not only provides the basics of exercise programs, lifestyle guidance, and COPD education for patients with COPD, but also supports the patient's personal exercise program <sup>[30]</sup>. By setting goals and receiving encouragement or reward messages pushed by the system after completing the goals, the patient's adherence to exercise is increased while improving the patient's mobility. Deng *et al.* applied the developed pulmonary rehabilitation mHealth system to patients' pulmonary rehabilitation exercises <sup>[31]</sup>. The rehabilitation compliance rate of patients using the system reached 82.20%, and the compliance level remained at a high level throughout the entire intervention period. MHealth technology allows patients to have a clearer understanding of their disease and thus tend to improve their daily behaviors and compliance with rehabilitation. In the future, more online discussions can be carried out, experts can be invited to answer questions on pulmonary rehabilitation-related content, and patients can be organized to actively exchange and share their experiences, which can provide positive interventions and rehabilitation motivation for more patients with chronic obstructive pulmonary disease.

### **5. Issues and recommendations for the application of mHealth technology in patients with chronic obstructive pulmonary disease**

#### **5.1. Limited user base**

COPD patients are predominantly older individuals with generally low health literacy, and some may have cognitive impairments or conditions such as dementia, making them unable to self-manage their condition or familiarize themselves with related technology software <sup>[32]</sup>. Among COPD patients, those who use mobile

applications tend to be relatively younger, with higher incomes, higher education levels, and self-reported good health <sup>[33]</sup>. Older patients have relatively weaker learning and adaptation abilities regarding new technologies and are less inclined to use mobile application devices. A survey on the use of mHealth devices among the elderly population in China revealed that functional impairments, including visual impairments, cognitive impairments, reduced hand dexterity, and poor health status, are the most common factors hindering the elderly from using mobile medical applications. Other factors include technological fear and lack of professional support <sup>[34]</sup>. Additionally, educational attainment is another influencing factor. Research has shown that the dropout rate for mobile medical programme use among patients with an education level of junior high school or below was 50.4%, higher than that of patients with a high school education or above <sup>[32]</sup>. This indicates that lower educational attainment is a significant barrier to understanding and using mHealth technology, thereby affecting its promotion and application in this population. Software development should design user interfaces that are age-friendly and require low literacy levels. Healthcare professionals can regularly organize special training courses and lectures to provide patients with detailed information about the functions and advantages of mHealth technology and train them in the skills required to use mHealth care applications.

## **5.2. Software-related technical issues**

Due to the complexity of the software and cumbersome operation of some mHealth care programs, patients have more difficulties in the process of using them, which reduces the motivation to use them. MHealth care software needs to accurately collect, process, and analyze users' health data; however, some mHealth care software has errors during data collection and processing due to insufficient accuracy sensors and software algorithms, resulting in inaccurate measurement results <sup>[35]</sup>. The stability of mHealth technology is also a key factor influencing patient acceptance. If issues such as data transmission interruptions or software crashes occur, it can reduce patients' trust in the technology and their willingness to use it <sup>[36]</sup>. Alharbey *et al.* developed a mHealth application system called "MyLung" based on mHealth technology <sup>[37]</sup>. The system design includes three modules: education, risk reduction, and monitoring. Each module is simple, clear, and user-friendly. After using the application, patients showed increased attention to symptoms of COPD. As such, relevant technical departments should optimize technical design to provide a simple, intuitive application interface that is easy for patients to operate. Nurses and patient representatives should be involved in usability testing during the development phase. Additionally, a user feedback mechanism should be established to collect user opinions and suggestions as needed, continuously improving the software's performance.

## **5.3. Privacy and security issues**

Quach *et al.* searched the Google Play and Apple App Stores for mHealth applications specifically designed for self-management by patients with COPD <sup>[38]</sup>. They found that most applications were developed by for-profit organizations, while only a few were developed by non-profit organizations and unknown developers. Although many applications had privacy policies, only three described their security systems, and two mentioned compliance with local health information and data usage laws. Patients also face the risk of data breaches when using these apps <sup>[39]</sup>. Technical personnel should take strict data encryption measures for patients' personal information and health data, set reasonable user access management permissions, strengthen supervision of the platform, establish security management systems, and conduct regular security checks and risk assessments. Medical staff should also strengthen safety education and training for patients to raise their awareness of information security.



## 6. Conclusion

Chronic Obstructive Pulmonary Disease remains a major public health challenge as one of the three leading causes of death worldwide<sup>[40]</sup>. As a new technology in the high-tech era, mHealth has played a significant role in the rehabilitation treatment and self-management of patients with COPD. From smart wearable devices to remote monitoring systems, the application of mHealth has enhanced patients' self-management capabilities and adherence to rehabilitation exercises, resulting in improved lung function and quality of life. However, challenges remain, including low user acceptance, concerns over personal privacy and data breaches, and the incomplete development of mHealth technologies. In the future, more high-quality, large-scale, multi-centre randomized controlled trials should be conducted to further explore the effectiveness of mHealth in self-management for COPD patients. Interdisciplinary collaboration should be strengthened to optimize solutions. Relevant authorities should establish corresponding policies, actively implement mHealth-related nursing services, increase research efforts and depth in mHealth technology, expand research areas, and promote the development of mHealth technology.

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# Correlation Analysis Between Symptom Clusters and Quality of Life in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease

Wenjie Wang<sup>1</sup>, Na Wang<sup>1</sup>, Yujiao Wang<sup>2</sup>, Dan Liu<sup>3\*</sup>

<sup>1</sup>Nursing Department, Taihe Hospital, Hubei University of Medicine, Shiyan 442000, Hubei, China

<sup>2</sup>Hubei University of Medicine, Shiyan 442000, Hubei, China

<sup>3</sup>Department of Pulmonary and Critical Care Medicine, Taihe Hospital, Hubei University of Medicine, Shiyan 442000, Hubei, China

\*Corresponding author: Dan Liu, 188576927@qq.com

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**Abstract:** *Objective:* This study aims to investigate the patterns of symptom occurrence in patients experiencing acute exacerbations of chronic obstructive pulmonary disease (AECOPD). It will explore the composition of symptom clusters and analyze the correlation between these clusters and health-related quality of life (HRQoL). *Methods:* A total of 207 patients with AE-COPD were surveyed from a tertiary grade A hospital. Data collection was conducted using three validated instruments: the Basic Information Questionnaire (BIQ), Disease Symptom Survey Questionnaire (MSAS), and Quality of Life Questionnaire (CAT). Statistical software SPSS 22.0 was used to analyze the correlation between symptom clusters and quality of life. *Results:* Exploratory factor analysis showed that five major symptom clusters existed in the patients, including the psycho-emotional symptom cluster, the sleep-related symptom cluster, the other side effects symptom cluster, the energy deficiency symptom cluster and the cough-loss of appetite symptom cluster, and the severity of the symptom clusters showed a significant negative correlation with the quality of life of the patients ( $P < 0.05$ ). *Conclusion:* Strengthening the comprehensive management of symptom clusters in patients with AE-COPD can help to effectively reduce the symptom burden of patients, and then significantly improve their quality of life.

**Keywords:** COPD; Acute exacerbation; Symptom cluster; Quality of life

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## 1. Introduction

Chronic obstructive pulmonary disease (COPD) is a respiratory disease characterized by persistent airflow limitation, with high morbidity and mortality rates, and is now one of the three leading causes of death in the world bringing a heavy burden to patients, families, and society<sup>[1]</sup>. Acute exacerbation (AE-COPD), as a key stage in the course of COPD, causes serious injury to patients' lung function, accelerates the malignant progression of

the disease, aggravates the degree of respiratory distress, and reduces the quality of life, which greatly affects the patients' physical function and prognosis <sup>[2-4]</sup>. Currently, most domestic and international studies on COPD focus on the stabilization period, while there are relatively few studies on the symptom clusters of AECOPD patients, especially the correlation between the symptom clusters and the quality of life is even more scarce. This study aims to analyze the composition of symptom clusters and their correlation with the quality of life of AE-COPD patients, so as to provide a scientific basis for the clinical development of more precise and effective interventions, and thus effectively improve the quality of life of patients.

## **2. Methods**

### **2.1. Participants**

Using convenience sampling, a total of 207 patients hospitalized with AE-COPD were consecutively recruited from the Department of Pulmonary and Critical Care Medicine at a tertiary grade A hospital between January 2024 and January 2025. A questionnaire survey was conducted by trained researchers through direct distribution. Based on the sample size calculation principle (5–10 variables per case) and accounting for a 20% anticipated attrition rate, a total of 220 questionnaires were administered. The inclusion criteria were as follows: (1) Meeting the 2020 diagnostic and treatment guidelines for COPD issued by the Chinese Thoracic Society, with pulmonary function classified as GOLD stages 1–4; (2) Aged between 18 and 80 years; (3) Provision of written informed consent by the patient. The exclusion criteria included: (1) Current participation in other interventional clinical studies; (2) Presence of comorbid respiratory diseases (e.g., pulmonary tuberculosis, asthma); (3) Concurrent neurological or psychiatric disorders.

### **2.2. Instruments**

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

This questionnaire includes the patient's demographic information (e.g., gender, age, education, etc.), basic disease profile (e.g., year of COPD diagnosis, number of acute exacerbations in the last 12 months, etc.), comorbidities (e.g., cardiovascular disease, metabolic disease, etc.), and degree of dyspnea (using the modified Medical Research Council Dyspnea Score, mMRC).

#### **2.2.2. Symptoms of Illness Questionnaire (MSAS)**

This questionnaire was developed by Portenoy *et al.* in the mid-1990s to assess the frequency, severity, and degree of distress of the patient's symptoms in the last 7 days. The questionnaire contains 32 common symptoms, and patients rate each symptom according to their own conditions. The MSAS has good reliability and validity, with an internal consistency coefficient (Cronbach's  $\alpha$ ) of 0.92 and a retest reliability of 0.89, which is able to effectively assess the patients' symptoms.

#### **2.2.3. Quality of Life Questionnaire (CAT)**

This questionnaire was developed by Jones *et al.* in 2009 and was specifically designed to assess the impact of COPD on patients' quality of life. The questionnaire contains 8 entries with a total score of 0–40, with higher scores indicating poorer quality of life. The CAT scale has good reliability and validity, with an internal consistency coefficient (Cronbach's  $\alpha$ ) of 0.85 and a re-test reliability of 0.83, which can effectively assess the



quality of life of patients with chronic obstructive pulmonary disease (COPD).

## 2.3. Data analysis

Data were analyzed using SPSS 22.0 statistical software. Descriptive statistics were employed to summarize the basic information and symptom occurrences of the patients. Exploratory factor analysis (EFA) was conducted to identify the types and numbers of symptom clusters. Multiple linear regression analysis was performed to investigate the factors influencing the severity of the symptom clusters, while Spearman's rank correlation analysis was utilized to evaluate the relationship between symptom clusters and quality of life.

## 3. Results

### 3.1. Demographic characteristics

A total of 207 valid questionnaires were returned, yielding an effective response rate of 94.09%. The cohort comprised 152 males (73.4%) and 55 females (26.6%), with a mean age of  $64.3 \pm 9.8$  years. The median duration since COPD diagnosis was 5 years (IQR: [range to be calculated]). Patients with mMRC grade 4 accounted for 47.8%, and 42.0% reported a monthly household income between ¥1,000–3,000. Detailed demographic and clinical characteristics are presented in **Table 1**.

**Table 1.** Demographic characteristics of patients with AE-COPD (n=207)

Variables	Category	Number of cases	Percentage (%)
Gender	Male	152	73.43
	Female	55	26.57
Living Situation	Living alone	11	5.31
	Living with spouse	79	38.16
	Living with children	30	14.49
	Living with spouse and children	87	42.03
Place of Residence	Rural	74	35.75
	County/town	78	37.68
	City	55	26.57
Religious Belief	Yes	14	6.76
	No	193	93.24
Employment Status	Unemployed or not working	95	45.89
	Employed	25	12.07
	Retired	87	42.03
Marital Status	Married	173	83.58
	Not married	34	16.42
Household Income	Below 1000 RMB	45	21.74
	1000–3000 RMB	87	42.03
	3000–5000 RMB	55	26.57
	Above 5000 RMB	20	9.66



**Table 1 (Continued)**

Variables	Category	Number of cases	Percentage (%)
Financial Burden of Disease	Mild	32	15.46
	Moderate	93	44.93
	Severe	82	39.61
mMRC Grade	Grade 2	44	21.26
	Grade 3	64	30.92
	Grade 4	99	47.83
Mode of Admission	Emergency admission	2	0.97
	Outpatient admission	205	99.03
Duration Since Diagnosis of COPD	≤ 1 year	42	20.29
	1–5 years (excluding 5)	102	49.28
	5–10 years (excluding 10)	53	25.60
	> 10 years	10	4.83
Number of Acute Exacerbations of COPD in the Past 12 Months	1	85	41.06
	2	61	29.47
	3	45	21.74
	4	8	3.87
	5	4	1.93
	6	2	0.97
Number of COPD-related Hospitalizations in the Past 12 Months	1	48	23.19
	2	49	23.67
	3	56	27.05
	4	23	11.11
	5	16	7.73
	6	8	3.87
	7	7	3.38
Comorbidities	Other	53	25.60
	None	6	2.90
	Cardiovascular diseases	129	62.32
	Metabolic diseases	19	9.18
Severity of Comorbidities	None or mild	51	24.64
	Moderate	97	46.86
	Severe	59	28.50
Smoking Status	Never smoked	74	35.75
	Former smoker	98	47.34
	Current smoker	35	16.91

**Table 1 (Continued)**

Variables	Category	Number of cases	Percentage (%)
Alcohol Consumption	Never drinks	116	56.04
	Former drinker	70	33.82
	Current drinker	21	10.15
Regular Physical Activity	Yes	87	42.03
	No	120	57.97
Age	≤ 50 years	18	8.70
	51–60 years	33	15.94
	61–70 years	76	36.71
	71–80 years	80	38.65
Highest Educational Level	Illiterate	6	2.90
	Primary school	99	47.83
	Junior high school	71	34.30
	High school / technical secondary school	25	12.08
	College and above	6	2.90

### 3.2. Symptom occurrence

The top five symptom occurrences of the patients were: shortness of breath (100%), cough (100%), dry mouth (92.3%), difficulty in sleeping (89.9%), and worry (88.4%). From the comprehensive analysis of the frequency, severity, and degree of distress of symptoms, shortness of breath, cough, dry mouth, difficulty in sleeping, and worry had the greatest impact on the patients. Detailed symptom occurrences are shown in **Table 2**.

**Table 2.** Occurrence of symptoms in AE-COPD (n=207)

Symptom	Frequency	Incidence Rate (%)	Mean score
Shortness of breath	207	100(1)	3.04(1)
Cough	207	100(1)	2.45(2)
Dry mouth	191	92.3(2)	1.97(4)
Difficulty falling asleep	186	89.9(3)	2.38(3)
Anxiety	183	88.4(4)	1.75(5)
Feeling of sadness	170	82.1(5)	1.49
Loss of appetite	170	82.1(5)	1.49
Feeling irritable	156	75.4	1.35
Drowsiness	141	68.1	1.27
Feeling nervous	137	66.2	1.18
Sweating	136	65.7	1.17
Difficulty concentrating	108	52.2	0.93
Pain	103	49.8	1.03
Swelling in legs or arms	96	46.4	0.76

**Table 2 (Continued)**

Symptom	Frequency	Incidence Rate (%)	Mean score
I don't look like myself	73	35.3	0.64
Nausea	62	30	0.45

○ means the numbers in “○” in the table indicate the ranking of the symptom.

### 3.3. Quality of life

The patients' total quality of life score was ( $28.66 \pm 4.84$ ), with the highest score for daily situation ( $11.52 \pm 2.63$ ), the score for physiological situation was ( $9.87 \pm 2.13$ ); and the score for mental situation was ( $7.26 \pm 1.51$ ). This indicates that the overall quality of life of AE-COPD patients is at a low level, especially as daily activities and mental status are seriously affected.

### 3.4. Symptom cluster

Five major symptom clusters were extracted by EFA, and the symptom composition and variance contribution rate of each symptom cluster were as follows. The variance contribution rate of psycho-emotional cluster (feeling of sadness, worry, feeling irritable, feeling nervous) was 23.407%. The variance contribution of sleep-related cluster (difficulty falling asleep, shortness of breath, arm edema, I don't look like myself) was 13.591%. The variance contribution of other side effects cluster (pain, dry mouth, sweating, nausea) was 11.2%. The variance contribution of energy deficiency cluster (low energy, feeling lethargic) was 7.908%. The variance contribution of Cough-anorexia cluster (cough, loss of appetite) was 7.095%. The symptom component loading matrix for each symptom cluster is shown in **Table 3**.

**Table 3.** Matrix of symptom component loadings in patients with AE-COPD

Symptom	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Sadness	0.832				
Anxiety	0.805				
Irritability	0.747				
Nervousness	0.528				
Difficulty falling asleep		0.628			
Shortness of breath		0.699			
Swelling in arms		0.695			
I don't look like myself		0.681			
Pain			0.666		
Dry mouth			0.560		
Sweating			0.726		
Nausea			0.544		
Lack of energy				0.583	
Drowsiness				0.823	
Loss of appetite					0.520

**Table 3 (Continued)**

Symptom	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Cough					0.857
Symptom Group Label	Psychological-Emotional	Sleep-Related	Side Effect-Related	Low Energy	Cough–Appetite Loss
Cronbach's $\alpha$	0.760	0.658	0.593	0.586	0.373
Variance Explained (%)	23.047	13.591	11.2	7.908	7.095
Cumulative Variance (%)	23.047	36.638	47.838	55.746	62.84

### 3.5. Analysis of influence factors

Multivariate linear regression analysis identified the following predictors for symptom cluster severity.

- (1) Psycho-emotional cluster: alcohol consumption, residence, mMRC grade, household income.
- (2) Sleep-related cluster: mMRC grade, comorbidity severity, disease economic burden.
- (3) Other side effects cluster: comorbidity severity, employment status, gender, household income.
- (4) Energy deficiency cluster: smoking status, physical activity, disease economic burden, employment status, alcohol consumption, age, COPD exacerbation frequency.
- (5) Cough-anorexia cluster: mMRC grade.

### 3.6. Correlation analysis

The results of Spearman rank correlation analysis showed that the severity of each symptom cluster was negatively correlated with the total quality of life score and the scores of each dimension ( $P < 0.05$ ). Among them, the sleep-related symptom cluster had the strongest correlation with the total quality of life score ( $r = -0.626$ ,  $P < 0.001$ ). The results of the detailed analysis was shown in **Table 4**.

**Table 4.** Correlation between the severity of each symptom cluster and quality of life in patients with AE-COPD

Symptom group	Physical condition (r)	Daily condition (r)	Mental condition (r)	Total score (r)
Psychological-Emotional Symptom Group	-0.235**	-0.267**	-0.296**	-0.333**
Sleep-Related Symptom Group	-0.302**	-0.560**	-0.594**	-0.626**
Other Side Effects Symptom Group	-0.166*	-0.119	-0.298**	-0.213**
Low Energy Symptom Group	-0.246**	-0.205**	-0.205**	-0.272**
Cough–Appetite Loss Symptom Group	-0.351**	-0.315**	-0.130	-0.367**

\*Correlation is significant at the 0.05 level (two-tailed).

\*\*Correlation is significant at the 0.01 level (two-tailed).

## 4. Discussion

The findings of this study revealed that patients experiencing acute exacerbations of chronic obstructive pulmonary disease (AE-COPD) exhibit a diverse array of symptoms, with notably high prevalence rates. Among these, respiratory manifestations—including dyspnea and cough—are the most ubiquitous, reaching a 100% occurrence rate. This observation aligns with the results reported by Yang *et al.*, underscoring the profound detrimental impact of these respiratory symptoms on pulmonary function<sup>[5]</sup>. Concurrently, non-respiratory symptoms such as

sleep disturbances and psychosocial issues were prominently identified. Insufficient sleep duration significantly exacerbated patients' fatigue severity, while psychosocial comorbidities correlated with prolonged disease duration, deteriorating pulmonary function, impaired physical mobility, and diminished health-related quality of life (HRQoL) <sup>[6, 7]</sup>. Collectively, these findings suggest that clinical nursing staff should prioritize strengthening symptom management strategies, optimizing integrated clinical treatment-nursing workflows, and implementing precision nursing interventions to achieve efficient disease management. Such efforts would enable patients to perceive a tangible sense of control and improvement over their symptoms, thereby enhancing therapeutic adherence and clinical outcomes.

The total quality of life score of the 207 AE-COPD patients included in this study was  $(28.66 \pm 4.84)$ . According to the total score of CAT scale, it indicated that the mean score of quality of life of the patients in this study was in the severe stage of the disease, and most of the patients had a low quality of life <sup>[8]</sup>. Analysis of the mean scores of each dimension revealed that the highest score of daily situation ( $11.52 \pm 2.63$ ) indicated that COPD had a great impact on the daily life of the patients; the score of physiological situation ( $9.87 \pm 2.13$ ); and the score of mental situation ( $7.26 \pm 1.51$ ) showed that the mental state of the patients was also seriously affected. This shows that the quality of life of AE-COPD patients is low and needs to be highly emphasized in clinical practice.

The symptom clusters observed in patients with acute exacerbations of chronic obstructive pulmonary disease (AE-COPD) include the psycho-emotional cluster, sleep-related cluster, other side effects cluster, energy deficiency cluster, cough-anorexia cluster. Among these, the psycho-emotional and sleep-related clusters exerted a more pronounced impact on patients' quality of life. The psycho-emotional symptom cluster may arise from the acute exacerbation of the disease, significant alterations in the patient's body and lifestyle, leading to feelings of maladjustment and powerlessness regarding their condition <sup>[9]</sup>. Furthermore, the severity of sleep-related symptom cluster demonstrated a significant positive correlation with patients' physical, daily, mental, and overall quality of life scores, as evidenced by studies conducted by some international scholars <sup>[10]</sup>. The side effect cluster encompassed pain, dry mouth, sweating, nausea, and other symptoms. Research has indicated that pain is an integral component of the disease process that cannot be overlooked, as it exacerbates the severity of both physical and mental symptoms, thereby creating a negative synergistic relationship among the symptoms <sup>[11]</sup>. Additionally, there was a correlation between energy deficiency cluster and the severity of COPD symptoms. Studies have shown that the incidence of energy deficiency issues, such as lack of energy, drowsiness, and fatigue, is positively correlated with the severity of acute exacerbations in COPD patients. These energy deficiency symptoms negatively impact the psychological state of the patient, potentially leading to a loss of self-awareness and even cognitive decline <sup>[12]</sup>. Lastly, the cough-anorexia cluster, which includes both cough and loss of appetite, exhibits a significant positive correlation with the patients' physiological condition.

In this study, it is found that the severity of each symptom cluster is negatively correlated with quality of life, suggesting that alleviating the symptom burden can significantly enhance patients' quality of life. Key factors influencing the corresponding symptom clusters included family income, mMRC dyspnea class, residence status, disease duration, smoking status, physical activity, economic burden, degree of comorbidity, age, and number of hospital admissions. These findings align closely with those of Lim *et al.* <sup>[13, 14]</sup>. Therefore, it is imperative to implement targeted interventions in clinical practice to improve the quality of life for patients. Relevant studies have demonstrated that the implementation of effective respiratory rehabilitation care significantly enhances patients' lung function <sup>[15]</sup>. This includes utilizing respiratory muscle training to counteract respiratory muscle

atrophy, alleviate respiratory distress, and improve sputum expectoration capabilities, which are crucial for mitigating the severity of the disease. Furthermore, the severity and number of comorbidities correlate with the symptoms of acute exacerbation of COPD <sup>[16]</sup>. Consequently, healthcare personnel must promptly assess patients' comorbidity situations and administer appropriate management strategies tailored to the various types and degrees of comorbidities. This approach aims to facilitate timely interventions and effective treatments for patients with specific comorbid conditions. It is also essential to strengthen psychological counseling for patients with chronic illnesses, particularly focusing on educating those who have experienced multiple hospital admissions. Additionally, greater medical attention and humanistic care should be directed towards rural patients, individuals with limited economic resources, and elderly patients. Post-discharge, patients are encouraged to engage in physical activities and respiratory rehabilitation training to enhance lung function and respiratory health. It is advisable to gradually improve their physical capabilities through walking, Baduanjin, and Tai Chi, thereby facilitating the enhancement of various bodily functions through appropriate exercise <sup>[17]</sup>.

There were some limitations in this study that cannot be neglected. The generalizability of our findings may be constrained by the limited sample size and geographical scope of this study. Furthermore, while the MSAS and CAT utilized in this research demonstrate considerable clinical utility, their predefined symptom inventories and patient-reported outcome (PRO) items may introduce measurement limitations, potentially affecting the comprehensiveness of our results. Future investigations should prioritize expanding sample diversity through multicenter recruitment, implementing longitudinal designs to elucidate symptom cluster trajectories, and employing mixed-methods approaches to examine sustained associations between symptom dynamics and health-related quality of life (HRQoL). These enhancements would provide more robust evidence for optimizing symptom management protocols in clinical nursing practice.

## 5. Conclusion

This study investigated the characteristics of symptom clusters and their correlation with quality of life in patients with AE-COPD. The findings revealed the existence of five major symptom clusters among the patients, with the severity of each cluster showing a significant negative correlation with their quality of life. Comprehensive management of these symptom clusters is expected to significantly enhance patients' quality of life and improve their prognosis.

## Disclosure statement

The authors declare no conflict of interest.

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# A Study of the Effect of Supervised Pulmonary Rehabilitation Training on Patients with Bronchiectasis in a Home-based Rehabilitation Model

Qianwen Xiang<sup>1,2</sup>, Di Wu<sup>3,\*</sup>

<sup>1</sup> Medical Science Center, Yangtze University, Jingzhou 434023, Hubei, China.

<sup>2</sup> Jingmen Vocational College, Jingmen 448000, Hubei, China.

<sup>3</sup> The First Affiliated Hospital of Yangtze University, Jingzhou 434000, Hubei, China.

*\*Author to whom correspondence should be addressed.*

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**Abstract:** Bronchiectasis is a chronic inflammatory airway disease, and patients often suffer from recurrent airway infections leading to decreased lung function and impaired quality of life. In this study, the effects of supervised pulmonary rehabilitation training on pulmonary function, training compliance, and quality of life in patients with bronchiectasis under home rehabilitation mode are investigated. Ninety stable patients were selected, and the observation group adopted the home-supervised mode of pulmonary rehabilitation training. The results showed that the observation group's pulmonary function indexes, quality of life, and training adherence were better than those of the control group. The differences were statistically significant ( $P < 0.05$ ). The supervised pulmonary rehabilitation training in home rehabilitation mode can effectively improve patients' pulmonary function and quality of life, and improve training compliance, which has good clinical application value.

**Keywords:** Bronchiectasis; Pulmonary rehabilitation training; Home rehabilitation; Supervisory model

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## 1. Introduction

Bronchiectasis is a common chronic inflammatory disease of the airways, and patients often present with symptoms such as cough, sputum, and shortness of breath, and the condition may gradually worsen without timely intervention, affecting the quality of life or even endangering life <sup>[1]</sup>. Pulmonary rehabilitation training, as an effective non-pharmacological intervention, can improve patients' lung function and prognosis, but its long-term compliance is poor, which restricts the efficacy of the treatment. Home-based rehabilitation provides a convenient rehabilitation environment for patients, while supervised pulmonary rehabilitation improves the standardization and continuity of training through professional supervision <sup>[2]</sup>. The combination of the two is expected to enhance

patient compliance and improve the effectiveness of rehabilitation. From April 2024 to April 2025, this study enrolled patients with stable bronchiectasis from two respiratory wards of a tertiary hospital in a prefecture-level city. A supervised pulmonary rehabilitation program was implemented within a home-based model to improve training adherence, aiming at exploring a more scientific and feasible rehabilitation pathway.

## 2. Objects

### 2.1. Study objects

The study population consisted of patients hospitalized in two wards of the Department of Respiratory Medicine in a tertiary care hospital in a prefecture-level city from April 2024 to April 2025 during the stable phase of bronchiectasis. The block random grouping method was used, in which patients were assigned to the intervention and control groups on a 1:1 basis by a randomized grouper using the Blockrand package in the R language, with the stratification factors being the first and second wards of the Department of Respiratory Medicine, and a mixed block group of 4 and 6, and 6 and 4, respectively, for the two wards. The generated grouping sequences were written in cards of uniform size and thickness, placed in separate sealed opaque envelopes of the same shape, and opened and placed according to ward. Groups were determined by opening the envelopes sequentially according to the order of discharge of patients from each ward (sequence A for the intervention group and sequence B for the control group). Randomization groupers were not allowed to disclose the patient grouping to any study-related personnel. The persons measuring the indicators before and after the intervention were blinded, but the patients, their families and the care implementers were not blinded.

In the control group, there were 22 males and 23 females, with ages ranging from 22 to 65 years, with a mean age of  $(43.70 \pm 10.46)$  years; the duration of the disease ranged from 1 to 10 years, with a mean of  $(5.81 \pm 2.06)$  years; of these subjects, 9 had an education level of less than 9 years, 21 had an education level of between 9 and 12 years, and 15 had an education level of more than 12 years. In the observation group, there were 24 males and 21 females, aged between 23 and 65 years, with a mean age of  $(44.23 \pm 10.22)$  years; the duration of the disease ranged from 1 to 12 years, with a mean of  $(6.60 \pm 2.44)$  years; of these, 10 subjects had an education level of less than 9 years, 19 had an education level of between 9 and 12 years, and 16 had an education level of more than 12 years. There was no statistically significant difference between the two groups in terms of general information ( $P > 0.05$ ) and they were comparable.

### 2.2. Inclusion and exclusion criteria

#### 2.2.1. Inclusion criteria

- (1) Meet the diagnostic criteria of the Expert Consensus on the Diagnosis and Treatment of Bronchiectasis in Adults, and are diagnosed with bronchiectasis by the S Hospital <sup>[3]</sup>.
- (2) Have completed inpatient treatment, are in stable condition, and have the conditions to carry out home-based rehabilitation training.
- (3) Have signed an informed consent form and voluntarily participate in the home-based rehabilitation interventions.
- (4) Have normal communication skills and are able to understand and cooperate with the rehabilitation guidance.
- (5) Aged between 20 and 65 years old <sup>[4]</sup>.

### 2.2.2. Exclusion criteria

- (1) The presence of severe hepatic and renal insufficiency.
- (2) Accompanied by obvious neurological disorders.
- (3) The presence of physical dysfunction, unable to complete the rehabilitation training.
- (4) The combination of other serious organic diseases, such as serious cardiovascular disease, malignant tumours, etc.
- (5) The combination of other lung diseases, such as chronic bronchitis, pneumonia, tuberculosis, etc., which affect the effect of the research intervention <sup>[5]</sup>.

## 3. Methods

### 3.1. Control group

The control group implemented routine discharge guidance and follow-up care. Before the patients are discharged from the hospital, the responsible nurse carries out health education, including knowledge about bronchiectasis, medication guidance, reasonable diet, lifestyle adjustment (such as quitting smoking and alcohol, preventing colds), condition monitoring, and identification of acute exacerbation and coping methods. After discharge, patients were advised to perform aerobic exercise (e.g., jogging, walking, or jumping rope) for about 2 hours daily for 3 months <sup>[6]</sup>. Nursing staff followed up the patients every fortnight by telephone to understand the execution of exercise and provide necessary rehabilitation guidance.

### 3.2. Observation group

The observation group implemented supervised pulmonary rehabilitation training under the home rehabilitation model on the basis of the control group.

For the pre-discharge intervention preparation, the nursing team organized the patients and their family members to participate in a supervised mobilization meeting for pulmonary rehabilitation training, which was conducted by the head nurse or nurse-in-charge and assisted by the rest of the nurses, and lasted 40 minutes. The content of the mobilization included: (1) Explaining the importance of pulmonary rehabilitation training and the expected results; (2) Showing standard training movements through video, and the nurse led the patient and family members to practice together on the spot; (3) Clarifying the supervisory responsibilities of family members in the process of family rehabilitation, supervising the patient's training every day, providing timely feedback on the rehabilitation situation and giving emotional support and encouragement; (4) Establishing a WeChat follow-up group, which the patient and the family members designated by the patient swept the code to join, and the nurse sent training video materials on a regular basis, the patient sent training video materials every morning. The nurse regularly sends training video materials, the patient trains once a day in the morning and once in the evening, and the family members record and upload the video of each training session to the group, the nurse in charge records and evaluates once a week and reminds those who do not follow the training requirements by phone <sup>[7]</sup>.

The pulmonary rehabilitation training content included:

- (1) Breathing training: (a) Lip-contraction breathing method: deep inhalation through the nose, slow exhalation with puckered lips, exhalation time of 46 seconds, 6 times a day, 15 minutes each time; (b) Active circular breathing techniques, including breath control (abdominal relaxation perception), chest expansion (deep inhalation and then hold the breath), forceful exhalation training (long and deep huffing),

each repeated 5 times <sup>[8]</sup>.

- (2) Expectorant training: (a) percussion expectoration: family members to bowl palm percussion back to assist expectoration; (b) Postural drainage: adjust the position according to the orientation of the lesion 12 hours after the meal to promote the drainage of secretions <sup>[9]</sup>.
- (3) Cough training: The patient sits in a forward-leaning position, hands on the abdomen, three consecutive huffs to perceive the abdominal pressure, and then deep inhalation after the practice of the sound of 'k' and cough for two consecutive times <sup>[10]</sup>.
- (4) Aerobic exercise: Jogging in the family (30 minutes/time), walking (1 hour/time) or jumping rope (1 hour/time). Aerobic exercise: choose one of jogging (30 minutes/times), walking (1 hour/times), or jumping rope (2,000 times/times) at home, and do it once a day <sup>[11]</sup>.

The training lasted for 3 months, during which time the family was supervised daily and nursing staff regularly tracked, assessed, and provided individualized guidance via WeChat video and telephone.

### 3.3. Observation indicators and evaluation criteria

- (1) Lung function-related indexes: Before and after training, the first-second forceful expiratory volume (FEV1), forceful lung capacity (FVC), and FEV1/FVC ratio of the two groups of patients were measured by using a lung function detector to evaluate the changes in lung function <sup>[12]</sup>.
- (2) Dyspnoea assessment: The modified version of the British Medical Research Council respiratory questionnaire (mMRC) was used to assess the severity of dyspnoea before and after the training of the patients, which was divided into grades 0–4, with higher grades indicating more severe symptoms, and grades  $\geq 2$  suggesting more severe dyspnoea <sup>[13]</sup>.
- (3) Training adherence: After the training, the patient's family members and the nurse in charge jointly assessed the patient's training adherence, covering 4 indicators of training attitude, participation, movement accuracy and autonomy, with a score of 1 to 4 points for each item and a total score of 4 to 16 points, with 4 to 8 points as low adherence, 9 to 12 points as fair adherence, and 13 to 16 points as high adherence. The training adherence rate was calculated as the percentage of the number of patients with high and fair adherence to the total number of patients.
- (4) Quality of life: The St George's Respiratory Questionnaire (SGRQ) was used to assess the quality of life of patients before and after training, covering three items, namely symptoms, activities and life impact, with a total of 50 items and a total score of 0–100, with higher scores indicating poorer quality of life <sup>[14]</sup>.

## 4. Results

### 4.1. Comparison of lung function-related indexes between the two groups

Before training, the differences between the FEV1, FVC, and FEV1/FVC values of the two groups of patients were not statistically significant ( $P > 0.05$ ) and were comparable. After the supervised pulmonary rehabilitation training in the home rehabilitation mode, the pulmonary function indexes of both groups improved compared with the pre-training period, and the degree of improvement of the observation group was significantly better than that of the control group ( $P < 0.05$ ). The results are shown in **Table 1**.



**Table 1.** Comparison of lung function-related indexes between the two groups

Group	Sample size	FEV1(L)		FVC(L)		FEV1/FVC(%)	
		Before training	After training	Before training	After training	Before training	After training
Observation group	45	1.52 ± 0.13	1.78 ± 0.20(1)	1.93 ± 0.15	2.18 ± 0.08(1)	78.76 ± 2.42	81.65 ± 3.87(1)
Control group	45	1.54 ± 0.14	1.69 ± 0.17(1)	1.95 ± 0.17	2.11 ± 0.13(1)	78.97 ± 2.59	80.09 ± 3.12(1)
<i>t</i>		0.702	2.300	0.592	3.076	0.397	2.105
<i>P</i>		0.484	0.024	0.556	0.003	0.692	0.038

Note: (1) $P < 0.05$  compared with the same group before training

## 4.2. Comparison of the degree of dyspnoea between the two groups

Before the training, the difference in the degree of dyspnoea between the two groups of patients was not statistically significant ( $P > 0.05$ ), and was similar at baseline. After the supervised pulmonary rehabilitation training in home rehabilitation mode, the degree of dyspnoea in both groups improved significantly compared with that before training, and the degree of dyspnoea in the observation group was significantly lower than that in the control group ( $P < 0.05$ ). The details are shown in **Table 2**.

**Table 2.** Comparison of dyspnea between the two groups [Example (%)]

Time	Group	Sample size	Level 0	Level 1	Level 2	Level 3	Level 4	u	P
Before training	Observation group	45	0(0.00)	5(11.11)	22(48.89)	10(22.22)	8(17.78)	1.160	0.246
	Control group	45	0(0.00)	7(15.56)	20(44.44)	11(24.44)	7(15.56)		
After training	Observation group	45	10(22.22)	34(75.56)	1(2.22)	0(0.00)	0(0.00)	4.245	< 0.001
	Control group	45	2(4.44)	25(55.56)	13(28.89)	5(11.11)	0(0.00)		

Note: Control group post-training vs. pre-training  $u = 4.394$ ,  $P < 0.001$ ; Observation group post-training vs. pre-training  $u = 7.396$ ,  $p < 0.001$

## 4.3. Comparison of training adherence between the two groups

Under the supervision of the family rehabilitation model, the training adherence rate of the observation group was 95.56%, which was significantly higher than that of the control group, which was 75.56% ( $P < 0.05$ ), as shown in **Table 3**.

**Table 3.** Comparison of training adherence between the two groups [cases (%)]

Group	Sample Size	Low compliance	Fairly good compliance	High compliance	Training compliance rate
Observation group	45	2(4.44)	13(28.89)	30(66.67)	43(95.56)
Control group	45	11(24.44)	19(42.22)	15(33.33)	34(75.56)
$\chi^2$					7.283
<i>P</i>					0.007

## 4.4. Comparison of the quality of life between the two groups

Before training, the difference between the St George's Respiratory Questionnaire (SGRQ) scores of the two groups of patients was not statistically significant ( $P > 0.05$ ) and was comparable. After the supervised pulmonary



rehabilitation training in the home rehabilitation mode, the quality of life of patients in both groups improved, as evidenced by a significant decrease in SGRQ scores compared with the pre-training period, and the scores of the observation group were significantly lower than those of the control group ( $P < 0.05$ ), as shown in **Table 4**.

**Table 4.** Comparison of quality of life between the two groups (points)

Group	Sample Size	Before training	After training
Observation group	45	81.67 ± 6.38	70.19 ± 5.36 <sup>(1)</sup>
Control group	45	80.52 ± 5.95	73.04 ± 6.82 <sup>(1)</sup>
<i>t</i>		0.884	2.204
<i>P</i>		0.379	0.030

Note: (1) Comparison with the same group before training  $P < 0.05$

## 5. Discussion

Bronchiectasis is a chronic inflammatory disease of the airways, and repeated infections lead to the destruction of airway structures and a continuous decline in lung function, which seriously affects the quality of life of patients. Pulmonary rehabilitation training, as an important part of non-pharmacological treatment, has been widely used in the rehabilitation of respiratory diseases. Pulmonary rehabilitation training in the traditional hospital setting is effective, but it is often difficult to achieve ideal results due to poor patient compliance and restricted training environment. In recent years, the home rehabilitation model has gradually gained attention because of its convenience and continuity<sup>[15]</sup>. Supervised pulmonary rehabilitation training, as a key part of home rehabilitation, significantly improves patient compliance through the dual supervision of family members and caregivers.

The results of this study showed that the patients in the observation group who received supervised pulmonary rehabilitation training under the home rehabilitation model had significantly better lung function indexes FEV1, FVC, and FEV1/FVC than those in the control group, indicating that the model had a positive effect on improving the patients' lung function. The improvement of dyspnoea degree was equally obvious, and the patients' subjective symptoms were relieved, and their quality of life was improved. In terms of adherence, the observation group reached 95.56%, which was significantly higher than the 75.56% of the control group, reflecting that home supervision can effectively promote patients' adherence to the training, and overcome the problems of insufficient motivation and non-standardized operation that existed in traditional training.

The training content includes lip-contraction breathing, active cyclic breathing, sputum expectoration training and aerobic exercise, all of which are suitable for carrying out in the home environment, simple and easy to learn, and convenient for patients to persist in the long term. Lip-contraction breathing helps relieve dyspnoea by lengthening expiratory time, reducing airway resistance, and improving alveolar ventilation; active circular breathing strengthens respiratory muscles and improves lung capacity; sputum expectoration training effectively removes airway secretions and prevents the recurrence of infections; and aerobic exercise strengthens cardiorespiratory endurance and promotes overall health. The supervision mechanism ensures the standardization and continuity of the training and improves the training effect through the continuous accompaniment of family members and the professional guidance of responsible nurses, using a combination of online and offline methods.

The family rehabilitation mode facilitates patients to integrate pulmonary rehabilitation training in their daily life, reduces the economic and time burden of frequent medical visits, and enhances patient satisfaction

and motivation. In terms of quality of life, the St George's Breathing Questionnaire scores of patients in the observation group decreased significantly, indicating that the training not only improved physiological function, but also promoted the recovery of mental health and social function. Relevant literature also supports that home-supervised pulmonary rehabilitation training is effective for patients with chronic respiratory diseases.

In conclusion, supervised pulmonary rehabilitation training in the home rehabilitation mode effectively improves the pulmonary function and quality of life of patients with bronchiectasis by enhancing adherence and training quality, which is worthy of clinical promotion and application. In the future, the construction of resources related to home rehabilitation should be strengthened, and the means of supervision should be optimized to promote more patients to benefit.

## 6. Conclusion

Supervised pulmonary rehabilitation training in the home rehabilitation mode can not only significantly improve lung function and dyspnoea in patients with bronchiectasis, but also effectively enhance patients' training compliance and quality of life. When pulmonary rehabilitation training is carried out alone without systematic family supervision, patient compliance is difficult to guarantee, and the rehabilitation effect is often unsatisfactory. Clinics should actively advocate and guide patients' family members to participate in the supervision process of rehabilitation training, through the continuous supervision and support of family members, which not only promotes patients' adherence to training, but also helps family members to deeply understand the content and importance of pulmonary rehabilitation care, thus enhancing the overall effect of rehabilitation. The present study has a limited sample size and geographical limitations, so the study can be expanded in the future to further validate the clinical effectiveness and promotion value of supervised pulmonary rehabilitation training under the family rehabilitation model.

## Disclosure statement

The authors declare no conflict of interest.

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# Impact of MBTI on Teaching Effectiveness in Internal Medicine Nursing: Teaching Performance, Teaching Quality, and Occupational Identity

Qingxia Yu, Shifeng Chen, Xiaofeng Hou, Mengyan Ma\*

Tianfu College of Southwestern University of Finance and Economics (SWUFE), Chengdu 610066, Sichuan, China

\*Author to whom correspondence should be addressed.

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**Abstract:** *Introduction:* This study examined the application of targeted education strategies for nursing students of different MBTI types to enhance students' theoretical and practical grades. Nursing students have different personalities, therefore learning behaviors are significantly different. It is worth exploring whether teaching methods influence these differences and can be improved through specific education strategies. *Methods:* Experimental research methods and Questionnaire survey methods were used to test the effect of MBTI with different personality types on the implementation of targeted education strategies. *Results:* There was a significant correlation between MBTI and teaching effect ( $p < 0.005$ ). Targeted changes in education strategies could effectively improve teaching effect ( $p < 0.005$ ), improve teaching quality ( $p < 0.005$ ), and improve nursing students' professional identity ( $p < 0.005$ ). *Conclusion:* The results showed that targeted changes in education strategies can effectively improve teaching effectiveness, teaching quality, and nursing students' sense of occupational identity.

**Keywords:** MBTI; Nursing students; Teaching effect; Nursing education

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## 1. Introduction

With the vigorous development of modern information technology, thousands of information content outbreaks, brought about by the awakening of self-consciousness of students in colleges, cognitive and decision-making abilities continue to improve, prompting the students of colleges on the education mode and teaching methods to build a set of unique self-knowledge and insights<sup>[1]</sup>. This phenomenon not only promotes the development of teachers' teaching ability but also highlights the importance of respecting the individual differences of college students to realize the importance of tailored teaching. However, previous studies have shown a long-term mismatch between students' and teachers' teaching styles, and it is not easy to achieve consistency in the development of the two<sup>[2]</sup>. Although the traditional teaching strategy of "teaching students according to their aptitude" has been advocated to improve the quality of teaching and learning for students in higher education, its

implementation as a stand-alone teaching strategy will lead to a thin presentation of teaching effects <sup>[3]</sup>.

Research and teaching are considered core requirements of medical education and continuing professional development <sup>[4]</sup>. The efficacy of pedagogical methods is pivotal in shaping the trajectory of medical personnel training. Numerous scholars have recognized that a comprehensive understanding of student's teaching requirements, facilitated by preparation, enables the development of personalized education strategies. Implementing these strategies within the educational process has enhanced teaching effectiveness <sup>[5]</sup>. A group of scholars, led by Edafe, has devised a novel clinical teaching methodology grounded in the FAIR principle (i.e. Feedback, Activity, Individuality, and Relevance). This innovative approach investigated the impact on students' clinical internship learning. The findings of this study indicated that an understanding of the teaching needs of one's peers can yield positive outcomes in the form of feedback, activity, and individual experiences.

MBTI Myers-Briggs Type Indicator (MBTI Myers-Briggs Type Indicator) is a personality type assessment tool widely used in career planning, education, and psychological counseling. The assessment of the content of the four dimensions of the eight endpoints, a total of 16 different personality types, is an essential indicator of the current understanding of individual behavioral differences <sup>[6]</sup>. This assessment tool can be used in the teaching and learning process to gather information about students in colleges, understand the basic cognition of students in colleges, make judgments based on cognition and other mental activities, and predict students' academic behavior and grades is possible by comprehensively understanding their personality traits <sup>[7, 8]</sup>. Li *et al.* have demonstrated a correlation between the various MBTI profiles of software engineering students and their programming styles, attitudes, and research personalities <sup>[9]</sup>. Internal medicine nursing is designed to develop college nursing students' professional competence, practical skills, and professionalism. It is an integral part of the medical and nursing disciplines and is a core course that lays the foundation for subsequent clinical nursing work. The contents and theories of the course are relatively abstract and complex, and the degree of mastery of students could be better. Internal medicine nursing is not only to strengthen the theoretical teaching of students but also to take into account the cultivation of students' practical ability, which has become a crucial and challenging point in the teaching process <sup>[10]</sup>. However, educators are only concerned with the improvement of students' professional competence in internal medicine nursing education. This teaching method, which prioritizes the dissemination of professional knowledge over students' individual learning needs, will ultimately result in suboptimal student development. Therefore, this study was conducted to investigate the relationship between MBTI and teaching effectiveness in internal medicine and to elucidate the impact of tailored teaching strategies on teaching effectiveness among both introverted and extroverted nursing students at our university.

## 2. Methods

### 2.1. Sample and setting

This study consists of two distinct research components, with consistent sample size control and preliminary screening criteria. However, the subsequent research methods differ, where the first part is a survey study, while the second part is an experimental study.

For the survey study, third-year undergraduate nursing students 178 in the university from August 2023 to January 2024 were selected as the study subjects, and the inclusion criteria were: (1) All of them were third-year nursing students; (2) Informed consent and voluntary participation in this study. Exclusion criteria: (1) Students who were absent during lectures, took leave, withdrew, and failed to complete the study as required. After that,



MBTI information was collected from the study participants, and no control group was set up. The data collected was used as agreed with those being studied.

For the experimental study, third-year undergraduate nursing students 171 in the college from February 2024 to June 2024 were selected as the study subjects, and the inclusion criteria were: (1) all of them were third-year nursing students; (2) informed consent and voluntary participation in this study. Exclusion criteria: students who were absent during lectures, took leave, withdrew, and failed to complete the study as required. After that, MBTI information was collected from the study subjects, and two classes were randomly selected as the control group and two as the experimental group. (3)The data collected was used as agreed with those being studied.

## 2.2. Research methodology

Both adopt the traditional theoretical teaching mode and case study practical teaching mode.

- (1) Theory teaching: According to the requirements of the internal medicine nursing syllabus, before the class by the teacher according to the teaching requirements of the production of heart failure courseware, the application of multimedia routine teaching, and finally by the teacher to summarize the teaching experience and Q&A, then to organize the students to complete the “questionnaire star” assessment of heart failure.
- (2) Practical training teaching: According to the requirements of the internal medicine nursing syllabus. Before the class, the teacher will make the courseware on respiratory failure according to the teaching requirements, apply multimedia to guide the students to discuss the cases, determine the diagnosis of the disease according to the information of the cases, and put forward the corresponding nursing measures, then organize the students to complete the examination of respiratory failure through the “questionnaire star.”

The control group adopted the traditional theoretical and case study practical training teaching modes. The experimental group adopts the theoretical teaching mode of “Mind map + BOPPPS”: students are guided to learn about leukemia and complete the mind map drawing before the class. Students were guided to learn about leukemia and complete the mind map drawing before the class. Before the course, they completed the pre-course test based on their self-understanding of leukemia knowledge points; during the course, teachers produced leukemia courseware according to teaching requirements and conducted real-time assessment tests during the course; and at the end of the course, they summarized the course and completed the post-course test.

According to the average score of the three assessment results as one of the standards for testing teaching results, the experimental group adopts a “Progressive case study” practical training teaching mode. Before the class, the teacher will make endocrine courseware according to the teaching requirements. According to the different episodes of the patient’s progressive storyline for the question and answer competition, the correct answer group can get points and part of the patient’s case information. Ultimately, according to the case information obtained for the organization of the discussion, the first group to come up with a diagnosis of the disease won. The total number of points earned by each group was used as one of the criteria to test the teaching results.

In addition, an occupational identity questionnaire was distributed to both groups of students at the end of the course to understand the change in the Occupational identity of the nursing students, as well as a feedback questionnaire on the quality of teaching and learning to understand the level of satisfaction with the change in education strategies.

## 2.3. Statistical methods

Data were analyzed with the help of SPSS 23.0 software, using descriptive information, independent samples t-test, and correlation analyses, and differences were considered statistically significant at  $P < 0.05$ .



### 3. Results

Based on the 16 MBTI personality types, this study mainly categorized the nursing student group into the well-known introvert (I) and extrovert (E) categories. It was found that introverted (I) nursing students had a higher theoretical mean score compared to extroverted (E) nursing students and were more adept at applying theoretical knowledge (**Table 1**), while extroverted (E) nursing students had a higher practical training mean score compared to introverted (I) nursing students (**Table 2**).

**Table 1.** Appraisal of introverted (I) nursing students analysis.

Appraisal project		n	%	M ± SD
Theoretical grades	66–70	3	3%	90.32 ± 6.54
	81–85	17	20%	
	86–90	25	29%	
	91–95	24	28%	
	96–100	17	20%	
Total		86	100%	
Practical grades	66–70	1	1%	86.1 ± 8.55
	71–75	8	9%	
	76–80	17	20%	
	81–85	33	38%	
	86–90	4	5%	
	91–95	4	5%	
	96–100	19	22%	
Total		86	100%	

**Table 2.** Appraisal of extroverted (E) nursing students analysis.

Appraisal project		n	%	M ± SD
Theoretical grades	66–70	2	2%	83.72 ± 5.05
	71–75	4	4%	
	71–80	1	1%	
	76–80	13	14%	
	81–85	50	55%	
	86–90	15	16%	
	91–95	6	7%	
	96–100	1	1%	
	81–85	6	7%	
	86–90	16	17%	94.02 ± 5.27
	91–95	31	34%	
	96–100	37	40%	
Total		92	100%	
Practical grades	76–80	2	2%	

Therefore, this study analyzed the correlation between MBTI and assessment scores in linear regression and found that (**Table 3**) there was a significant correlation between theory assessment scores, practical training assessment scores, and different personality types ( $p < 0.005$ )

**Table 3.** Comparison of differences between different types of MBTI students and each of the test items.

Variable	MBTI( $\bar{X} \pm SD$ )		<i>t</i>	<i>p</i>
	I( $\bar{X} \pm SD$ )	E( $\bar{X} \pm SD$ )		
Theoretical grades	90.320 $\pm$ 6.539	83.723 $\pm$ 5.048	7.497	0.001
Practical grades	86.105 $\pm$ 8.554	94.022 $\pm$ 5.267	-7.375	0.001

\* $P < 0.05$ , \*\* $P < 0.01$

To further understand the specific effects of different MBTIs and performance on teaching assessment an independent samples t-test was conducted on the theory and practical training scores between introverted (I) and extroverted (E) nursing students, and it was found that there was a significant difference between the theory scores and practical training scores for the different types of MBTI. In theory assessment scores (**Table 4**), introverted (I) nursing students (  $\bar{X} = 83.723$ ,  $SD = 5.048$  ) had a better presentation of teaching and learning outcomes than extroverted (E) (  $\bar{X} = 90.320$ ,  $SD = 6.539$  ),  $t = 7.497$ ,  $p = 0.001 < 0.01$ . In practical assessment scores (**Table 5**), compared to introverted (I) nursing students (  $\bar{X} = 86.105$ ,  $SD = 8.554$  ), the Extroverted (E) nursing students (  $\bar{X} = 94.022$ ,  $SD = 5.267$  ) will have a better presentation of teaching results,  $t = -7.375$ ,  $P = 0.001 < 0.01$ .

**Table 4.** Correlation analysis between different types of MBTI students and theoretical grades.

	Unstandardized coefficients		Standardized coefficients	<i>t</i>	<i>p</i>
	B	SE	Beta		
	90.32	0.627		144.011	.001
MBTI	-6.597	0.872	-0.495	-7.562	.001

a. Dependent variable: Theoretical grades

\* $P < 0.05$ , \*\* $P < 0.01$

**Table 5.** Correlation analysis between different types of MBTI students and practical grades.

	Unstandardized coefficients		Standardized coefficients	<i>t</i>	<i>p</i>
	B	SE	Beta		
	94.022	0.735		127.941	.001
MBTI	-7.917	1.057	-0.492	-7.488	.001

a. Dependent variable: Practical grades

\* $P < 0.05$ , \*\* $P < 0.01$

Based on the above findings, the internal medicine course team, in the subsequent reflection on teaching work, suggested that the teaching effect affected by different types of MBTI could be improved by changing the intervention of education strategies and that the correlation model between “personality type, education strategies, and teaching effect” could be established.

A comparison is to be made of the results obtained by two groups of students in each assessment. In the theoretical grades (**Table 6**), the introvert (I) nursing students in the control group had an assessment score of ( $79.3 \pm 14.963$ ) and the introvert (I) nursing students in the experimental group had an assessment score of ( $81.62 \pm 8.599$ ), with no statistically significant difference ( $P = 0.405 > 0.05$ ); the extrovert (E) nursing students in the control group had an assessment score of ( $79.95 \pm 9.063$ ) and the extrovert (E) nursing students' assessment scores were ( $85.52 \pm 6.96$ ). The difference was statistically significant ( $P = 0.002 < 0.05$ ).

**Table 6.** Comparison of theoretical grades scores of different types of MBTI in control and experimental groups.

Variable	Group	X $\pm$ SD	t	p
Introvert nursing students	CG(n=37)	79.3 $\pm$ 14.963	-0.840	0.405
	EG(n=47)	81.62 $\pm$ 8.599		
Extrovert nursing students	CG(n=43)	79.95 $\pm$ 9.063	-3.219	0.002
	EG(n=44)	85.52 $\pm$ 6.960		

\* $P < 0.05$  \*\* $P < 0.01$

In the practical grades (**Table 7**), the assessment results of introverted (I) nursing students in the control group were ( $68.59 \pm 4.14$ ), and those of introverted (I) nursing students in the experimental group were ( $75.64 \pm 3.626$ ), and the differences were statistically significant ( $P = 0.001 < 0.05$ ); the assessment results of extroverted (E) nursing students in the control group were ( $72.53 \pm 2.658$ ), and those of extroverted (E) nursing students' assessment scores were ( $74.43 \pm 3.914$ ), and the difference was statistically significant ( $P = 0.010 < 0.05$ ).

**Table 7.** Comparison of practical grades scores of different types of MBTI in control and experimental groups.

Variable	Group	X $\pm$ SD	t	p
Introvert nursing students	CG(n=37)	68.59 $\pm$ 4.14	-8.303	0.001
	EG(n=47)	75.64 $\pm$ 3.626		
Extrovert nursing students	CG(n=43)	72.53 $\pm$ 2.658	-2.650	0.010
	EG(n=44)	74.43 $\pm$ 3.914		

\* $P < 0.05$  \*\* $P < 0.01$

In the theoretical achievement, the theoretical teaching under the implementation of the “Mind map+ BOPPPS” teaching mode can effectively improve the theoretical achievement of the extroverted (E) nursing students. However, the theoretical achievement of the introvert (I) nursing students did not show a significant difference in the change, but it can also improve the theoretical teaching achievement of the introvert (I) nursing students; in the practical training achievement, the implementation of the “Progressive case study” teaching mode can effectively improve the theoretical achievement of the E people. Implementing the “Progressive case study” teaching model of practical training can significantly improve the practical training performance of people I and E, and there is a significant difference.

Based on the questionnaire on teaching quality and occupational identity, in the feedback of teaching quality (**Table 8**), the score of the control group was ( $90.06 \pm 17.511$ ), and the score of the experimental group was ( $95.55$

$\pm 10.553$ ), and the difference was not statistically significant ( $P = 0.016 > 0.005$ ). In the score of Occupational identity (**Table 9**), the score of the control group was ( $33.58 \pm 5.509$ ), and the score of the experimental group was ( $37.18 \pm 5.425$ ), the difference is statistically significant ( $P = 0.000 < 0.005$ ). Based on the analysis of MBTI personality type, the implementation of targeted education strategies can significantly improve the nursing students' sense of identity for the nursing profession, and enhance the cognitive orientation of the self-professional; similarly, to a certain extent, it can improve the satisfaction of the nursing students with the quality of teaching, and enhance the interest of the course.

**Table 8.** Teaching quality feedback questionnaire scores.

Group	X $\pm$ SD	<i>t</i>	<i>p</i>
CG(n=80)	90.06 $\pm$ 17.511	-2.440	0.016
EG(n=91)	95.55 $\pm$ 10.553		

\* $P < 0.05$  \*\* $P < 0.01$

**Table 9.** Occupational identity questionnaire scores.

Group	X $\pm$ SD	<i>t</i>	<i>p</i>
CG(n=80)	33.58 $\pm$ 5.509	-4.299	0.000
EG(n=91)	37.18 $\pm$ 5.425		

\* $P < 0.05$  \*\* $P < 0.01$

## 4. Discussion

### 4.1. Different personality types of students present different instructional results

The above results show that students with introverted (I) and extroverted (E) personality types performed differently in theory and practical training scores. They can be the key factors affecting the study of internal medicine, and there is a significant correlation between them and internal medicine scores. This performance may be related to differences in learning styles, learning interests, and behaviors due to personality differences <sup>[11]</sup>. This study's results are consistent with Kim's findings that non-cognitive factors, such as learners' personalities are significantly associated with postgraduate dental students' academic achievement and clinical performance <sup>[12]</sup>. Similarly, Li's findings suggest significant learning differences between academic achievement and MBT and that educators can adjust curriculum design and teaching style to help students with different MBTIs adapt to the teaching and learning process <sup>[13]</sup>. Therefore, there are limitations in the correlation between learners' major cognitive factors, personality factors, and college teaching outcomes in the traditional education model <sup>[14]</sup>. Also indicates that there is a demand for differentiated learning modes for students with different personality types and preferences and that the design of education strategies based on the MBTI perspective can break through the teaching law of "there is a way to teach, but there is no definite way."

### 4.2. Optimizing theoretical teaching models improves systematic knowledge presentation

Students with an extrovert (E) preference have a positive attitude toward learning, love to study exciting content, are highly practical, and often come up with innovative ideas. However, these students have weak learning

habits, are often weak in the reception of stereotypical and rigid theoretical knowledge, and need more systematic knowledge organization. The application of the “Mind Map + BOPPPS” theoretical teaching mode for students with extrovert (E) preference is to organize and preview the knowledge points in the form of a “Mind Map” before class and activate the original knowledge and demonstrate the new knowledge in class. During the lesson, students activate the original knowledge, demonstrate the new knowledge, try to apply the practice, and integrate the knowledge in a continuous cycle, to improve the students’ active learning ability. Their ability to understand and master the content and organize the content systematically <sup>[15]</sup>. The results of the above studies also show that this teaching mode can significantly improve the theoretical performance of this type of student group, and meeting students’ basic psychological needs creates positive attitudes towards teaching and learning and promotes constructive teacher-student relationships in the teaching and learning process, with far-reaching effects on students’ approaches to self-learning <sup>[16]</sup>.

Therefore, in the face of students with extroversion (E) preference, teachers need to develop diversified teaching thematic activities in the teaching process to stimulate learning interest and realize all-round, multi-faceted, and systematic knowledge sorting in the teaching process, to exercise their ability to pay attention to the theme and to cultivate their ability to think logically.

### **4.3. Optimizing the practical training model improves teaching motivation**

Students with an introverted (I) preference are more independent in their learning, more inclined to self-exploratory learning, often set up unique learning methods for themselves, and have strong independent judgment and the ability to think and analyze problems. However, these students are weak in divergent thinking due to their established learning patterns. The application of “Progressive case study” practical training teaching mode for students with introverted (I) preference, through the group combined with the case storyline progressive scenario mode practical training, inspires nursing students to discover problems and solve problems layer by layer, promote nursing students to feel the actual clinical work atmosphere, better realize the theory link to practice, improve the learning effect, to cultivate nursing students’ independent learning ability and improve their ability to think and analyzing. Learning effect: To cultivate nursing students’ independent learning abilities, nursing students need evidence-based thinking and critical thinking <sup>[17]</sup>. The results of the above studies also show that this teaching mode can significantly improve the practical training performance of this type of student group. Therefore, teachers can adopt exploratory topics or challenging knowledge points to guide students with introverted (I) preferences to think differently to improve the traditional linear thinking mode.

## **5. Conclusion**

In this study, introverted (I) and extroverted (E) students were chosen as the research subjects, explored their performance in internal medicine, and found that different personality types existed in different students had a certain influence on the teaching effect and the influence also appeared that there was a differentiated learning mode of the individual students’ demands. The emergence of this “demand” also warns teachers how to realize the change of education strategies in the process of teaching to meet the student’s learning demands and improve the effectiveness of teaching. Although the MBTI is an effective intermediary tool for teachers to understand students and realize the differentiated learning needs of different students, the MBTI test assessment has a certain time limit and a particular stage. For the subsequent long-term teaching process, how to design education strategies to

meet the individual teaching needs of nursing students to stimulate the learning interest of each nursing student to promote the cultivation of high-quality nursing talents in colleges is an area that needs to be continuously explored and intensely cultivated.

## Disclosure statement

The author declares no conflict of interest.

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# Research Progress of Traditional Chinese Medicine in Treating Limb Movement Disorders after Stroke

Zhiguang Song<sup>1,2</sup>, Wanghua Liu<sup>1,2\*</sup>

<sup>1</sup>Hunan University of Chinese Medicine, Changsha 410208, Hunan, China

<sup>2</sup>Key Laboratory of TCM Diagnostics of Hunan Province, Changsha 410208, Hunan, China

\*Corresponding author: Wanghua Liu, 003439@hmucm.edu.cn

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**Abstract:** Limb movement disorder after stroke is one of the main causes of disability, seriously affecting patients' quality of life. Although modern medical treatment can alleviate some symptoms, it has limitations. Traditional Chinese medicine, with an overall perspective and syndrome differentiation and treatment as its core, intervenes in the disease through various therapies, such as acupuncture, Chinese herbal medicine, Tuina massage, and traditional exercise, demonstrating unique advantages. This article reviews the understanding of the etiology and pathogenesis of limb movement disorders after stroke in traditional Chinese medicine, systematically summarizes the clinical application and research progress of main treatment methods such as acupuncture, Chinese herbal medicine, and Tuina massage, analyzes the problems existing in current research, and looks forward to future development directions, aiming to provide references for clinical treatment.

**Keywords:** Stroke; Limb movement disorder; Traditional Chinese medicine treatment; Acupuncture; Chinese herbal medicine; Tuina massage; Rehabilitation

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## 1. Introduction

Stroke is a neurological disease characterized by high incidence, high disability rate, and high recurrence rate <sup>[1]</sup>. Among them, ischemic stroke accounts for 70% to 80%. However, 70% to 80% of the surviving patients have limb movement disorders, mainly manifested as hemiplegia, muscle weakness, muscle spasms, coordination disorders, etc., which seriously affect the patients' self-care ability and also adversely affect the healthy development of their families and society <sup>[2]</sup>. Currently, clinical methods mainly include rehabilitation training (Bobath technique, Brunnstrom staging training), neurotrophic drugs (butylphthalide, citicoline), and surgical correction. However, these methods often have problems such as long rehabilitation periods, poor efficacy for some patients, and significant drug side effects <sup>[3]</sup>. Traditional Chinese medicine has a thousand-year-old tradition in treating stroke. Its

“holistic regulation, syndrome differentiation and treatment” philosophy and “multi-target” intervention approach have significant advantages in improving limb function and quality of life. In recent years, with the continuous deepening of research on the integration of traditional Chinese and Western medicine, traditional Chinese medicine therapies have been further developed and improved clinically, and their mechanisms of action have gradually been understood. This article aims to systematically review the research progress of traditional Chinese medicine in treating limb movement disorders after stroke, providing references for clinical practice and scientific research.

## **2. Understanding of limb movement disorder after stroke in traditional Chinese medicine**

Although traditional Chinese medicine does not have a specific term for “stroke”, based on its clinical manifestations, the disease falls under categories such as “stroke,” “hemiplegia,” and “paralysis syndrome”. Traditional Chinese medicine’s understanding of this disease can be traced back to the pre-Qin period, and over two thousand years of theoretical refinement and clinical practice have formed a systematic diagnosis and treatment system.

### **2.1. Origin of the disease name**

The concept of “stroke” was first proposed in the “Yellow Emperor’s Inner Canon”. The “Plain Questions: Regulating the Menstrual Cycle” records: “When blood and Qi rise upward together, it causes great syncope. Syncope leads to sudden death. If Qi returns, the person revives; if not, the person dies.” This describes the critical manifestations of stroke in the acute phase. The “Miraculous Pivot: Needling Jie and Eliminating Pathogenic Factors” mentions, “When Xie Qi attacks one side of the body, it penetrates deeply and resides in the Ying and Wei vessels. When the Ying and Wei vessels weaken, genuine Qi departs, and pathogenic Qi remains, causing hemiplegia.” This clarifies that “hemiplegia” (limb paralysis) is the main sequelae of stroke. In the Eastern Han Dynasty, Zhang Zhongjing further elaborated in the “Synopsis of Golden Chamber: Classification and Treatment of Stroke and Arthralgia Syndrome” that “When wind causes disease, it often leads to hemiplegia, or sometimes only paralysis of the arm. This is called Bi syndrome. The pulse is weak and rapid, which is caused by stroke.” This closely associates limb movement disorders with “wind pathogenic factors”<sup>[4]</sup>.

### **2.2. Etiology and pathogenesis**

Traditional Chinese medicine believes that the core pathogenesis of post-stroke limb movement disorders is “Qi and blood disorder, cerebral vessel obstruction or blood overflow in the cerebral vessels, damage to the brain and nerves, and malnutrition of the limbs”. Specifically, it can be summarized as follows:

- (1) The influence of wind: External wind invasion or internal wind (liver Yang transforming into wind, Yin deficiency, and wind movement) disturbance can lead to Qi and blood disorder and cerebral vessel imbalance<sup>[5]</sup>.
- (2) Interaction of phlegm and blood stasis: Improper diet can lead to endogenous phlegm dampness, or Qi deficiency and inability to move blood can lead to blood stasis blockage. Phlegm and blood stasis block cerebral vessels, causing malnutrition of the limbs.
- (3) Deficiency of healthy Qi: Aging and long-term illness consume Qi. Qi deficiency leads to weakness in promotion, poor blood circulation, and ultimately “Qi deficiency and blood stasis”. This is a common pathogenesis during the recovery phase.

- (4) Liver and kidney deficiency: Liver and kidney Yin deficiency leads to Yin failing to control Yang, Yang hyperactivity transforming into wind, and at the same time, tendons and bones are malnourished, aggravating limb weakness <sup>[6]</sup>.

## **2.3. Deepening understanding of modern traditional Chinese medicine**

With the advancement of integrated traditional Chinese and Western medicine research, the understanding of traditional Chinese medicine (TCM) regarding certain diseases has gradually aligned with modern medicine. For example, through imaging observations, it has been found that patients with “Qi deficiency and blood stasis syndrome” in TCM often exhibit symptoms such as low cerebral perfusion and leukoaraiosis. The “wind-phlegm obstructing collaterals syndrome” is frequently associated with abnormalities in blood lipids and increased inflammatory factors (such as IL-6 and TNF- $\alpha$ ). This combined approach of “syndrome differentiation and disease differentiation” provides a more precise theoretical basis for TCM treatment.

## **3. Main therapies**

### **3.1. Acupuncture therapy**

Acupuncture, by stimulating acupoints to regulate the Qi and blood of the meridians, promotes blood circulation in the brain and the normal operation of the nervous system. It is an important clinical treatment method in traditional Chinese medicine <sup>[7, 8]</sup>.

#### **3.1.1. Body acupuncture therapy**

Body acupuncture focuses on the principle of “dredging meridians, activating collaterals, nourishing Qi, and promoting blood circulation”. The selection of acupoints mainly focuses on the Yangming meridians of the hands and feet (because “treating flaccidity requires focusing on the Yangming meridians”), combined with the Governor Meridian and local acupoints <sup>[9]</sup>. Commonly used acupoints include Jianyu, Quchi, Shousanli, Waiguan, and Hegu for the upper limbs; Huantiao, Zusanli, Yanglingquan, Sanyinjiao, and Taichong for the lower limbs; and Baihui, Fengchi, Shuigou for the head and face. Modifications based on symptoms include adding Guanyuan and Qihai for Qi deficiency and blood stasis, and adding Fenglong and Fengfu for wind-phlegm obstructing the meridians.

Special acupuncture techniques include:

- (1) Xingnaokaiqiao acupuncture (created by Academician Shi Xuemin): This technique uses Shuigou, Neiguan, and Sanyinjiao as the core acupoints, employing the techniques of “reducing Shuigou, reinforcing Neiguan, and reinforcing Sanyinjiao” to awaken the mind, open the orifices, and dredge the meridians <sup>[9]</sup>.
- (2) Balanced acupuncture: This method selects remote acupoints such as “shoulder pain point” and “knee pain point”, and regulates limb function through nerve reflexes. It is suitable for patients in the spasticity phase and can reduce the Modified Ashworth Spasticity Scale (MAS) score.
- (3) Tongdu Diaoshen acupuncture: This technique involves acupuncture at acupoints on the Governor Meridian such as Dazhui and Mingmen, regulating spinal nerve conduction and improving limb coordination <sup>[10]</sup>.

#### **3.1.2. Scalp acupuncture therapy**

Scalp acupuncture is based on the theory of “correspondence between scalp stimulation areas and brain functional areas” and directly targets brain-derived movement disorders, featuring strong targeting.

Commonly used stimulation areas include the motor area (located in the projection area of the precentral gyrus), the sensory area (the projection area of the postcentral gyrus), and the balance area (the projection area of the cerebellum). Specifically, the upper 1/5 of the motor area is used to treat lower limb movement disorders, while the middle 2/5 is for upper limb movement disorders.

During the procedure, the needle is quickly advanced under the galea aponeurotica using the “air extraction method”. The needle is twisted at a frequency of 200 times per minute, continuously applied for 1–2 minutes, and left in place for 30 minutes each time, with 2–3 sessions of needle manipulation. Scalp acupuncture is often combined with body acupuncture. Studies have shown that, compared to individual treatments, the combination can significantly improve FMA scores and increase intracerebral blood flow<sup>[11]</sup>.

### 3.1.3. Other acupuncture-related therapies

#### (1) Electroacupuncture

Based on body acupuncture or scalp acupuncture, an electroacupuncture device is connected. The use of sparse-dense waves (2/100Hz) can alleviate muscle spasms, while continuous waves (50Hz) can enhance muscle strength, especially suitable for patients with muscle strength  $\leq 3$ .

#### (2) Moxibustion

Warm acupuncture and moxibustion (placing moxa sticks at the end of the needle after acupuncture) or moxibustion at acupoints such as Zusanli and Guanyuan with ginger in between, mainly to warm Yang and nourish Qi, is suitable for treating Qi deficiency and blood stasis syndrome, and can effectively alleviate symptoms such as cold limbs and fatigue.

#### (3) Blood-letting puncture and cupping therapy

Pricking bloodletting at Jianjing and Weizhong points, followed by cupping therapy, can promote blood circulation, remove blood stasis, dredge meridians, and relieve pain, thus alleviating limb pain during spasms.

## 3.2. Traditional Chinese medicine therapy

Traditional Chinese medicine follows the basic principle of “syndrome differentiation and treatment”, and achieves the goal of regulating the body’s Qi and blood and accelerating the recovery of nerve function after injury through the compatibility of multiple medicinal herbs.

### 3.2.1. Oral administration of Chinese medicine

#### (1) Classical prescriptions

“Buyang Huanwu Decoction” (Astragalus, Angelica, Red Peony, Earthworm, etc.) has the effect of inhibiting platelet aggregation, reducing blood viscosity, and increasing the level of brain-derived neurotrophic factor (BDNF), thus accelerating nerve repair. This prescription is the preferred choice for patients with Qi deficiency and blood stasis syndrome. A multi-center clinical study has shown that this prescription, combined with rehabilitation training, can promote the rapid recovery of patients’ limb movement ability and improve the damage of nerve function<sup>[12]</sup>. “Zhengan Xifeng Decoction” (Achyranthes Bidentata, Hematite, Dragon Bone, etc.) is suitable for patients with hyperactivity of liver-yang, which can lower blood pressure, reduce cerebral edema, and improve limb tremor and spasms; “Banxia Baizhu Tianma Decoction” (*Pinellia*, *Atractylodes*, *Gastrodia*, etc.) has the effects of reducing lipids and anti-inflammatory, which can improve symptoms such as heavy limbs and difficulty in moving.



This prescription is mainly targeted at wind-phlegm obstructing collaterals syndrome<sup>[13]</sup>.

(2) Modern preparations

“Naoxintong Capsule” (*Astragalus*, *Salviae Miltiorrhizae*, Safflower, etc.) is commonly used in the recovery phase clinically, which can improve cerebral microcirculation and reduce the recurrence rate; “Tongxinluo Capsule” (Ginseng, Leech, Scorpion, etc.) can improve limb ischemia by protecting vascular endothelial function and promoting the establishment of collateral circulation<sup>[14]</sup>.

### 3.2.2. External application of Chinese medicinal herbs

- (1) Fumigation and washing therapy: Use herbs such as Shenjin Cao (*Herba Lycopodii*), Tougu Cao (*Speranskia tuberculata*), Hong Hua (*Flos Carthami*), and Ai Ye (*Folium Artemisiae Argyi*) to make a decoction for fumigating and washing the affected limb. Through the dual effects of warmth and medication, it can improve local circulation, relieve muscle adhesion, and is especially suitable for patients with shoulder-hand syndrome.
- (2) Acupoint application: Make a plaster with herbs such as She Xiang (Moschus), Ru Xiang (Olibanum), and Mo Yao (Myrrha), and apply it to acupoints such as Quchi and Zusanli. This can promote blood circulation and dredge meridians through transdermal absorption<sup>[15]</sup>.
- (3) Chinese medicine iontophoresis: Use direct current to introduce medicinal liquids such as Dan Shen (*Radix Salviae Miltiorrhizae*) and Huang Qi (*Radix Astragali*) into the affected limb, which can increase local drug concentration and enhance the therapeutic effect.

### 3.3. Tuina and massage therapy

Tuina achieves the purpose of dredging meridians, relaxing muscles, and improving limb movement ability through manipulation on the body surface, especially suitable for patients with spasmodic seizures and convalescence<sup>[16]</sup>. Rubbing, pinching, and rolling techniques are used to relieve muscle spasms around joints such as shoulders, elbows, and knees; acupoint pressing methods (such as pressing and rubbing Quchi, Zusanli, etc.), passive joint activities (such as shoulder joint abduction, ankle dorsiflexion) promote the recovery of joint range of motion; for deformities such as foot drop and elbow flexion, use levering and stretching methods to adjust the force line. It should be noted that during the spasm phase, attention should be paid to the technique when performing Tuina, which should be gentle to avoid muscle spasms; during the recovery phase, the intensity can be increased, and active exercise should be performed at the same time.

### 3.4. Traditional exercise therapy

Traditional exercises, characterized by the integration of movement and stillness, improve physical coordination and balance through the adjustment of body posture, breathing, and mindset, making them suitable for long-term rehabilitation. Tai Chi, with its core principles of “slowness, continuity, and circularity,” enhances lower limb balance through weight-shifting exercises. Studies have confirmed that practicing Tai Chi three times a week (30 minutes per session) can reduce the risk of falls for patients<sup>[17]</sup>. The Eight-Section Brocade, with movements such as “Lifting Hands to Regulate the Triple Warmer” and “Shooting Arrows Like an Archer,” can strengthen shoulder and arm muscles and improve upper limb function<sup>[18]</sup>. Yi Jin Jing emphasizes “stretching the bones and muscles” and alleviates muscle adhesion and increases limb flexibility through movements like “Wei Tuo Offers the Pestle” and “Nine Demons Pull the Horse’s Blade.” Traditional exercises are often combined with modern rehabilitation



training to form an “integrative rehabilitation program of traditional Chinese and Western medicine.” For instance, the integration of Tai Chi and Bobath techniques can significantly improve patients’ walking ability <sup>[19]</sup>.

## 4. Conclusion

Traditional Chinese Medicine (TCM) has demonstrated multiple advantages in treating post-stroke limb motor dysfunction, including diverse treatment methods, definite therapeutic effects, and minimal side effects. Its core mechanism involves multi-target interventions to improve cerebral circulation, promote neural repair, and regulate muscle function <sup>[20, 21]</sup>. Currently, therapies such as acupuncture and Buyang Huanwu Decoction have been included in various clinical guidelines and have become important approaches in integrated traditional Chinese and Western medicine rehabilitation. However, current research still has several shortcomings: first, most clinical studies are small-scale and single-center designs, lacking large-sample randomized controlled trials (RCTs) for validation; second, efficacy evaluations predominantly rely on scale scores and lack objective biological markers (such as neuroimaging or molecular biomarkers); third, treatment protocols lack standardization, including inconsistent selection of acupuncture points and varying intensities of manual therapies, which affects the comparability of results. Future research should focus on three aspects: first, conducting high-quality RCT studies to establish evidence-based support for TCM treatments; second, integrating molecular biology and neuroimaging technologies to elucidate the scientific connotation of TCM’s “syndrome differentiation and treatment”; third, developing standardized treatment protocols to promote the standardization and internationalization of TCM rehabilitation. With further research, TCM is expected to play a more significant role in the treatment of post-stroke limb motor dysfunction, providing patients with better rehabilitation options.

## Disclosure statement

The authors declare no conflict of interest.

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# Investigation and Analysis of Humanistic Care Experience and Influencing Factors of Elderly Residents in Integrated Medical and Nursing Institutions

Mingli Zhang, Juan Zheng, Ji Zhou, Qinghua Pen, Huijun Gou\*

Guangyuan Hospital of Traditional Chinese Medicine, Guangyuan628000, Sichuan, China

*\*Author to whom correspondence should be addressed.*

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**Abstract:** This empirical study examines the integration of medical and elderly care services in Guangyuan City through stratified random sampling, targeting 283 eligible residents aged 60+ from three representative integrated institutions. The research employed a self-designed questionnaire titled “Humanistic Care Experience and Demand Influencing Factors” to collect subjective perceptions regarding basic care, psychological support, health education, and social interaction using a Likert five-point scale. Descriptive statistics, one-way ANOVA, and multiple regression modeling were conducted with SPSS 25.0 software. Results indicated that overall humanistic care experience scores were moderately high, with the “caregiving” dimension scoring highest and “psychological/social support” the lowest. Analysis revealed significant correlations between educational attainment, income, self-reported health status, and family support frequency ( $P < 0.001$ ), particularly among seniors with higher education, better health, and stronger family support. While integrated care facilities provide relatively comprehensive basic care, they should focus on addressing gaps in humanistic services, especially providing targeted support for groups with “low education, low income, poor health, and lack of family support.”

**Keywords:** Medical and nursing integration; Elderly residents; Humanistic care; Influencing factors

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## 1. Introduction

Against the backdrop of China’s “Healthy China” strategy and intensifying aging trends, the integration of medical and elderly care services is rapidly advancing. This model aims to consolidate healthcare and senior care resources, achieving seamless coordination between daily living support and health management for seniors. However, some integrated care facilities currently overemphasize medical functions and daily care while neglecting the core dimension of humanistic care. This issue becomes particularly pronounced in Guangyuan

City, where population aging has reached alarming levels. According to the Seventh National Population Census data, Guangyuan's population aged 60 and above accounts for 24.5%, significantly higher than the national average. Beyond basic medical coverage and living assistance, this demographic increasingly demands emotional comfort, social interaction, and dignity preservation during their retirement years. Although policies emphasizing humanistic care systems continue to be introduced, practical implementation still lacks data-driven insights into seniors' actual experiences. Through a combination of quantitative surveys and qualitative interviews, this study systematically evaluates the humanistic care experiences and demand gaps among residents in integrated care institutions, exploring underlying influencing mechanisms. The findings provide empirical support and policy recommendations for optimizing elderly care strategies in Guangyuan City and Sichuan Province.

## **2. Survey methods and tools**

### **2.1. Subject Investigated**

This study employed stratified random sampling to select three representative integrated medical and elderly care institutions in Guangyuan City, with 283 residents aged 60 and above as survey subjects. Inclusion criteria included age, self-care ability, normal cognitive function, and informed consent. Participants were excluded from those with severe cognitive impairment or mental disorders to ensure their capacity for complete expression of personal experiences and needs.

### **2.2. Investigation method**

The questionnaire was developed using a self-compiled version of the "Survey on Humanistic Care Experiences and Influencing Factors for Elderly Residents in Integrated Medical and Elderly Care Institutions", incorporating elements from Wang Yang's "Humanistic Care Needs Questionnaire for Inpatients" and relevant literature. The questionnaire consists of 32 items across four dimensions: basic information, nursing care needs, psychosocial support, and health education. Using the Likert 5-point scale, it demonstrates excellent reliability with a Cronbach's  $\alpha$  coefficient of 0.82, indicating strong validity and consistency.

### **2.3. Data collection and statistical methods**

The questionnaire was distributed and interview guidance were conducted by professionals who had received unified training. The data were entered by two people and imported into SPSS 25.0 software. Descriptive statistics, factor analysis, Pearson correlation coefficient, and multiple regression modeling methods were used to identify significant variables affecting the score of humanistic care experience and establish a prediction model.

## **3. Results**

### **3.1. Overall situation of humanistic care experience**

A questionnaire survey of 283 elderly residents at three integrated medical and nursing institutions in Guangyuan City revealed that while the overall level of humanistic care experiences was moderately high, significant differences existed across dimensions. Most seniors generally acknowledged basic care and daily support, but showed notable gaps in emotional comfort, respectful communication, and personalized interaction. Particularly, those living alone, with lower educational attainment, or facing financial constraints scored significantly lower in

perceived humanistic care satisfaction, indicating substantial room for improvement in institutional care details and service depth. This study quantified four key dimensions of humanistic care using a Likert five-point scale, with statistical results presented in **Table 1** below.

**Table 1.** Overall experience of humanistic care (n = 283)

Order number	Dimension name	Number of projects (items)	Mean score $\pm$ Standard deviation (score)	Full marks (out of 100)	Scoring average (%)
1	Respect basic care needs	8	33.4 $\pm$ 5.6	40	83.50%
2	Care and assistance with daily life	10	41.8 $\pm$ 6.2	50	83.60%
3	Health education and information support	6	23.9 $\pm$ 4.3	30	79.70%
4	Psychological and social support needs	8	28.1 $\pm$ 6.8	40	70.30%
	total points	32	127.2 $\pm$ 15.4	160	79.50%

The data in the table reveals a clear hierarchical pattern in the average scores of elderly care institutions across four dimensions of humanistic care. The “Nursing Care and Daily Assistance” dimension shows the highest score (average 41.8 points, 83.6% compliance rate), indicating well-established daily care protocols and mature basic service systems. Conversely, the “Psychological and Social Support Needs” dimension ranks lowest at 28.1 points (70.3% compliance rate), reflecting insufficient emotional support, companionship, and social engagement for seniors, with some particularly reporting significant “emotional voids.” Additionally, the relatively low score in “Health Education and Information Support” highlights room for improvement in health education and medication guidance dissemination. While integrated medical-care facilities have established a foundation for comprehensive humanistic care systems, they still face structural gaps in personalized spiritual support and proactive communication with empathy. Future optimization should focus on strengthening emotional support mechanisms, enriching social activity content, and establishing two-way communication channels to enhance seniors’ sense of fulfillment and belonging.

## 3.2. Analysis of main influencing factors

### 3.2.1. The influence of education

The effects of different subdivisions of cultural degree are shown in **Table 2**.

**Table 2.** The influence of education level on the experience of humanistic care

Degree of education	Sample capacity	Humanistic care score (mean $\pm$ standard deviation)	F price	P price
Junior middle school	70	123.9 $\pm$ 12.7	26.24	< 0.05
College degree or above	73	134.0 $\pm$ 12.4		
Primary school and below	50	115.1 $\pm$ 13.3		
High school/technical secondary school	90	130.8 $\pm$ 12.6		

The survey results indicate that older adults with higher educational attainment demonstrate stronger positive evaluations of humanistic care services in integrated medical-nursing institutions. Data from the table shows college graduates or above scored an average of 139.0  $\pm$  11.1, while those with primary school education or below



recorded a score of  $117.1 \pm 14.5$ , showing a significant difference. The analysis of variance (ANOVA) yielded  $F = 33.74$  with  $P < 0.001$ , indicating highly statistically significant differences.

Educated seniors demonstrate greater initiative in information reception, emotional expression, and rights awareness, leading to more profound experiences when engaging with humanistic services. Conversely, those with lower educational backgrounds may face communication barriers or struggle to articulate their needs, often feeling neglected and experiencing less satisfaction. When designing humanistic care services, institutions should adopt tailored approaches, using more accessible and concrete methods to communicate with less-educated populations, thereby enhancing their sense of participation and fulfillment.

### 3.2.2. The impact of economic income

The impact of different economic income segments on the experience of humanistic care is shown in **Table 3**.

**Table 3.** The impact of economic income subdivision on humanistic care experience

Economic income	Sample capacity	Humanistic care score (mean $\pm$ standard deviation)	<i>F</i> price	<i>P</i> price
1000–2999 yuan	75	$122.3 \pm 13.4$	21	< 0.05
3000–4999 yuan	80	$130.8 \pm 14.9$		
< one thousand yuan	55	$117.9 \pm 13.1$		
$\geq$ five thousand yuan	73	$134.0 \pm 11.0$		

Survey data indicates that economic income level is a crucial social factor influencing elderly individuals' evaluation of humanistic care experiences. The table shows that seniors with a monthly income  $\geq 5,000$  yuan scored an average of  $137.1 \pm 12.6$ , while those earning < 1,000 yuan scored merely  $117.3 \pm 16.2$ . The analysis of variance ( $F=27.68$ ) with a  $P$ -value < 0.001 demonstrates statistically significant differences.

High-income groups typically demonstrate higher expectations for quality of life and greater service sensitivity, often actively providing feedback on institutional services. In contrast, economically disadvantaged individuals may prioritize basic survival-level care, with insufficient access to emotional support and information exchange. Their lower self-worth may also undermine their motivation to positively evaluate services. Therefore, elderly care institutions should provide more “non-material” support and emotional compensation through humanistic care approaches such as regular counseling sessions, psychological companionship, and value recognition guidance, thereby alleviating feelings of psychological emptiness and marginalization.

### 3.2.3. The impact of health status

The effects of different health conditions on humanistic experience are shown in **Table 4**.

**Table 4.** The impact of health status subdivision on humanistic experience

Health condition	Sample capacity	Humanistic care score (mean $\pm$ standard deviation)	<i>F</i> price	<i>P</i> price
same as	70	$119.7 \pm 15.4$	44.45	< 0.05
difference	50	$110.8 \pm 17.6$		
good	85	$129.0 \pm 13.1$		
beyond compare	78	$137.9 \pm 10.4$		



According to the health status grouping data, the elderly who self-rated as “very good” scored  $139.3 \pm 11.8$ , while those with poor health status scored only  $113.2 \pm 15.7$ , a difference of 26 points. The analysis of variance showed  $F=31.12$ ,  $P < 0.001$ , which was highly significant.

Individuals with better health status typically demonstrate stronger self-management capabilities and effective communication skills. They can better comprehend care services, actively participate in activities, and build trusting relationships with caregivers, which enhances their subjective satisfaction with humanistic care experiences. Conversely, elderly individuals with poor health often suffer from multiple chronic conditions and functional impairments, requiring high dependence on basic care and exhibiting greater mental vulnerability. If institutional facilities fail to provide adequate attention, their humanistic experiences may be overshadowed by the “medical model”. Therefore, it is recommended to enhance “warmth-oriented” services in high-care-level regions, such as emotional companionship, daily conversations, and bedside art activities, to alleviate loneliness and dependency-related stress.

### 3.2.4. The impact of family support

The impact of family support segmentation on humanistic experience is shown in **Table 5**.

**Table 5.** Effects of family support segmentation

Family support	Sample capacity	Humanistic care score (mean $\pm$ standard deviation)	F price	P price
Visit occasionally	70	$123.9 \pm 12.8$	36.53	< 0.05
Visit regularly	88	$133.0 \pm 13.2$		
Resident care	77	$139.9 \pm 11.6$		
No support	48	$117.5 \pm 14.8$		

The level of family support is closely associated with elderly individuals’ subjective experiences in humanistic care. The table data shows that the resident caregiver group scored  $139.9 \pm 11.6$ , while the non-family support group scored only  $117.5 \pm 14.8$ . The analysis of variance ( $F=36.53$ ,  $P < 0.001$ ) demonstrated the most significant difference among the four groups.

Family support not only serves as the primary source of emotional belonging but also significantly impacts seniors’ psychological well-being, service satisfaction, and sense of hope in life. Elderly individuals lacking family visits or companionship are more prone to social isolation and identity disconnection. This can lead to passive, indifferent, and anxious responses when interacting with institutional services, thereby diminishing their perception of humanistic care. Therefore, it is recommended that institutions establish a “family communication mechanism” by regularly organizing family video calls, holiday companionship activities, and other interactive programs. These measures will strengthen the collaboration between institutions and families, enhancing both the continuity and diversity of emotional support for seniors.

## 4. Recommendations

### 4.1. Establish stratified and classified standards of humanistic care services to enhance support for key groups

Based on the survey findings, a stratified care intervention model should be developed that considers factors

such as elderly individuals' educational background, health status, and financial capacity. For seniors with lower education levels, service language, educational approaches, and care procedures should incorporate visual aids and scenario-based elements. For economically disadvantaged groups, non-material psychological support should be provided through public welfare resources. For those with poorer health conditions, enhanced bedside emotional interventions and art therapy should be implemented as low-intensity companionship mechanisms to improve both physical and psychological support effectiveness.

#### **4.2. Promote the linkage mechanism between institutions and families, and build an “integrated internal and external” companionship system**

Research indicates that family support levels show a significant positive correlation with the experience of humanistic care. It is recommended to establish a “family participation” mechanism in institutional services, such as setting up remote video visitation channels, regularly organizing family integration activities, and implementing family-participatory care programs. By strengthening familial interactions, extending the boundaries of institutional services, enhancing the emotional security and social belonging of elderly individuals, and achieving tripartite collaborative care among medical institutions, nursing homes, and families.

#### **4.3. Improve the humanistic care training system and enhance the professional quality of nursing team**

Nursing staff serve as the primary caregivers in elderly daily interactions, and their level of humanistic service directly determines patients' perception of quality. It is recommended to incorporate humanistic care into mandatory pre-service training and continuing education programs. A systematic curriculum should be developed covering communication skills, psychological counseling, cultural sensitivity, and ethical literacy. Concurrently, establishing performance evaluation systems with positive incentives will guide nursing teams to transition from “function-focused” to “empathy-driven” approaches, ultimately forming a sustainable and systematic humanistic service capability framework.

### **5. Conclusions**

This study investigates three integrated medical and elderly care institutions in Guangyuan City through questionnaires and interviews with 283 residents, comprehensively analyzing their actual experiences and influencing factors in humanistic care services. The findings indicate that while basic care and daily support services receive high satisfaction overall, there remain shortcomings in psychological comfort, health education, and expressions of respect. Demographic variables including educational level, income, self-rated health status, and frequency of family support significantly impact subjective experience scores among seniors, with statistically significant differences observed across groups ( $P < 0.001$ ). Particularly, low-income, illiterate, health-challenged, and family-support-deficient populations demonstrate notably inadequate humanistic care experiences, highlighting the need to enhance care capabilities for vulnerable groups within existing integrated medical and elderly care systems. Therefore, establishing a multi-level individual-centered humanistic care framework and optimizing service mechanisms have become crucial pathways to improve seniors' sense of fulfillment and quality of life.

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# Evaluating the Effectiveness of Chinese Herbal Footbath on Sleep Quality among Postpartum Women in Advanced Maternal Age

Wenxuan Qiu\*, Francis Obmerga

Institute of Health Sciences and Nursing – Graduate Studies, Far Eastern University, Manila, Philippines

\*Corresponding author: Wenxuan Qiu, 2019162841@feu.edu.ph

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**Abstract:** This study evaluated the effectiveness of Chinese herbal foot bath therapy in improving sleep quality among postpartum women of advanced maternal age. A quasi-experimental design was used, involving 60 participants with sleep disturbances recruited from Zouping County Traditional Chinese Medicine Hospital. Participants were divided into control and experimental groups, and sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) before and after the intervention. The experimental group received Chinese herbal foot bath therapy, while the control group did not. Post-intervention results showed a significant improvement in sleep quality for the experimental group, with a mean PSQI score of 7.79 (SD = 2.90), compared to 13.45 (SD = 2.57) in the control group, indicating continued poor sleep. Statistical analysis confirmed that the therapy led to significant improvements across overall and component PSQI scores. The study concludes that Chinese herbal foot bath therapy is a safe, non-invasive, and cost-effective method to enhance sleep quality among postpartum women, especially those of advanced maternal age. It holds promise as a complementary treatment option and could be integrated into standard postpartum care practices to address sleep disturbances without relying on pharmacological interventions.

**Keywords:** Chinese herbal foot bath, Postpartum insomnia, Advanced maternal age, Sleep quality, Non-pharmacological therapy

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## 1. Introduction

With China's rising economic prosperity and evolving social attitudes, many women are postponing marriage and childbirth. This trend, coupled with educational and policy shifts—such as the transition from the “double two-child” to the “full two-child” policy in 2016—has led to an increase in advanced maternal age, defined as childbirth at 35 years or older<sup>[1–3]</sup>. By 2017, the proportion of such mothers had grown from 15% in 2013 to 22%<sup>[4]</sup>. Globally, this pattern is echoed, with advanced maternal age reaching 12.3% in some regions and rising from 8.5% to 13.5% in 28 Chinese provinces<sup>[5, 6]</sup>.

This demographic shift is accompanied by increased childbirth risks. Advanced maternal age is linked to decreased vascular elasticity and higher susceptibility to hypertensive disorders and complications during delivery <sup>[7, 8]</sup>. These physiological challenges are compounded by psychological issues—older mothers often experience greater stress, anxiety, and sleep disturbances, which negatively impact both maternal recovery and newborn health <sup>[9–11]</sup>. The quality of maternal sleep, especially for older mothers, is poor. One month postpartum, older mothers average only 5–6 hours of sleep. The 2018 China Sleep Quality Survey found that 83.81% of the population suffers from sleep problems, with over 300 million experiencing sleep disorders, a situation exacerbated during the COVID-19 pandemic <sup>[12]</sup>. Postpartum psychological issues, particularly postpartum depression (PPD), are common in advanced maternal age. Symptoms include fatigue, anxiety, and suicidal ideation, and the prevalence is higher than in younger mothers—36.9% compared to 14.7% <sup>[13, 14]</sup>. Sleep disorders and psychological stress are closely linked; up to 80% of sleep issues are associated with depression, creating a cycle that affects maternal well-being and infant development <sup>[15, 16]</sup>.

In conclusion, the growing trend of delayed childbirth in China, driven by policy and social changes, has led to increased risks associated with advanced maternal age. These risks manifest physiologically and psychologically, particularly through elevated rates of postpartum depression and poor sleep quality, necessitating targeted maternal care strategies and interventions.

### **1.1. Statement of the problem**

This study examined the effectiveness of herbal footbaths in improving sleep quality among postpartum women of advanced maternal age. A total of 60 respondents with reported sleep disturbances were purposively selected and monitored for 21 days following hospital delivery. Participants were assigned to either a control group, which received traditional postpartum care, or an experimental group, which received an herbal footbath intervention in addition to standard care. The study aimed to determine whether the herbal footbath significantly improved sleep quality compared to traditional interventions alone. Specifically, it sought to answer the following research questions: “What is the quality of sleep among postpartum women of advanced maternal age prior to the intervention?” and “Is there a significant difference in sleep quality between the control and intervention groups after the intervention, as measured by the Pittsburgh Sleep Quality Index (PSQI)?”.

### **1.2. Significance of the study**

This research highlights the benefits of herbal footbaths as a non-pharmacological intervention for postpartum sleep disturbances, particularly among pregnant women of advanced maternal age. The practice offers a natural, accessible, and culturally sensitive method for enhancing sleep quality and promoting recovery. Healthcare providers such as nurses, midwives, and obstetricians can use this evidence to incorporate holistic, low-resource approaches into postpartum care without relying on medications.

Maternal and child health programs may also adopt this cost-effective intervention to enhance postpartum support, reduce complications, and improve overall program outcomes. Lastly, future researchers are encouraged to explore the broader applications, efficacy, and scalability of herbal footbaths, fostering interdisciplinary work in maternal care and traditional medicine.

### **1.3. Scope and limitations**

This study investigated the effects of traditional Chinese medicine (TCM) foot baths on postpartum sleep quality



in women of advanced maternal age (35 and above), using a quasi-experimental design with 60 participants at a TCM hospital in Shandong, China. Participants with poor sleep quality (PSQI  $\geq 8$ ) were divided into an experimental group, which received twice-daily TCM foot baths for 21 days, and a control group that received standard postpartum care. Sleep quality was assessed using the Pittsburgh Sleep Quality Index before and after the intervention. The study found improvements in sleep quality for the experimental group, supported by daily monitoring and data verification, though limitations included a small, localized sample, reliance on self-reported data, and short intervention duration. Future research is recommended to include larger, more diverse samples, longer follow-up, and more objective sleep assessment methods.

#### 1.4. Theoretical framework

This study utilizes Kolcaba's Comfort Theory to guide its approach in improving sleep quality and well-being among postpartum women of advanced maternal age through Chinese foot baths<sup>[17]</sup>. Kolcaba's theory emphasizes that comfort is a core need in healthcare, encompassing physical, psychospiritual, sociocultural, and environmental dimensions.

The theory identifies three types of comfort: (1) Relief (elimination of specific discomforts); (2) Ease (a state of calm); (3) Transcendence (rising above challenges). The Chinese foot bath intervention supports: Relief, by easing physical fatigue and sleep issues; Ease, by reducing anxiety and depressive symptoms; and Transcendence, by helping mothers build resilience and a positive outlook.

The theory also highlights individualized, holistic care, aligning with the study's focus on the unique needs of older postpartum women, who face greater risks for sleep and mood disturbances. By enhancing comfort, the intervention may encourage health-promoting behaviors and support both maternal and infant well-being. Overall, Kolcaba's theory provides a strong, patient-centered foundation for using non-pharmacological, traditional interventions like foot baths to improve postpartum outcomes.

#### 1.5. Hypothesis

H<sub>0</sub>: There is no significant difference in sleep quality between the control and intervention groups after the intervention, as measured by the Pittsburgh Sleep Quality Index (PSQI).

### 2. Materials and methods

This study used a quasi-experimental design to evaluate the impact of traditional Chinese herbal footbaths on sleep quality in postpartum women of advanced maternal age ( $\geq 35$  years). A total of 60 participants were purposively sampled at a TCM hospital in Zouping, Shandong Province, from January to April 2025. Participants were divided into an experimental group (n=29), which received 21 days of twice-daily herbal footbaths, and a control group (n=31), which received only routine postpartum care and sleep guidance.

#### 2.1. Key methodological elements

- (1) Design: Quasi-experimental, suitable for naturalistic clinical settings without randomization.
- (2) Sampling: Purposive sampling of postpartum women within 7 days of delivery, with sleep disorders (PSQI  $\geq 8$ ), and no serious health or mental issues.
- (3) Intervention: Herbal footbath conducted twice daily (15–20 mins), using standardized herbs (e.g., *Angelica*



*sinensis*, *Artemisia argyi*, *Poria cocos*). The control group received only standard postpartum care and non-herbal foot soaking advice.

- (4) Location: A Grade II Class A Traditional Chinese Medicine hospital with high rates of older postpartum mothers.
- (5) Compliance: Strict adherence is monitored by trained nursing staff, with daily records and personalized follow-up to minimize participant dropout.
- (6) Measurement tool: The Pittsburgh Sleep Quality Index (PSQI) was used before and after intervention to assess sleep quality changes.
- (7) Data collected: Age, postpartum days, weekly average sleep duration, and PSQI scores to ensure group comparability and control for confounding variables.

## **2.2 Research Instruments (PSQI):**

The Pittsburgh Sleep Quality Index (PSQI) is a validated 19-item questionnaire used to measure sleep quality, including among pregnant women in China. It assesses seven components: sleep duration, disturbances, latency, quality, daytime dysfunction, medication use, and efficiency. Each component is scored from 0 to 3, with a total score range of 0 to 21—higher scores indicate poorer sleep. A score over 5 identifies poor sleep quality, with over 10 indicating more severe issues. The PSQI shows strong sensitivity (89.6%), specificity (86.5%), and internal reliability (Cronbach's  $\alpha = 0.83$ ). It correlates well with sleep-related issues but poorly with unrelated factors. A pretest with 12 women confirmed the PSQI's feasibility and helped refine the data collection and interview process.

## **2.3. Data collection procedure**

- (1) Approval: The study received ethical approval from Far Eastern University and the hospital.
- (2) Participant selection: Older pregnant women with sleep issues visiting Zouping Traditional Chinese medicine hospital (Jan–Apr 2025) were selected using purposive sampling based on inclusion criteria.
- (3) Informed consent: Researchers fully explained the study and obtained informed consent from all participants, ensuring they understood the research details.
- (4) Pre-collection: After approval and consent, demographic data (e.g., name, age, postpartum days, sleep time) were collected, and participants were instructed to complete the PSQI sleep quality questionnaire.

### **2.3.1. Data collection**

- (1) Both experimental and control groups completed initial questionnaires.
- (2) The experimental group received Chinese herbal foot baths twice daily.
- (3) The control group was advised on moderate exercise and warm water foot soaks.
- (4) After 3 weeks, the data were collected again and prepared for analysis.

## **2.4. Statistical treatment**

The statistical methods used to evaluate the impact of traditional Chinese medicine foot baths on sleep quality in postpartum mothers of advanced maternal age. It employed both descriptive statistics (to summarize participant information and sleep status) and inferential statistics, specifically independent t-tests, to compare PSQI scores between experimental and control groups before and after the intervention. The study met the necessary

assumptions for the t-test, including the use of continuous interval data and independence of samples, making the statistical approach valid and appropriate.

## 2.5. Ethical considerations

The study was approved by the Ethical Review Committee of Far Eastern University and followed strict ethical standards, including informed consent, participant privacy, safety, and fairness.

## 2.6. Social value

- (1) Direct benefits: Participants experienced improved sleep quality from the Chinese herbal foot bath intervention.
- (2) Indirect benefits: The study contributed to medical knowledge and postpartum care practices, helping late-term mothers understand and manage sleep-related issues.
- (3) Informed consent: Participants were fully informed about the study, their rights, and had the freedom to decline or withdraw. The Informed Consent Form was thoroughly reviewed to ensure compliance with ethical standards.
- (4) Vulnerability: Vulnerable populations were excluded to prevent harm or exploitation.
- (5) Privacy and confidentiality: Personal data was securely stored, encrypted, and only accessible to authorized researchers. Data handling followed legal and ethical standards to protect participant confidentiality.
- (6) Risks, benefits & safety: The intervention posed no known risks. Participants experienced benefits without physical or psychological harm.
- (7) Justice: All participants were treated fairly, regardless of their background or participation status. Personal information was not reused or disclosed.
- (8) Transparency: The research process was open and clear, with confidentiality maintained unless consent for disclosure was given.

## 3. Results and discussion

This study established a foundation by detailing the research background, literature review, and methodology to explore the effects of traditional Chinese medicine (TCM) foot baths on sleep quality in postpartum mothers of advanced maternal age. This section presents, analyzes, and interprets the data collected from 60 participants, beginning with a clear overview of their basic information and pre-intervention sleep quality. Using descriptive and bivariate statistical methods, the study compares sleep quality outcomes between the control and experimental groups post-intervention, assessing the effectiveness of TCM foot baths across various dimensions. The analysis also explores factors influencing sleep quality and interprets findings in light of existing theories and literature, aiming to provide strong evidence for clinical practice and future research, with results presented in alignment with the research questions outlined in **Section 1.1**.

### 3.1. Quality of sleep among postpartum in advanced maternal age prior to the intervention

**Table 1** presents and analyzes the pre-intervention sleep quality of older pregnant women in both control and experimental groups using the Pittsburgh Sleep Quality Index (PSQI). It finds that both groups experienced poor

sleep, with the experimental group showing slightly worse conditions in several dimensions, including longer sleep latency, slightly worse subjective sleep quality, and similar sleep efficiency. Both groups also reported high sleep disturbances, heavy daytime dysfunction, and high reliance on sleep medications (especially the control group).

These findings establish a baseline for evaluating the effectiveness of a Chinese medicine foot bath intervention, which is theorized to improve sleep and promote maternal well-being. Existing research supports its benefits, and this study aims to scientifically validate those claims. Despite some differences between groups before intervention, the data are valuable for tracking post-intervention changes.

These findings conclude that poor sleep is common among older pregnant women and is influenced by both physical and emotional factors. It emphasizes the importance of comprehensive care—combining physical recovery strategies like foot baths with emotional support—to improve maternal sleep quality.

**Table 1.** Quality of sleep of the advanced maternal age before the intervention

PSQI Components	Control group (n=31)		Experimental group (n=29)	
	Mean	SD	Mean	SD
Sleep Latency	1.94	0.25	2.03	0.42
Duration of Sleep	2.48	0.76	2.79	0.49
Sleep Efficiency	2.97	0.18	2.97	0.19
Sleep Disturbance	3.00	0.00	3.00	0.00
Overall Sleep Quality	2.94	0.25	3.00	0.00
Need Meds to Sleep	0.58	0.91	0.28	0.70
Day Dysfunction Due to Sleepiness	3.00	0.00	3.00	0.00
Global PSQI Score	16.90	1.51	17.07	1.25

Score = 0 (better); Maximum Score = 21 (worse); Interpretation: TOTAL  $\leq 5$  associated with good sleep quality; TOTAL  $> 5$  associated with poor sleep quality

### 3.2. Quality of sleep among postpartum in advanced maternal age after the intervention

This study explored the impact of traditional Chinese medicine foot baths on the sleep quality of postpartum mothers of advanced maternal age by examining multiple sleep dimensions, including sleep latency, duration, efficiency, disturbances, need for sleep medication, and overall sleep quality (PSQI score). The intervention group, which received foot baths, showed significantly lower PSQI scores and more stable sleep patterns across all dimensions compared to the control group. These improvements included reduced sleep latency, fewer sleep disturbances, higher sleep efficiency, and less reliance on sleep medications. The treatment group also experienced reduced daytime dysfunction, indicating better alertness and daily performance. These findings suggest that traditional Chinese medicine foot baths may effectively enhance sleep quality and support postpartum recovery.

The data from **Table 2** reinforce these outcomes, aligning with existing research on sleep challenges in postpartum women of advanced maternal age. Both groups started with similarly high PSQI scores, consistent with literature highlighting the vulnerability of this population to sleep issues. However, the experimental group showed notable improvement in sleep health after the intervention. The study also observed that both groups had low reliance on sleep medication, likely due to concerns about infant safety, echoing broader trends in postpartum care. Overall, this research provides strong evidence that traditional Chinese medicine foot baths can serve as a

safe, non-pharmacological intervention to significantly improve sleep quality in postpartum women of advanced maternal age.

**Table 2.** Quality of sleep of the advanced maternal age after the intervention

PSQI components	Control group (n=31)		Experimental group (n=29)	
	Mean	SD	Mean	SD
Sleep Latency	1.71	0.46	1.07	0.26
Duration of Sleep	1.68	1.08	0.76	1.18
Sleep Efficiency	2.39	0.80	1.24	1.06
Sleep Disturbance	2.58	0.56	1.90	0.49
Overall Sleep Quality	2.29	0.59	1.38	0.73
Need Meds to Sleep	0.39	0.76	0.14	0.44
Day Dysfunction Due to Sleepiness	2.42	0.50	1.31	0.47
Global PSQI Score	13.45	2.57	7.79	2.90

Score = 0 (better); Maximum Score = 21 (worse; Interpretation: TOTAL  $\leq 5$  associated with good sleep quality; TOTAL  $> 5$  associated with poor sleep quality

### 3.3. Comparison of sleep quality between the control and intervention groups after the intervention, as measured by the Pittsburgh Sleep Quality Index (PSQI)

**Table 3** shows that the intervention group that received herbal foot baths showed a significant improvement in sleep quality compared to the control group, with a notable reduction in PSQI scores (mean difference = 5.66,  $t = 8.02$ ,  $p < 0.001$ ). These findings indicate that TCM foot baths are both statistically and clinically effective as a non-pharmacological intervention for sleep disturbances in this population.

**Table 3.** Independent samples t-test comparing post-test global PSQI scores

Group	M	SD	t	df	p
Control (n = 31)	13.45	2.57			
Experimental (n = 29)	7.79	2.90	8.02	58	< 0.001

The results align with previous studies and meta-analyses supporting the benefits of TCM therapies for postpartum sleep issues. The study suggests that herbal foot baths can be a valuable addition to conventional maternal care, offering a relaxing and effective method to improve sleep in postpartum women of advanced maternal age.

## 4. Summary of findings

### 4.1. Participant background

The study involved 60 postpartum mothers of advanced maternal age ( $\geq 35$  years), with 61.67% aged 35–40. This diverse group supports a comprehensive evaluation of traditional Chinese medicine (TCM) foot baths on sleep quality.

## 4.2. Sleep quality before intervention

Both the experimental (mean PSQI = 17.07) and control groups (mean PSQI = 16.90) had poor sleep quality with no significant baseline differences, confirming comparability.

## 4.3. Sleep quality after intervention

After 21 days, the experimental group showed substantial improvements in all PSQI dimensions, with a final mean PSQI of 7.79 vs. 13.45 in the control group. The experimental group also had more stable and consistently better sleep quality.

### Statistical Analysis

The decrease in PSQI scores in the experimental group was statistically significant ( $t=19.52$ ,  $P < 0.001$ ). Improvements were seen in sleep latency, duration, efficiency, disturbances, and daytime function, with  $P < 0.05$  across comparisons.

## 4.4. Contributions to maternal care

TCM foot baths can be adopted as an effective postpartum nursing intervention. The findings support personalized care, enhanced nursing education, and further research into optimizing TCM foot bath protocols for maternal sleep improvement.

## 5. Recommendations

- (1) Nursing practice: Incorporate herbal footbath therapy into routine postpartum care for women of advanced maternal age to help with sleep issues.
- (2) Nursing administration and policy: Include evidence-based complementary therapies like herbal footbaths in maternal programs, especially where pharmacologic sleep aids are discouraged.
- (3) Future research: Replicate the study with larger, more diverse populations. Explore the long-term effects of herbal footbaths. Investigate specific herbs used and their effects. Conduct comparative studies with other non-drug interventions like aromatherapy, massage, or mindfulness.
- (4) Nursing education and community care: Educate postpartum women and caregivers on the safe preparation and benefits of herbal footbaths. Train nursing staff and caregivers to ensure safe and consistent use at home.
- (5) Implementation in postpartum care: Integrate herbal footbaths into standard care protocols for advanced maternal age women with sleep issues.
- (6) Holistic approach: Combine herbal footbaths with other sleep hygiene and lifestyle practices to enhance effectiveness.

## 6. Conclusions

The study concludes that women of advanced maternal age often experience poor postpartum sleep quality. A herbal footbath intervention significantly improved their sleep, showing better sleep latency, duration, efficiency, and overall quality. The results were statistically significant, indicating the benefits were due to the intervention itself. The herbal footbath is a low-cost, non-invasive, and effective complementary therapy that can be integrated

into postpartum care. It has valuable implications for nursing practice, education, and research, enabling personalized care plans, enriching training programs, and laying the groundwork for further studies. Overall, it supports innovation and higher quality in maternal and child healthcare.

## Disclosure statement

The authors declare no conflict of interest.

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# The Effect of Nurse-Led Educational Intervention on the Use of Inhalers in COPD Patients — Multisystem Review and Semi-quantitative Analysis

Mingfu Hou<sup>1†</sup>, Zhiyu Wang<sup>2†</sup>, Yanqing Zhu<sup>3</sup>, Weinan Sun<sup>4\*</sup>

<sup>1</sup> Department of Anesthesiology and Operating Theater, The Seventh Affiliated Hospital of Sun Yat-sen University, Shenzhen 518107, Guangdong, China

<sup>2</sup> Department of Critical Care Medicine, The Fifth Affiliated Hospital of Sun Yat-sen University, Zhuhai 519000, Guangdong, China

<sup>3</sup> Department of Neurosurgery, The First Affiliated Hospital of Sun Yat-sen University, Guangzhou 510080, Guangdong, China

<sup>4</sup> Department of Anesthesiology and Operating Theater, The First Affiliated Hospital of Sun Yat-sen University, Guangzhou 510080, Guangdong, China

† These authors contributed equally to this work and share the first authorship.

\*Corresponding author: Weinan Sun, 2919646279@qq.com

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**Abstract:** *Purpose:* The aim was to synthesize quantitative and qualitative research that identified the most effective educational strategies for nurse-led inhaler technique (IT) education in Chronic Obstructive Pulmonary Disease (COPD) patients, as perceived by patients, healthcare providers, and nurses. *Methods:* A systematic literature search in Embase, PubMed, Cochrane Library, Web of Science, and CINAHL from 2018 to 30 June 2024 was conducted. In total, 327 articles were identified. The results of 14 studies that met the inclusion criteria were synthesized. Data were analyzed with descriptive and semi-quantitative methods to yield summarizing findings on the effectiveness of different educational strategies. All investigations had assessed patient adherence to IT. *Results:* Data indicated that nurse-led IT teaching strategies are effective in promoting IT adherence and correctness in COPD patients utilizing the personalized Teach-Back method. However, studies in disease control and comparison of patient IT satisfaction and self-efficacy need further investigation. *Conclusion:* The results of this study may contribute to the understanding of the most effective educational strategies in nurse-led IT education for COPD patients. The synthesized findings can be used for the development of new educational interventions and assessment instruments for IT adherence.

**Keywords:** COPD; Inhaler use; Educational; Management; GOLD guidelines

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## 1. Introduction

COPD defined as a progressive chronic disease characterized by airway obstruction and difficulty breathing, ranking as the third leading cause of death worldwide <sup>[1]</sup>. With an expected 23% increase in prevalence by 2050, COPD poses a significant burden on healthcare systems and patients' quality of life <sup>[2]</sup>. Inhalation therapy is a crucial component of COPD management, yet patients often use inhalers incorrectly, and adherence is low despite device improvements. Previous studies have identified factors contributing to low adherence and incorrect inhaler use, including educational background, age, lack of effective training, comorbidities, and socioeconomic status <sup>[3-6]</sup>. Guidelines recommend ongoing assessment and intervention to ensure effective inhaler use, emphasizing the role of nurses in COPD patient self-management. Nurse-led interventions aim to improve adherence through personalized support, education, and follow-up, which have shown to enhance quality of life and reduce disease exacerbations <sup>[7]</sup>. However, the effectiveness of different educational methods and strategies for inhaler use in COPD patients remains insufficiently understood. A systematic review is necessary to identify the most effective educational strategies, providing nurses with the latest evidence-based practices to improve inhaler use and patient outcomes. Thus, this study aimed to critically evaluate and compare diverse educational methodologies and instructional strategies that have been employed to augment the efficacy of inhaler therapy among COPD patients. The insights gleaned from this comprehensive review are anticipated to hold significant clinical utility, informing and enhancing future nurse-led educational initiatives aimed at optimizing inhaler therapy outcomes in the near future.

## 2. Methods

### 2.1. Review of the literature

A search strategy was implemented using a PICO model (stands for Problem, Intervention, Comparator, Outcomes) (**Table 1**). The main aim of this investigative research is to address the pivotal question: "What constitutes the most efficacious nurse-led instructional strategies within the sphere of inhaler utilization for COPD patients based on the available evidence?"

**Table 1. PICO framework**

PICO strategy	Meaning
P (Population)	Patients with Chronic Obstructive Pulmonary Disease (COPD)
I (Intervention)	Nurse-led instructional strategies for inhaler use
C (Comparator)	Other types of inhaler use instructions or standard care without specific guidance
O (Outcomes)	Efficacy of inhaler use, including but not limited to, correct usage skills, patient satisfaction, symptom control, and quality of life

### 2.2. Criteria of study

#### 2.2.1. Inclusion criteria

This review prioritizes the inclusion of RCTs to obtain high-quality evidence. However, preliminary searches revealed limited RCT data relevant to the research question. To address this evidence gap and cover a broader range of modern interventions, the inclusion criteria have been expanded to include various study designs, such as

non-randomized controlled trials, cohort studies, pre-post studies, quasi-experimental studies, and mixed methods studies, thereby enhancing the comprehensiveness of the review's evidence base.

### **2.2.2. Exclusion criteria**

In alignment with the methodologies outlined in the Cochrane Handbook, this review will exclude further review articles, secondary reports, conference abstracts, case reports, and non-peer-reviewed studies from consideration. The rationale for this exclusion is that the methodological rigor and data presented in such literature are often insufficient to permit a thorough quality assessment and subsequent analysis<sup>[8]</sup>.

### **2.3. Research methods for identification of studies**

This review's search strategy encompasses the retrieval of published articles from a selection of esteemed databases, including Embase (2018-2024.6), PubMed (2018-2024.6), Cochrane Library (2019-2024.6), Web of Science (2018-2024.6), and CINAHL (2018-2024.6). In addition to these electronic searches, the authors diligently conducted a manual search of reference lists, a practice that is particularly effective in mitigating the risk of omission and enhancing the comprehensiveness and reliability of the study's evidence base. This dual approach ensured exhaustive coverage of available literature throughout the review process<sup>[9]</sup>.

The search strategy was meticulously designed, leveraging truncation (\*) and Boolean operators, which were crucial for broadening the search terms and refining the accuracy and sensitivity of the search. The search formula was constructed as follows: (("Pulmonary Disease, Chronic Obstructive" OR COAD OR "Chronic Obstructive Airway Disease" OR "Chronic Airflow Obstruction" OR "Chronic Obstructive Lung Disease" OR COPD OR "Chronic Obstructive Lung Disease\*" OR "Chronic Bronchitis" OR "Chronic Obstructive Pulmonary Diseases") AND ("Nebulizers and Vaporizers" OR "Inhaler therapy\*" OR "Inhalation techniques" OR Atomizer OR "Inhalation Devices" OR Inhaler OR Inhalator OR Nebulizer OR Vaporizer) AND (nursing OR nurse OR care) AND ("Patient Compliance" OR "Medication Adherence" OR Adherence)). This systematic and comprehensive search strategy is instrumental in identifying the most relevant and high-quality studies, thereby providing a solid foundation for the review's findings and conclusions.

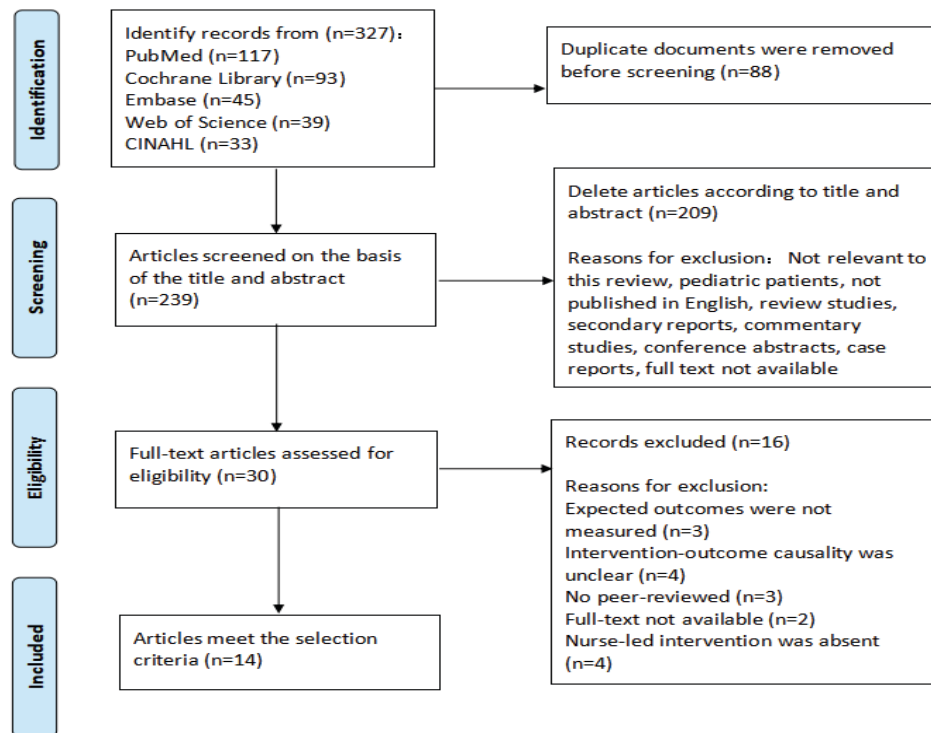
### **2.4. Extraction, management, and analysis of data**

- (1) Screening process: This review, conducted according to the PRISMA guidelines, involved a reviewer searching the database using predefined strategies. The search results were deduplicated using EndNote and then screened for irrelevant literature through title and abstracts. The remaining articles were thoroughly reviewed. The screening process strictly adhered to established standards, with the PRISMA intervention study flowchart and MOOSE observational study guidelines used to document the procedures, ensuring transparency and traceability.
- (2) Quality assessment and risk of bias: For assessing the risk of bias in randomized controlled trials, the Risk of Bias 2 (RoB2) tool was employed<sup>[11]</sup>. The Methodological Index for Non-Randomized Studies (MINORS) was used for assessing observational studies and non-randomized controlled trials.

## **3. Results**

### **3.1. Research characteristics**

Fourteen studies were included in the review, published between 2018 and 2024, showcasing a diverse array of experimental designs as detailed in **Figure 1**. The cohort includes 6 randomized controlled trials, 3 non-randomized controlled trials, 2 prospective studies, and 3 single-group experimental studies. These studies span across various global regions, with representation from the Netherlands, the United States, Spain, Taiwan, South Korea, Australia, Turkey, Sweden, Jordan, and Germany. The sample sizes vary significantly, ranging from 29 to 726 participants, and the study durations span from 3 to 21 months, as detailed in **Table 2**.



**Figure 1. PRISMA Flowchart of study inclusion**

**Table 2. Study characteristics**

Author/Year	Region	Design	Sample size	Duration
(Ahn <i>et al.</i> , 2020)	South Korea	Prospective cohort study	261	6 months
(Ansari <i>et al.</i> , 2020)	Australia	Single-group experimental study	50	6 months
(Kim <i>et al.</i> , 2020)	South Korea	Non-randomized controlled trial	59	Control group: 7 months, Experimental group: 3 months
(Efil <i>et al.</i> , 2020)	Turkey	Randomized controlled trial	29	12 months
(Press <i>et al.</i> , 2020)	United States	Randomized controlled trial	121	19 months
(Luley <i>et al.</i> , 2020)	Germany	Single-group experimental study	38	12 months
(Çigdem <i>et al.</i> , 2022)	Turkey	Randomized controlled trial	67	4 months
(Hsiao <i>et al.</i> , 2022)	Taiwan	Prospective, observational study	109	8 months
(Lindh <i>et al.</i> , 2022)	Sweden	Non-randomized experimental study	79	6 months
(Barnestein <i>et al.</i> , 2023)	Spain	Randomized controlled trial	726	12 months
(Vázquez <i>et al.</i> , 2023)	Spain	Cluster randomized controlled trial	286	12 months

(Al-Kharouf <i>et al.</i> , 2023)	Jordan	Randomized controlled trial	103	3 months
(Achterbosch <i>et al.</i> , 2024)	Netherlands	Single-group experimental study	79	21 months
(Visser <i>et al.</i> , 2024)	Netherlands	Non-randomized controlled trial	81	4 months

Demographically, the studies present a spectrum of participant characteristics, with age, gender ratio, socioeconomic status, and lifestyle information not uniformly measured across all research. Regarding COPD, the mean disease duration reported in six studies varies from 3.6 years to 29.5 years, and the severity of COPD is declared using the Global Initiative for Chronic Obstructive Lung Disease (GOLD) standards in six studies. Comorbidity numbers are reported in five studies, and baseline inhaler usage information, including types, numbers, duration of use, and inhalation therapy, is mentioned in nine studies. In terms of intervention descriptions, two studies compared the effectiveness of online video teaching and face-to-face teaching. Press *et al.* contrasted virtual target teaching with face-to-face target teaching in hospitalized patients, while Al-Kharouf *et al.* evaluated a video-based Teach-to-Goal intervention against conventional verbal education over a three-month period<sup>[12, 13]</sup>.

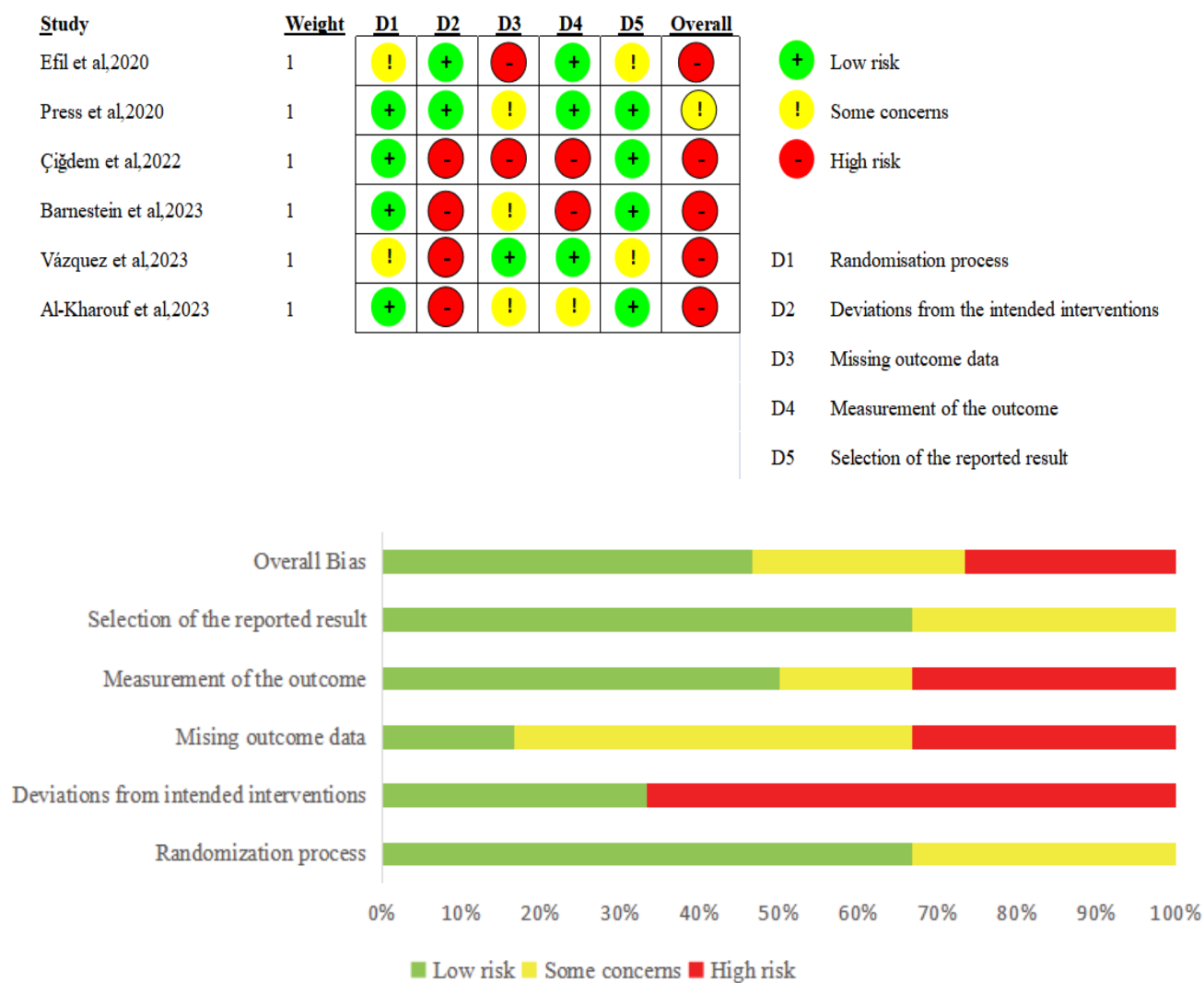
Three additional studies combined face-to-face teaching with teach-back intervention and placebo demonstrations, with follow-up education every three months within a year<sup>[14–16]</sup>. These studies targeted medium to severe COPD patients to test the impact of inhaler training on treatment management, with an emphasis on proper inhalation technique and individual training by instructors. Four studies investigated the effects of repeated, additional, and intensive education on inhaler use, focusing on repeated education regarding inhaler technique, adherence, quality of life, and satisfaction. Ansari *et al.* aimed to improve patient activation and correct inhaler use in a single-group study, while Lindh *et al.* conducted an unrandomized trial on inhaler use errors, and Luley *et al.* provided an 8-day multimodal training program with daily counseling and video demonstration<sup>[17–19]</sup>. Five studies applied individual teaching methods to address and rectify the challenges faced by COPD patients during the use of inhalation devices<sup>[20–24]</sup>. Despite variations in educational interventions and outcomes, these studies consistently demonstrate the effectiveness of nurse-led inhaler education for COPD patients.

### 3.2. Risk assessment of bias and study quality

**Figure 2** presents a comparison of the methodological rigor across studies utilizing the RoB2 tool. Among the six RCTs, five were identified as having a high risk of bias, while one carried a medium risk. A significant strength across these RCTs was the employment of random allocation methods, which is crucial for bolstering internal validity. However, the lack of detailed randomization processes in studies by Efil *et al.* and Vázquez *et al.* introduces potential biases<sup>[14, 16]</sup>.

The majority of studies conformed to CONSORT guidelines, suggesting a low risk of selective reporting bias. Nevertheless, common limitations such as issues with blinding and incomplete outcome data were noted. Four studies exhibited a high risk of deviations from intended interventions, indicating variability in intervention delivery. However, the application of the intention-to-treat principle in studies by Barnestein *et al.* and Vázquez *et al.* ensured the inclusion of all participants, providing a comprehensive understanding of intervention effectiveness<sup>[15, 16]</sup>. Concerning outcome measures, inconsistencies in the application of inhaler technique checklists and scales, along with the variability in personnel involved, raise questions about the standardized assessment of inhaler proficiency. These methodological inconsistencies highlight the necessity for standardized protocols with validated checklists and uniformly trained evaluators to enhance data reliability and comparability. For the seven non-randomized studies assessed using the MINORS, only two studies demonstrated a low risk of bias. Other studies presented validity and reliability constraints, such as non-synchronization of





**Figure 2. Risk of bias judgment using the Cochrane Risk of Bias 2 tool**

**Table 3.** Risk of bias assessment using a modified MINORS checklist for non-randomized studies (Criteria 1–8).

Author	Title	(1) A clearly stated aim	(2) Inclusion of consecutive patients	(3) Prospective collection of data	(4) Endpoints appropriate to the aim of the study
Ahn JH, 2020	The effects of repeated inhaler device handling education in COPD patients: a prospective cohort study	Low RoB	Moderate RoB: Not explicitly mentioned	Low RoB	Low RoB
Ansari S, 2020	Activating primary care COPD patients with multi-morbidity through tailored self-management support	Low RoB	High RoB: Not mentioned	Low RoB	Low RoB: Patient activation, COPD-related quality of life, and inhaler device technique
Kim YM, 2020	Effects of a tailored inhaler use education program for chronic obstructive pulmonary disease patients.	Low RoB	Moderate RoB: From hospitalized patients in G University Hospital	Low RoB	Low RoB: Disease knowledge and correct inhaler use
Luley MC, 2020	Training improves the handling of inhaler devices and reduces the severity of symptoms in geriatric patients suffering from chronic obstructive pulmonary disease.	Low RoB	Moderate RoB: Not specify whether all eligible consecutive patients were included	Low RoB: Prospective intervention study	Low RoB: The frequency of mistakes during handling of inhaler devices, FEV1, FVC, CAT
Hsiao YH, 2022	Shared decision-making facilitates inhaler choice in patients with newly diagnosed chronic obstructive pulmonary disease: a multicenter prospective study.	Low RoB	High RoB: Not mentioned	Low RoB: multicenter, prospective, observational	Low RoB: The CAT score, mMRC dyspnea scale, adherence, satisfaction score, willingness to keep the initial inhaler
Lindh A, 2022	One additional educational session in inhaler use to patients with COPD in primary health care—a controlled clinical trial.	Low RoB	Moderate RoB: Not clearly stated	Low RoB	Low RoB: The differences in inhaler use and health status
Visser CD, 2024	Self-management support with the Respiratory Adherence Care Enhancer instrument in asthma and chronic obstructive pulmonary disease: An implementation trial	Low RoB	Low RoB: From 5 participating community pharmacies	Low RoB: Acceptability, practicality and the implementation process of the intervention	Low RoB: The RACE questionnaire, CRFs, an experience questionnaire and reported findings
Author	(5) Unbiased assessment of the study endpoint	(6) Follow-up period appropriate to the aim of the study	(7) Loss to follow-up less than 5%	(8) Prospective calculation of study size	
Ahn JH, 2020	Low RoB: Standardized checklist and questionnaires	Low RoB: Three visits within 6 months	High RoB: Forty patients were lost to follow-up	Low RoB	
Ansari S, 2020	Low RoB: Standardized and questionnaires	Low RoB: A 6-month follow-up period	High RoB: 12%	High RoB: Not mentioned	
Kim YM, 2020	Low RoB: Non-parametric statistics	Low RoB: Admission and after discharge	Low RoB: only one patient was discharged early	Low RoB: G *Power software	
Luley MC, 2020	Low RoB: Video demonstration	Low RoB: Short-term intervention with 8 days	High RoB: Unidentified and insufficient information	High RoB: Not mentioned	
Hsiao YH, 2022	Low RoB	Low RoB	High RoB: 12% (96/109)	High RoB: Not mentioned	
Lindh A, 2022	Low RoB	Low RoB: A 6-month follow-up period	High RoB: 19%	High RoB: Not mentioned	
Visser CD, 2024	Low RoB: A 10-week follow-up period	High RoB: Insufficient information	High RoB: Not mentioned	Low RoB	

Abbreviation: FEV1, the forced expiratory volume in 1 s; FVC, the forced vital capacity; CAT, COPD Assessment Test; CRFs, consultation case report forms

**Table 4.** Additional criteria in the case of comparative study (Criteria 9–12)

Author	An adequate control group	Contemporary groups	Baseline equivalence of groups	Adequate statistical analyses	Overall risk of bias assessment and total score
Ahn JH, 2020	N/A	N/A	N/A	Moderate RoB: Student's t-test and Mann–Whitney U test	Moderate RoB (14)
Ansari S, 2020	N/A	N/A	N/A	Moderate RoB: McNemar's Test	High RoB (11)
Kim YM, 2020	Low RoB: regular education	Moderate RoB: non-synchronized	Low RoB: no significant differences at baseline	Low RoB: Chi-square tests, Shapiro–Wilk test, Mann–Whitney U test, Cronbach's $\alpha$ or KR-20	Low RoB (22)
Luley MC, 2020	N/A	N/A	N/A	Low RoB: non-parametric methods (two-tailed Wilcoxon signed rank test for pre/post intervention comparisons, MannWhitney U test and Kruskal–Wallis test for unpaired observations)	Moderate RoB (13)
Hsiao YH, 2022	N/A	N/A	Moderate RoB: well-established SDM process	Moderate RoB: Fisher's exact test, Kruskal–Wallis test, Logistic regression analyses	High RoB (12)
Lindh A, 2022	Moderate RoB	Low RoB	Low RoB: no significant differences between the intervention and control groups regarding sociodemographic data, self-reported exacerbations, comorbidities, or smoking	Low RoB: an independent samples t-test, Fisher's exact test, Logistic regression, McNemar's test	Moderate RoB (18)
Visser CD, 2024	Low RoB	Low RoB	Low RoB	Low RoB: Chi-squared test for independent groups, the Fisher exact test, unpaired Student t-test, logistic regression analysis	Low RoB (20)

### 3.3. Effectiveness of intervention

#### 3.3.1. Adherence to treatment and inhaler technique (IT)

Except for the study by Achterbosch *et al.*, nearly all studies reported on inhaler technique (IT) accuracy and adherence among 2037 participants <sup>[23]</sup>. Educational methods included face-to-face, intensive, personalized, and video teaching with the Teach-Back method, all improving technique and adherence.

In three RCTs, nurses used the Teach-Back method with placebo assessments every three months. After 12 months, IT usage improved significantly. Efil *et al.* noted higher adherence scores in the intervention group despite a small sample <sup>[14]</sup>. Barnestein *et al.* found 46.1% of patients performed IT correctly, significantly more than controls <sup>[15]</sup>. Vázquez *et al.* reported better patient performance with trained professionals <sup>[16]</sup>. However, nearly half still couldn't perform IT correctly at 12 months, and breath control remained unimproved, indicating unresolved challenges.

Three studies based on the Teach-Back method and face-to-face demonstrations suggested that increasing the frequency and duration of educational interventions may help patients master IT techniques, though these interventions are still insufficient to fully address patients' difficulties. Ahn *et al.* found that repeated teaching significantly enhanced IT execution, but the lack of a control group and standard evaluation methods requires cautious comparison with other research <sup>[25]</sup>. Çiğdem *et al.* found that extended repeated training and duration improved the use of IT, but the study's high risk of bias due to the lack of a double-blind design must be considered <sup>[21]</sup>. Lindh *et al.* reported that an additional educational intervention did not significantly reduce errors in IT implementation, suggesting limitations when used with elderly patients or those with poor lung function <sup>[18]</sup>.

Hsiao *et al.* demonstrated that shared decision-making, adapted to patients' goals and desires, enhanced medication-taking behavior in patients with newly diagnosed COPD, with 82% following their prescriptions daily <sup>[22]</sup>. However, the lack of a control group means that the changes are not solely attributable to shared decision-making, necessitating further research. Press *et al.* showed that video learning with feedback had only 6% less IT accuracy than repeated face-to-face instruction <sup>[12]</sup>. Al-Kharouf *et al.* found that video learning achieved 93.4% IT accuracy compared to 67% for face-to-face verbal instruction. The research findings reveal that the Teach-Back method, supplemented with face-to-face demonstrations, video, and individualized learning strategies, is an effective component for IT education <sup>[13]</sup>. The Teach-Back method is crucial for evaluating patients' correct application of IT and for analyzing reasons and issues affecting adherence and correctness. In combination with a placebo and face-to-face demonstrations, the most effective method to enhance IT adherence and correctness was the Teach-Back approach. Increasing the frequency and duration of teaching based on this method helped improve patients' understanding and use of IT. Nurses using shared decision-making and motivational interviewing to identify patient issues during IT and providing personalized education based on these assessments seemed to be the most effective approach.

### 3.3.2. Respiratory control and COPD-related quality of life

Ten studies reported on respiratory distress and control post-IT education, utilizing various standard scales or tests for lung function. The majority of these studies reported outcomes using FEV1, FVC, CAT score, and mMRC dyspnea scale, with additional assessments employing the SGRQ, EuroQol-5D-5L, CARAT10, and the Clinical COPD Questionnaire.

Three studies on repeated, additional, and intensive education presented inconclusive results and low evidence for an effect on disease management. Ahn *et al.* (2020) showed no significant improvement in quality of life through repetitive face-to-face education <sup>[25]</sup>. Lindh *et al.* (2022) found no significant differences in CAT scores at a 6-month follow-up, indicating no substantial change in the severity of COPD symptoms <sup>[18]</sup>. Luley *et al.* found a significant median decrease in CAT scores of 5.0 points ( $p < 0.0001$ ), but only small changes in FEV1 and FVC, suggesting that physiological lung function measures may not align with patient-reported symptom improvements <sup>[19]</sup>. In contrast, Çiğdem *et al.* established significant decreases in dyspnea scores for the intervention group compared to the control group ( $p < 0.05$ ) using the Medical Research Council Dyspnea Scale and Modified Borg Dyspnea Scale <sup>[21]</sup>. This suggests that increasing teaching duration and one-to-one IT teaching may reduce the severity of dyspnea, although the subjective nature of this symptom and potential influences from psychological and general physical states were not fully accounted for in the study. The effectiveness of virtual education compared to traditional methods in disease control remains uncertain. Al-Kharouf *et al.* found improvement in the virtual intervention group with Asthma Control Test and CAT, with no significant difference

between groups<sup>[13]</sup>. Press *et al.* revealed no post-intervention comparative outcome differences, suggesting that it is premature to conclude the effectiveness of virtual inhaler education in disease control<sup>[12]</sup>.

While the Teach-Back method as a long-term educational intervention aids in COPD recovery and control, personalized and intensive education show greater potential for improving disease control and quality of life. However, results vary due to the heterogeneity of educational programs, individual patient characteristics, and the duration and frequency of interventions. The variability in intervention duration across studies also complicates the effective comparison of results.

### 3.3.3. Inhaler satisfaction or self-efficacy of patients

Few studies used standardized measures to assess inhaler satisfaction or COPD self-efficacy. Ahn *et al.* and Hsiao *et al.* found interventions significantly boosted satisfaction and self-efficacy, but lacked control groups, limiting causality establishment<sup>[22, 25]</sup>. Hsiao *et al.* also noted comorbidities and severe airflow limitation linked to negative satisfaction<sup>[22]</sup>. Ansari *et al.* and Çiğdem *et al.* reported self-efficacy gains, with Çiğdem *et al.*'s RCT offering higher-quality evidence<sup>[17, 21]</sup>. Overall, repetitive, personalized, and motivational education may enhance satisfaction and self-efficacy, yet diverse study designs and biases highlight the need for comprehensive support and robust research.

The reviewed studies consistently demonstrated that educational interventions, especially those incorporating the Teach-Back method, personalized teaching, and video-based learning, significantly improved inhaler technique, adherence, satisfaction, and self-efficacy in COPD patients. The most effective approach appears to be the Teach-Back method, whether supplemented with face-to-face or video demonstrations. Personalized education using shared decision-making and motivational interviewing also addresses challenging aspects for these patients, thereby increasing outcomes. While there are limitations to the studies, and there is a need for more rigorously designed research, the evidence supports the inclusion of these educational strategies in the treatment plan for COPD patients to better manage the disease process and enhance quality of life.

## 4. Discussion

### 4.1. The effectiveness and limitations of nurse-led educational intervention

COPD management demands long-term inhaler use, but poor adherence remains. This underscores the need for better nurse-led inhalation technique (IT) education. Duarte-de-Araújo *et al.* found 48.2% of COPD patients couldn't use inhalers correctly after a month, an issue confirmed by 13 other studies (excluding Achterbosch *et al.*)<sup>[23, 26]</sup>. A review of 14 studies proved the Teach-Back method effective and vital. These studies compared Teach-Back with others, offering a base for further research on optimal educational approaches.

The Teach-Back method, a widely practiced patient teaching technique in medicine, requires patients to demonstrate or repeat learned content, ensuring understanding and knowledge retention. Three RCTs by Efil *et al.*, Vázquez *et al.*, and Barnestein *et al.* consistently showed improvements in self-management of inhaler techniques with quarterly follow-up and teaching sessions by nurses using placebo demonstrations combined with the Teach-Back method<sup>[14–16]</sup>. This approach resulted in more efficient disease control and patient recovery. However, Barnestein *et al.* found that while IT accuracy among patients significantly improved in the first 1–3 months, the rate of improvement decelerated between 3–12 months, regardless of patient preferences for educational methods. Furthermore, at the 12-month follow-up, nearly half of the patients still could not perform IT correctly,



suggesting that interpersonal variations were not effectively addressed. The challenges identified as barriers related to individual differences are consistent with those found by Wu *et al.*, including patients' health status, comprehension ability, and psychological stress<sup>[27]</sup>. Thus, while the Teach-Back technique appears highly effective in the short term, its long-term effectiveness is questionable.

Ahn *et al.* and Çiğdem *et al.* echoed the effectiveness of intensive educational interventions with increasing durations, adopting the Teach-Back technique combined with placebo demonstrations, showing significant positive effects on IT self-management, patient self-efficacy, and satisfaction<sup>[21, 25]</sup>. However, Lindh *et al.* found that an additional teaching session did not significantly improve IT use in older patients or those with poor lung function, suggesting that the Teach-Back technique, given enough time for teaching, is superior at overcoming barriers due to heterogeneity among people. These trials show high risks of bias, indicating methodological insufficiencies and not providing adequate evidence for its benefits in COPD management. Therefore, implementing such an intense education strategy may not be wise in places with scarce medical facilities.

#### 4.2. The optimization direction of educational strategy

Kim *et al.*, Ansari *et al.*, and Hsiao *et al.* combined the Teach-Back method with personalized plans, showing significant positive effects on IT self-management, satisfaction, and self-efficacy<sup>[17, 20, 22]</sup>. Motivational interviewing and shared decision-making in these studies helped uncover barriers and difficulties faced by patients in the self-management process. A meta-analysis showed that motivational interviewing had reliable effects on behavior change and disease control in patients with COPD<sup>[28]</sup>. Shared decision-making helps understand patients' needs and concerns, leading to more personalized and feasible treatment regimens, ensuring higher adherence to medication. This resonates with the conclusion of this review. Given the limited nature of the literature regarding nurse-led IT training strategies for patients with COPD, these studies generally lack a control group or randomization, indicating the risk of bias and a lack of long-term follow-up; yet, this teaching approach is considered the most likely and efficient method.

Additionally, studies have shown that Video and gamification aids are effective supplements to COPD lung rehabilitation. Al-Kharouf *et al.* and Press *et al.* found that video-based instruction, combined with online assessments, is as effective as face-to-face teaching by nurses<sup>[12, 13]</sup>. Luley *et al.* confirmed that video learning, as a supplement to face-to-face instruction by nurses, is particularly effective for elderly patients and those with mild cognitive impairment<sup>[19]</sup>. With the widespread use of smartphones, video education is expected to become a high-potential auxiliary tool in nurse-led interventions, enhancing patients' IT self-management skills.

### 5. Conclusions

This review comprehensively assesses educational methods to enhance inhaler technique and adherence in COPD patients, revealing diverse approach effectiveness. However, it faces limitations: significant variations in study designs, teaching interventions (duration, frequency, session length), and assessment tools hinder meta-analysis and result in outcome heterogeneity, reducing result comparability. Given study heterogeneity and bias risk, evidence should be cautiously interpreted. Future research needs longer follow-ups, larger samples, standardized measurements, and data on other outcomes/adverse events for high-quality meta-analyses. Also, as long-term effects are unassessed, future studies should focus on the lasting impact of inhaler education for a fuller efficacy understanding over time.



## Disclosure statement

The authors declare no conflict of interest.

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# The Critical Role and Practice of Medical Device Design and Development Documentation in Quality Systems

Meiting He

Guangzhou Dimao Information Technology Co., Ltd., Guangzhou 510520, Guangdong, China

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**Abstract:** This paper highlights the critical role of medical device design and development documents within the quality system, including their compliance with regulatory standards, their function as a traceable record, their support for all stages, and their use in risk and change management. It also covers document template creation, review record association, information management, adverse event traceability, and the reconciliation of differences in international declarations.

**Keywords:** Medical devices; Design and development documents; Quality system

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## 1. Introduction

The quality system of medical devices is strictly constrained by regulations, among which the ISO 13485 standard is of great significance. On this basis, each country further refines its requirements based on its own national conditions and regulatory needs. The EU MDR clinical evaluation requirements (issued in 2017) emphasize the need to update risk analysis reports for design changes, while the Chinese NMPA registration application requirements (continuously improving relevant regulations) focus on structured construction of technical documents. These policies highlight the crucial role of medical device design and development documents. It is a key carrier of quality system traceability, which is crucial in all stages of design and development as well as the entire product lifecycle. It plays a core role in risk management, quality control, and adverse event tracing, and is an important support for ensuring the quality and safety of medical devices.

## 2. Theoretical correlation between the medical device quality system and design and development documents

### 2.1 Regulatory framework for medical device quality system

The quality system of medical devices is constrained by a series of regulatory frameworks, among which the ISO

13485 standard holds an important position. This standard imposes strict requirements on various aspects of the design and development of medical devices. During the design and development phase, emphasis is placed on risk management, process control, and ensuring that the product meets its intended use and is safe and effective<sup>[1]</sup>. On this basis, medical device regulations in various countries have special control requirements for the design and development stage according to their own national conditions and regulatory needs. These regulatory documents constrain the writing of design and development documents from different perspectives. The document must truthfully, accurately, and completely record the design and development process, including various stages such as design input, output, review, verification, and confirmation. By standardizing document writing, we ensure the effective operation of the medical device quality system and guarantee the quality and safety of medical devices.

## **2.2. The system status of design and development documents**

Design and development documents play an important role in the quality system of medical devices. It is a key carrier of traceability in the quality management system. Throughout the entire product lifecycle, from concept proposal to final launch and subsequent maintenance, design and development documents document detailed processes and information<sup>[2]</sup>. The file matrix constructed by it is like a knowledge network, providing solid support for various stages of the product. For example, in the design phase, documents document the design ideas, design verification process, etc., providing an accurate basis for subsequent production. In the production process, if problems arise, they can be traced back to the design and development documents to identify the root cause and take effective corrective measures. Meanwhile, in the process of product improvement and upgrade, these documents also provide historical references for technical personnel, ensuring the continuous improvement and stability of product quality.

## **3. Analysis of the key role of design and development documents in quality management**

### **3.1. Core basis for quality control**

The design and development documents (DMR, DHF, etc.) of medical devices play a crucial role as the core basis for quality control. These documents provide detailed technical benchmarks for process validation, ensuring that the production process meets predetermined quality standards. In terms of design change control, they clearly record the original design intent and key parameters, enabling changes to be made within a controllable range and avoiding adverse effects on product quality. For example, in the example of production specification compliance review, the technical indicators and design details in DMR and DHF documents become important criteria for determining whether the product meets quality requirements. They can help reviewers quickly identify potential issues and ensure the stability and reliability of product quality<sup>[3]</sup>.

### **3.2. Risk management technology carrier**

Design and development documents are the core carrier of medical device risk management technology. They systematically and structurally record information related to risk management throughout the entire product development process, providing important guarantees for product safety and reliability<sup>[4]</sup>. The risk analysis report, as a key component of the design and development document, comprehensively presents the risks that medical devices may face during the design and development phase by integrating the results of multiple risk analysis methods. Among them, Failure Mode and Effects Analysis (FMEA), as a forward-looking risk analysis tool,

occupies an important position in risk management. FMEA provides a scientific basis for developing effective risk control measures by identifying potential failure modes, analyzing their causes and effects, and assessing the severity and probability of risks.

In the practical application of medical devices, the traceability value of design and development documents is particularly prominent. Taking the medical device recall case as an example, by reviewing the risk analysis report and FMEA-related content in the design and development documents, it is possible to clearly trace the root cause of product defects and determine whether the defects stem from risks that were not fully identified or controlled during the design phase. Through a systematic risk management technology carrier, enterprises can continuously improve risk control measures throughout the product lifecycle, ensuring the safety and effectiveness of medical devices, and providing higher security for patients and users.

## **4. Integration practice of document management and quality system**

### **4.1. Standardized document preparation process**

#### **4.1.1. Stage deliverable management**

In the process of medical device design and development, establishing a comprehensive document template system for design input, verification, and confirmation stages is the key to ensuring product quality. In the design input stage, it is necessary to clarify the expected use, performance requirements, user needs, and regulatory requirements of the product, form standardized document templates, and ensure the completeness, accuracy, and traceability of input information <sup>[5]</sup>. These templates lay the foundation for subsequent development and avoid design deviations caused by unclear requirements. The document template for the verification phase should cover the verification plan, testing protocol, and verification report, detailing the verification process, methods, data, and results to ensure that the product design meets the expected functional and safety requirements. The template for the confirmation phase needs to reflect whether the product meets user needs and expected uses, as evidenced by user testing or clinical evaluation data.

The close relationship between design review records and technical documents is the core of quality management. The design review records should be clearly traced back to relevant technical documents, such as design input files or verification reports, to ensure transparency and traceability of the review process. At the same time, technical documents should reflect the problems identified during the review, improvement suggestions proposed, and implementation measures, forming a closed-loop management. This association mechanism not only enhances the traceability of documents, but also ensures the quality control of the design and development process <sup>[6]</sup>. Through a standardized document template system and review record management, enterprises can effectively integrate design and development information, meet regulatory requirements, support continuous improvement of quality systems, and provide reliable guarantees for the safety and effectiveness of medical devices.

#### **4.1.2. Application of electronic signature system**

In the design and development of medical devices, it is crucial to establish a comprehensive document template system for design input, verification, and confirmation stages. In the design input stage, it is necessary to clarify the expected use, performance requirements, user needs, and regulatory compliance requirements of the product. Standardized document templates should be used to ensure that input information is complete, accurate, and traceable, avoiding design deviations caused by vague requirements <sup>[7]</sup>. The document template for the verification



phase should include a verification plan, testing protocol, and verification report, detailing the verification process, testing methods, and results to ensure that the design meets functional and safety requirements. The template for the confirmation phase needs to be validated through user testing or clinical evaluation data to demonstrate that the product meets its intended use.

The correlation between design review records and technical documents is the core of quality management. The review records should be traceable to technical documents such as design inputs and verification reports to ensure transparency in the process. Technical documents should reflect the issues and improvement measures identified during the review, forming a closed-loop management system. This mechanism enhances the traceability and quality control of documents, supporting regulatory compliance. Through a standardized template system and review record management, enterprises can optimize the design and development process, ensure the safety and effectiveness of medical devices, and provide reliable support for the continuous improvement of the quality system.

## **4.2. Deep integration of risk management**

### **4.2.1. Dynamic maintenance of risk documents**

In the design and development of medical devices, the dynamic maintenance of risk analysis reports is the core link of deep integration of risk management. According to the EU MDR clinical evaluation requirements, design changes may affect the performance, safety, and effectiveness of medical devices, thereby altering the risk profile. Therefore, after each design change, it is necessary to promptly reassess the risks and update the risk analysis report to ensure that it accurately reflects the risk level of the product at each stage. The update process requires a systematic analysis of the impact of changes on failure modes, risk severity, and probability of occurrence, combined with tools such as FMEA, to identify potential risk points and develop control measures <sup>[8]</sup>. By continuously updating risk documents, enterprises can promptly identify and respond to potential issues, ensure the quality and safety of medical devices, and enhance the safety level of patients and users. In addition, standardized risk document maintenance helps companies gain an advantage in regulatory review and market competition, providing a solid foundation for quality management throughout the product lifecycle.

### **4.2.2. Adverse event traceability system**

In the operation of medical device quality management system, the integrity of design and development documents is the key to ensuring compliance and product quality. Taking typical quality system on-site inspection defect cases as an example, rectification verification needs to follow a systematic and rigorous method. When missing or incomplete documents are found, the first step is to trace back the original data and records, verify the accuracy and reliability of the information, and ensure the authenticity and credibility of the rectification foundation. To ensure the quality of rectification, it is necessary to establish a multi-level audit mechanism and organize cross-departmental audit teams to conduct a comprehensive review of the rectified documents, verifying their completeness, compliance, and traceability. During the rectification process, strengthen communication and collaboration among departments such as research and development, quality management, and production, clarify the division of responsibilities, and ensure efficient progress of rectification work. Through a systematic rectification process and audit mechanism, not only can document defects be effectively resolved, but the overall quality of design and development documents can also be improved, ensuring the safety and effectiveness of medical devices, and providing solid support for the continuous improvement of the quality system and regulatory



compliance.

## **5. Practical application of quality management system operation**

### **5.1. Practice of product registration and declaration**

#### **5.1.1. Structured construction of technical documents**

In the practice of medical device product registration and application, the structured construction of technical documents is a key link to ensure successful application and compliance with the quality management system. Based on the registration and application requirements of China NMPA, design documents need to be scientifically classified and archived, clearly classified according to the design and development stage (such as input, verification, confirmation), technical characteristics, or regulatory requirements, to ensure document systematicity and traceability<sup>[9]</sup>. For example, the design input document needs to cover expected uses, performance indicators, etc., the validation document needs to record the test plan and results, and the confirmation document needs to prove that the product meets user needs. All documents must comply with electronic submission standards and use standard formats to facilitate quick review by auditors and improve application efficiency. In addition, structured documents need to ensure the accuracy and completeness of technical information, clearly convey product characteristics and compliance evidence, and meet the requirements of the quality management system for product lifecycle management. Through scientific archiving and format standardization, structured documents not only reduce the risk of deviation in auditing but also provide strong support for the smooth launch of products, helping enterprises maintain competitiveness in a strict regulatory environment.

#### **5.1.2. Rectification case of physical examination defects**

In the operation of medical device quality management system, the integrity of design and development documents is the core to ensure product quality and regulatory compliance. Taking typical quality system on-site inspection defect cases as an example, systematic and rigorous methods should be adopted for rectification verification. When missing or incomplete documents are found, it is necessary to first trace the original data and records, including design inputs, verification reports, etc., to ensure the accuracy and reliability of the information and provide a true basis for rectification. To ensure the effectiveness of rectification, it is necessary to establish a multi-level audit mechanism, organize R&D, quality management, and other departments to form an audit team, conduct a comprehensive review of the rectified documents, verify their completeness, compliance, and traceability. During the rectification process, strengthen cross-departmental communication and collaboration, clarify responsibilities, optimize process efficiency, and ensure the smooth progress of rectification work. Through systematic rectification and review, not only can document defects be effectively resolved, but the quality of design and development documents can also be significantly improved, ensuring the safety and effectiveness of medical devices and providing solid support for continuous improvement of the quality system and regulatory compliance.

### **5.2. Regulatory response after listing**

#### **5.2.1. Adverse event analysis and traceability**

After the launch of medical devices, adverse event analysis and traceability are crucial in the quality management system, with the core relying on the integrity and traceability of design and development documents. To effectively respond to adverse events, it is necessary to establish a systematic MDR (Medical Device Reporting)/SAE (Serious

Adverse Event) analysis model, which uses scientific methods to sort out event-related information and quickly locate the root cause of the problem. The traceability of biological evaluation data is an important component of this model, which runs through the entire product lifecycle. Starting from the procurement stage of raw materials, it is necessary to record their biological characteristics in detail, such as chemical composition, biocompatibility, etc. During the production process, it is necessary to track the impact of processing on biological performance, record process parameters and test data; In the finished product stage, a complete biological evaluation report must be kept, including toxicity, irritation, and other test results. These records form a continuous traceability chain, ensuring comprehensive and traceable information <sup>[10]</sup>. When adverse events occur, based on the design and development documents, companies can quickly trace back to the raw materials, production, or design stages, identify potential defects such as improper material selection or process deviations, and analyze their impact on product safety. By tracing the results, enterprises can develop targeted corrective and preventive measures, optimize product design or production processes, effectively reduce risks, and ensure patient safety.

### **5.2.2. Design change control practice**

After the launch of medical devices, significant changes may pose challenges to document version control, involving adjustments to product design, raw materials, or production processes. To ensure compliance, it is necessary to strictly follow the requirements of the quality system and establish a standardized change management process. When changes occur, detailed records of the change content (such as design parameter adjustments, material replacement, or process optimization), reasons, time, and impact analysis should be kept, and DMR (equipment master file) and DHF (design history file) documents should be updated in a timely manner to ensure their traceability. These documents need to fully reflect the change process, maintain information integrity and accuracy, to comply with regulatory requirements such as China's NMPA or the EU's MDR. The re-registration application has strict requirements for document standardization, and any omissions or errors may result in application failure and affect product launch. Therefore, it is necessary to establish a multi-level document review mechanism, consisting of a review team composed of R&D, quality management, and other departments, to systematically review the changed documents, verify their compliance, consistency, and completeness, and ensure that they accurately reflect the current status of the product. Through standardized version control and review processes, enterprises can effectively manage change risks, reduce regulatory barriers caused by document issues, ensure that products continue to meet quality standards, smoothly complete re-registration applications, maintain market competitiveness, and provide reliable support for patient safety and product quality.

## **5.3. International certification collaborative management**

### **5.3.1. Conversion of declaration documents from multiple countries**

In the field of medical devices, there are differences in technical documents between the United States, Europe, and China. To achieve the conversion of multi-country declaration documents under international certification collaborative management, it is necessary to reconcile these differences. Firstly, conduct in-depth research on the requirements of all parties and clarify the differences. On this basis, a modular document architecture design methodology is proposed. This methodology divides documents into functional, procedural, and other modules, with each module corresponding to the core requirements of different regions. In this way, while meeting basic functional and quality requirements, module content can be flexibly adjusted to adapt to certification standards in different countries. This not only improves the efficiency of document writing and reduces repetitive work, but

also ensures the compliance of documents when applying in different regions, providing strong support for the international market expansion of medical device enterprises.

### **5.3.2. Dual compliance of quality system**

Building a design document management system that meets both ISO 13485 and FDA QSR is an important task for medical device companies. In the operation of the quality management system, it is necessary to clarify the commonalities and differences between the two standards. For design documents, it is important to ensure their completeness, accuracy, and traceability. From the formation of the product concept to final launch, documentation at each stage should adhere to double standards. In terms of file control procedures, optimization points include strict document approval processes to ensure that only authorized personnel can modify and publish documents. At the same time, establish an effective document version control mechanism to trace changes in different versions at any time. Through these practical applications, enterprises can better cope with the challenges of international certification collaborative management, ensure product quality meets the dual requirements of the quality system, and enhance their competitiveness in the international market.

## **6. Conclusion**

Medical device design and development documentation plays a critical role in the quality system, serving as a vital link that integrates various aspects of the system. On one hand, through systematic organization, it establishes its pivotal role in ensuring standardized and normalized processes within the quality system. On the other hand, the adoption of digital twin technology for intelligent document management opens new opportunities for enhancing efficiency. Empirical studies demonstrate significant benefits: standardized document management reduces product registration cycles by 30% and improves quality incident traceability efficiency by 45%. These outcomes highlight the practical value of design and development documentation in quality management and provide a replicable, effective solution for the full lifecycle quality management of medical devices, contributing to the high-quality development of the medical device industry.

## **Disclosure statement**

The author declares no conflict of interest.

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# Mental Health Status of International Nursing Students in the Philippines: Prevalence and Predictors in Times of Global Health Disruptions

Manli Li\*, Francis Obmerga

Institute of Health Sciences and Nursing - Graduate Studies, Far Eastern University, Manila, Philippines

*\*Corresponding author: Manli Li, 2018076961@feu.edu.ph*

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**Abstract:** This study investigates the mental health challenges faced by international nursing students in the Philippines during a global health disruption like the COVID-19 pandemic, particularly focusing on symptoms of depression, anxiety, and stress (DAS). With the first incidence of global outbreak in the Philippines reported in 2020, the pandemic has intensified psychological distress among international students, who already struggle with sociocultural adjustment issues such as alienation and culture shock. The study aimed to determine the prevalence and contributing factors of DAS among this group. Using descriptive statistics and the DASS-21 tool, the research found that international nursing students exhibited alarmingly high levels of depression, anxiety, and stress. Pearson's test of association was employed to explore relationships between DAS symptoms and demographic variables. Results highlighted key predictors of mental health distress, including age, gender, length of stay in the country, and sleep patterns. These findings address a significant gap in existing literature concerning international students' mental health in the Philippines during pandemics. The study concludes by urging healthcare providers and policymakers to integrate these insights into emergency preparedness plans and educational reforms, emphasizing the importance of supporting the psychological well-being of international students during crises. Replication with additional variables is recommended for a more comprehensive understanding.

**Keywords:** Depression; Anxiety; Stress; International in nursing students; Predictive symptoms; Demographic variables

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## 1. Introduction

A global health disruption such as the COVID-19 pandemic, declared by the World Health Organization as a global health crisis in 2020, brought unprecedented challenges to educational systems worldwide <sup>[1]</sup>. In the Philippines, the government implemented stringent measures, including a nationwide lockdown in March 2020, which forced people to stay home and suspended most social and educational activities <sup>[2]</sup>. This situation particularly impacted higher education, leading to the closure of schools and the shift to online learning <sup>[3]</sup>.



Many studies have highlighted the rise in anxiety, depression, and stress among students, especially those in higher education <sup>[4, 5]</sup>. The disruption of traditional learning methods, social isolation, and the shift to online education have caused significant emotional distress. This has been particularly true for international students, who already face the challenges of adjusting to a new culture and language <sup>[6]</sup>. In addition, many international students were confined to their homes due to the pandemic, which exacerbated issues such as time zone differences and poor internet connectivity, further complicating their learning experiences <sup>[7]</sup>.

International nursing students in the Philippines experienced a unique set of challenges. Not only did they struggle with adapting to online learning, but they also faced the stress of a healthcare curriculum amid a global health crisis <sup>[8]</sup>. The isolation from their families and communities, the fear of falling behind academically, and the moral distress of being unable to contribute to the pandemic's frontline efforts added to their mental burden. Moreover, limited access to culturally sensitive mental health support made it harder for these students to address their psychological needs <sup>[9]</sup>.

The transition to online education exposed significant inequalities, such as digital access and support services. Students faced academic stress, uncertainty about their future, and a lack of social support, which contributed to anxiety and depression <sup>[10]</sup>. The emotional toll was especially heavy on nursing students, who experienced emotional fatigue from constant exposure to news about the pandemic's impact on healthcare systems <sup>[11]</sup>.

Despite these challenges, there has been limited research on the mental health of international students, particularly in developing countries <sup>[12]</sup>. The study emphasizes the importance of understanding the unique struggles faced by these students to develop targeted mental health programs and academic support systems. Addressing the mental health needs of international students, especially in the context of a global crisis like the COVID-19 pandemic, is crucial for ensuring their well-being.

The primary goal of this study was to explore the prevalence and contributing factors of anxiety, depression, and stress among international nursing students in the Philippines. The findings aim to inform organizations and institutions to design preventive strategies for the mental health challenges posed by a global health disruption like the COVID-19 pandemic, ensuring that international students receive the necessary support during such crises.

## **2. Statement of the problem**

The main goal of this study is to determine the prevalence and associated factors of depression, anxiety, and stress symptoms among international nursing students enrolled in some Higher Education Institutions in the Philippines. Specifically, this research aimed to answer the following questions: (1) "What is the demographic profile of the participants, in terms of: Age group, Sex, Residence style, Length of stay in the Philippines, Sleep scale"; (2) "What is the level of depression, anxiety, and stress of the participants?"; (3) "Are there correlations between the demographic profile of International Nursing Students and their depression, anxiety, and stress levels?"; (4) "What are the predictors of depression, anxiety, and stress among International Nursing Students?"

### **2.1. Significance of the study**

This study aims to assess the prevalence and factors associated with depression, anxiety, and stress among international nursing students in the Philippines. Its findings provide valuable insights into nursing education, practices, and research. For educators, it offers baseline data to design strategies addressing mental health challenges, particularly during the global health disruption like the COVID-19 pandemic. For nursing practices, it

informs clinical interventions to minimize these mental health issues. Lastly, the study serves as a foundation for further research on mental health among nursing students.

## **2.2. Scope and limitations**

This study aimed to explore the prevalence and predictors of depression, anxiety, and stress among international nursing students enrolled in higher education institutions in the Philippines during the global health disruption, particularly the COVID-19 pandemic. It surveyed 53 students using the DASS-21 scale via a Google Form. However, the study faced limitations, such as potential response biases due to emotional instability or cognitive overload among participants experiencing psychological distress. The self-reporting nature of the survey could also lead to inaccuracies, underreporting, or overreporting of symptoms, which may affect the study's generalizability and internal validity. Future research could benefit from clinical interviews or longitudinal tracking.

## **2.3. Theoretical framework**

Newman's nursing theory focuses on stress management and patient rehabilitation through a model of three prevention levels: primary, secondary, and tertiary prevention. Nurses play a crucial role in maintaining system stability by addressing stressors and supporting patients returning to their wellness. This theory has been applied to understand how international nursing students in the Philippines respond to stress during the global health disruption, with interventions based on prevention levels used to reduce anxiety, depression, and stress, influenced by factors like age, life experience, and education.

## **2.4. Hypothesis**

- (1) This study tested the following null hypothesis at a 0.05 level of significance.
- (2) There is no significant correlation between the level of depression, anxiety, and stress among the participants and their demographic profile.
- (3) There are no significant demographic predictors of depression, anxiety, and stress among the participants.

## **3. Materials and methods**

This section outlines the research methodology used to study depression, anxiety, and stress among international nursing students in the Philippines. The study employed a cross-sectional exploratory design, with data collected at a single point in time. It used Cronbach's alpha for internal reliability, Pearson's  $r$  for correlations, and regression analysis to identify factors like sleep, sex, length of stay, and residence style as predictors of mental health issues.

The sample was selected using purposive sampling, targeting Chinese international nursing students enrolled in Philippine higher education institutions during 2021. The study included 53 students, exceeding the minimum sample size of 45, ensuring their representativeness. Inclusion criteria required students to be enrolled, have internet access, and understand English, while excluding those with pre-existing psychiatric conditions or incomplete responses.

The research was conducted in Metro Manila, where many international students reside, benefiting from the region's academic and cultural resources. Data collection utilized a demographic profile questionnaire and the Depression, Anxiety, Stress Scale 21 (DASS-21) to assess mental health. The analysis employed descriptive statistics for demographic data, Pearson's  $r$  to examine correlations, and multiple linear regression to identify

predictors of mental health outcomes.

This methodology provides a comprehensive approach to understanding the factors influencing the mental well-being of international nursing students during the global health disruption, the COVID-19 pandemic.

### **3.1. Data collection**

The study followed a structured, four-phase approach to ensure ethical compliance and reliable data collection:

(1) Phase 1 – Study approval

The study received approval from the Far East University ethics review committee. Written consent was granted, permitting the investigator to conduct the research.

(2) Phase 2 – Selection of respondents

Participants were selected based on criteria that included being an International Nursing Student enrolled in any Philippine Higher Education Institution, having internet access, and being able to read and understand the survey consent. Recruitment was conducted through purposive sampling, targeting international students who had studied in the host country for at least one semester. An informed consent form was provided, and only participants who consented could proceed. Data was collected via a secure online survey, and reminders were sent weekly for three weeks. The data collection lasted for one month.

(3) Phase 3 – Data collection

Data was collected using online platforms like WeChat, where the researcher invited participants via a formal message. A secure online survey included demographic items and the DASS-21 scale, measuring depression, anxiety, and stress. Participation was voluntary, and the survey took approximately 10–15 minutes to complete. After data collection, the responses were reviewed for completeness, and all data was stored securely. The researcher ensured confidentiality by coding responses with unique identifiers, and all paper-based materials were securely disposed of after analysis.

(4) Phase 4 – Data analysis

The researcher analyzed the collected data using statistical methods to answer the research questions and draw conclusions related to the psychological well-being of international nursing students.

### **3.2. Ethical considerations**

This study focuses on the ethical considerations related to international nursing students, particularly during the pandemic, to help them understand and manage their psychological conditions. The study adhered to several ethical principles:

(1) Informed consent/Assent: Participants were fully informed about the study's purpose, procedures, benefits, and potential risks. They gave voluntary consent by participating in the online survey after receiving a message outlining the study's details.

(2) Vulnerability and privacy: Respondent identities, including their names and institutions, were kept confidential. Data was used solely for the study, and participants could withdraw at any time without consequences.

(3) Risks, benefits, and safety: The study, conducted online due to COVID-19, included questions that could evoke emotional distress. Participants were informed they could skip questions or withdraw at any time. Support services were offered for those in need of mental health care.

(4) Justice: The study ensured fairness by treating all participants equally. Participation was voluntary, with no

impact on academic or personal relationships, and no coercion was involved.

- (5) Transparency: The study maintained transparency by clearly outlining the process and answering any questions from participants. Data and findings are publicly available while ensuring respondent privacy.

## 4. Results and discussions

### 4.1. Demographic profile

This study identified the demographic profile of international nursing students enrolled in Higher Education Institutions in the Philippines and determined potential predictors of depression, anxiety, and stress among them. The demographic profile of the participants includes factors such as age group, sex, residence style, length of stay in the Philippines, and sleep scale.

- (1) Age group: The majority of participants (54.7%) are in the 31-35 age range, followed by 39.6% in the 26–30 age range, and 5.7% in the 21–25 age range.
- (2) Sex: A significant proportion of participants are female (73.6%), while 26.4% are male.
- (3) Residence style: The majority of participants (58.5%) live alone, followed by those living with friends (26.4%) and those living with family (15.1%).
- (4) Length of stay: Most participants (47.2%) have stayed in the Philippines for 1-2 years, followed by 35.8% who have been in the country for 0–1 year. A smaller percentage have stayed for 2–3 years (11.3%), and only 5.7% have been in the country for 3 years or more.
- (5) Sleep scale: Most participants (49.1%) report sleeping for 6–8 hours, followed by 41.5% who sleep for 4–6 hours. A smaller portion (7.5%) sleeps for 8 hours or more, and 1.9% sleeps for less than 4 hours.

These demographic details can serve as potential predictors for the prevalence of depression, anxiety, and stress among international nursing students.

### 4.2. Levels of depression, anxiety, and stress among international nursing students in Higher Education Institutions (HEIs) of Philippines

Table 1 presents the following key findings of the study:

- (1) Depression: Sixteen respondents experienced moderate and extremely severe depression each. Ten experienced severe depression, 9 mild, and 2 normal levels.
- (2) Anxiety: Nineteen students had moderate anxiety, 16 experienced extremely severe anxiety, and 9 had severe anxiety. Only 5 had mild anxiety, and 4 reported normal anxiety levels.
- (3) Stress: Twenty-two respondents had moderate stress levels, while 16 and 9 experienced extremely severe and severe stress, respectively. Four reported mild stress, and 2 had normal levels.

The study emphasizes that the COVID-19 pandemic significantly worsened mental stress, particularly for international students facing added challenges like cultural adjustment, language barriers, and social isolation. Pre-pandemic, international students had already experienced high levels of depression (45.3%) and anxiety (24.7%). The study also highlighted a correlation between higher stress levels and factors such as female gender and international status, as found in similar studies.

**Table 1.** Level of depression, anxiety, and stress of the international nursing students in the higher education institutions in the Philippines

Level	Depression		Anxiety		Stress	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Normal	2	3.8	4	7.5	2	3.8
mild	9	17.0	5	9.4	4	7.5
Moderate	16	30.2	19	35.8	22	41.5
severe	10	18.9	9	17.0	9	17.0
Extremely severe	16	30.2	16	30.2	16	30.2

#### 4.3. Correlational relationship between the demographic profile and the level of depression, anxiety, and stress

In **Table 2**, the study explored the correlational relationship between the demographic profile and the levels of depression, anxiety, and stress (DAS) among international nursing students in the Philippines.

**Table 2.** Correlational relationship between the demographic profile and the level of depression, anxiety, and stress

	Depression			Anxiety			Stress		
	Pearson's <i>r</i>	p-value	Interpretation	Pearson's <i>r</i>	p-value	Interpretation	Pearson's <i>r</i>	p-value	Interpretation
Age group	0.865	0.000	Significant	0.856	0.000	Significant	0.873	0.000	Significant
Sex	0.731	0.000	Significant	0.21	0.000	Significant	0.48	0.000	Significant
Residence style	0.849	0.000	Significant	0.839	0.000	Significant	0.863	0.000	Significant
Length of stay	0.784	0.000	Significant	0.761	0.000	Significant	0.754	0.000	Significant
Sleep scale	0.826	0.000	Significant	0.796	0.000	Significant	0.801	0.000	Significant

The analysis revealed that age group, sex, residence style, length of stay in the country, and sleep quality were all significantly associated with DAS symptoms. Age had the strongest positive correlation with stress ( $r = 0.873$ ), indicating that age may influence vulnerability to psychological distress. Residence style (living alone or off-campus) was strongly correlated with stress ( $r = 0.863$ ) and depression ( $r = 0.849$ ), suggesting that isolation may exacerbate emotional burdens. Poor sleep quality was also a significant predictor, particularly for depression ( $r = 0.826$ ) and stress ( $r = 0.801$ ), reinforcing the link between sleep disturbances and mental health issues. While sex had a moderate influence, the length of stay in the Philippines was found to correlate with all three mental health indicators, with shorter stays associated with greater distress. The findings highlight the importance of addressing demographic and lifestyle factors in providing targeted mental health support for international nursing students.

#### 4.4. Predictors of the depression, anxiety, and stress symptoms of international nursing students in higher education institutions in the Philippines

**Table 3** presents the predictors of depression, anxiety, and stress symptoms among international nursing students



in the Philippines, using multiple regression analyses. The study evaluates the effects of demographic factors such as age, sex, residence style, length of stay, and sleep quality on mental health outcomes, while controlling for other variables. The analysis revealed that age, sex, residence style, length of stay, and sleep quality significantly predicted depression symptoms.

**Table 3.**Multiple regression analysis predicting depression

Predictor	B	SE B	$\beta$	t	p-value
Age group	0.32	0.07	0.40	4.57	0.000
Sex	0.21	0.05	0.30	4.20	0.000
Residence style	0.28	0.06	0.35	4.67	0.000
Length of stay	0.19	0.07	0.25	2.71	0.008
Sleep scale	0.35	0.06	0.42	5.83	0.000

$R^2 = 0.62$ ,  $F(5, 94) = 30.55$ ,  $p < 0.001$

Key findings include:

- (1) Age group was the most influential predictor of depression, with older students (31–35 years) being more prone to depressive symptoms due to increased academic and social pressures, especially during the pandemic.
- (2) Sex showed that female students had higher depression scores, likely due to greater emotional vulnerability and caregiving roles, compounded by isolation and acculturative stress.
- (3) Residence style, particularly living alone, significantly contributed to depression symptoms, as international students often rely on family support, which was disrupted during the pandemic.
- (4) Length of stay in the host country also influenced depression, with longer stays leading to cumulative stress, though its effect was smaller than other factors.
- (5) Sleep quality was found to have a strong impact on depression. Poor sleep, exacerbated by disrupted routines during the pandemic, significantly contributed to depressive symptoms.

This study highlights that improving sleep hygiene could be an important intervention for mitigating depression among international nursing students. **Table 4** presents that the anxiety model explained 58% of the variance in anxiety symptoms among international nursing students. Key predictors included age, with older students experiencing more anxiety due to concerns about academics, visa status, career prospects, and family responsibilities, intensified by the pandemic.

**Table 4.**Multiple regression analysis predicting anxiety

Predictor	B	SE B	$\beta$	t	p-value
Age group	0.30	0.08	0.37	3.75	0.000
Sex	0.12	0.05	0.17	2.40	0.018
Residence style	0.26	0.07	0.32	3.71	0.000
Length of stay	0.21	0.06	0.28	3.31	0.001
Sleep scale	0.33	0.05	0.39	6.26	0.000

$R^2 = 0.58$ ,  $F(5, 94) = 26.06$ ,  $p < 0.001$

Poor sleep quality was strongly correlated with higher anxiety, as sleep disturbances impair emotional regulation and increase physiological arousal. International students' disrupted circadian rhythms, caused by time zone differences and increased screen time, likely contribute to sleep problems. Residence style and length of stay also influenced anxiety, with students isolated from family and support networks experiencing higher anxiety. Female students reported more anxiety, possibly due to socialization patterns and heightened sensitivity to stress. Overall, the study highlights the complex nature of anxiety, emphasizing the need for holistic support addressing sleep, social connection, and specific demographic stressors.

**Table 5** presents the factors influencing stress symptoms among Chinese International Master's in Nursing Students, finding that demographic and lifestyle behaviors significantly impact mental health.

**Table 5.** Multiple regression analysis predicting stress

Predictor	B	SE B	$\beta$	t	p-value
Age group	0.34	0.07	0.42	4.71	0.000
Sex	0.18	0.06	0.24	3.00	0.003
Residence style	0.30	0.07	0.38	4.29	0.000
Length of stay	0.22	0.07	0.28	3.14	0.002
Sleep scale	0.31	0.06	0.37	5.43	0.000

$R^2 = 0.61$ ,  $F(5, 94) = 28.73$ ,  $p < 0.001$

The stress model accounted for 61% of the variance in stress levels, with age being the strongest predictor, as older students face more academic and personal pressures. Residence style also had a strong impact, with students living alone or without family support experiencing higher stress, especially during pandemic lockdowns. Poor sleep quality was identified as another critical predictor, exacerbating stress by impairing cognitive function and creating a cycle of mental health issues. Length of stay and sex differences were also significant, with females reporting higher stress levels due to gender-specific roles. The study suggests that interventions should target older students and focus on improving sleep hygiene while addressing social isolation. These findings support the need for culturally sensitive mental health programs tailored to international nursing students, considering both psychosocial and lifestyle factors.

## 5. Summary

The study aimed to explore the prevalence and associated factors of depression, anxiety, and stress (DAS) among international nursing students in the Philippines, particularly during the COVID-19 pandemic. Key findings are summarized as follows:

- (1) **Demographics:** The majority of participants were aged 31–35 years (54.7%); Most participants were female (73.6%) and lived alone (58.5%). A significant portion had been residing in the Philippines for 1-2 years (47.2%), with sleep durations primarily between 6–8 hours (49.1%).
- (2) **Prevalence of DAS Symptoms:** (a) **Depression:** Sixteen respondents had moderate and extremely severe levels of depression; (b) **Anxiety:** Nineteen respondents experienced moderate anxiety, while 16 had extremely severe levels; (c) **Stress:** Twenty-two respondents reported moderate stress levels, while 16 and 9 experienced extremely severe and severe stress, respectively.

- (3) Correlations with demographic profiles: Depression, anxiety, and stress had strong correlations with age, with age groups showing the highest correlations (0.865 for depression, 0.856 for anxiety, 0.873 for stress). Residence style, sleep scale, nationality, length of stay, and sex were also associated with DAS symptoms, though sex had the lowest correlation for both anxiety (0.21) and depression.
- (4) Predictive factors: All demographic profiles, including age, gender, nationality, residence style, length of stay, and sleep scale, were identified as predictors of DAS symptoms among the international nursing students, suggesting these factors influence their mental health during the pandemic.

## 6. Recommendations

The recommendations of this study suggest that nursing educators should prioritize the mental health of international nursing students, especially during challenging times like the pandemic, by incorporating mental health courses and counseling mechanisms. Nursing practices should integrate mental health assessments and interventions, particularly in clinical settings, with tailored support programs for international students to develop psychological coping skills. Future research should focus on expanding the scope of this study, exploring additional influencing factors such as cultural adaptation and social support, and employing longitudinal designs to track changes in students' mental health over time. Researchers are encouraged to use the findings to create targeted interventions that address sleep quality, housing support, and culturally adapted counseling services for international students.

## 7. Conclusion

This study found high levels of DAS among International Nursing Students in the Philippines, highlighting the impact of the global health disruption, particularly the COVID-19 pandemic, on their mental health. The study emphasized the importance of considering demographic factors like age, gender, length of stay, and sleep quality when creating plans to address the psychological needs of international students in future crises. The findings call for policymakers and healthcare providers to incorporate these insights into emergency plans and educational reforms. Additionally, the study suggests that further research is needed to explore additional factors contributing to DAS among international students.

## Disclosure statement

The authors declare no conflict of interest.

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# Exploring the Application Effect of Comprehensive Geriatric Assessment Tool-Oriented Chronic Disease Trajectory Nursing in Community Elderly Hypertension

Xiaocui Wang, Qiuchen Wang, Wenwen Zhao, Lu Chen, Xiaosu Ni\*

Department of Cardiovascular Medicine, The Affiliated Taizhou People's Hospital of Nanjing Medical University, Taizhou 225300, Jiangsu, China

\*Author to whom correspondence should be addressed.

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**Abstract:** *Objective:* To study the application effect of comprehensive geriatric assessment tool-oriented chronic disease trajectory nursing in community elderly hypertension. *Methods:* Sixty nine elderly hypertensive patients admitted to the hospital from April 2022 to April 2024 were randomly assigned to the intervention group (n=35) and the control group (n=34). The control group received routine community hypertension health management, while the intervention group underwent comprehensive geriatric assessment for comprehensive screening of elderly health issues based on routine management, and implemented targeted nursing interventions based on the characteristics of the chronic disease trajectory. After three months of intervention, the blood pressure, medication compliance, self-efficacy, and quality of life of the two groups were evaluated and analyzed. *Results:* After the intervention, the intervention group showed significant improvement in blood pressure control, medication compliance, self-management efficacy scores, and quality of life scores compared to the control group ( $P < 0.05$ ). *Conclusion:* Combining comprehensive geriatric assessment with the concept of chronic disease trajectory nursing in the management of community elderly hypertension can effectively optimize the effect of chronic disease management, which has important practical value.

**Keywords:** Hypertension; Elderly patients; Comprehensive geriatric assessment tools; Chronic disease trajectory nursing; Application effects

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## 1. Introduction

Research shows that the prevalence of hypertension among people aged 60 and over in China is 40.6%, and the risk increases with age<sup>[1]</sup>. Blood pressure control is difficult for elderly patients with hypertension, and they often



suffer from multiple comorbidities, affecting their quality of life and imposing a burden on families and society [2]. The course of hypertension is long and complex, with varying characteristics and needs at different stages. Traditional nursing lacks systematicness and targeted approaches, making it difficult to meet personalized needs throughout the entire process. However, the chronic illness trajectory theory provides new ideas for nursing. It suggests that chronic diseases develop dynamically, allowing for the development of adapted nursing plans at different stages to effectively manage the disease trajectory, control the condition, and improve quality of life [3]. Comprehensive Geriatric Assessment (CGA) is a multidimensional, interdisciplinary assessment method that accurately identifies health problems and potential risks in older adults through comprehensive and systematic evaluation, providing a scientific basis for developing personalized nursing plans [4]. Combining it with chronic illness trajectory nursing is expected to provide precise and effective services for elderly hypertensive patients in the community. However, there is currently limited research on the application effects of this approach. Therefore, this study explores the application effects of this model, aiming to provide references for optimizing nursing strategies for elderly hypertensive patients in the community.

## 2. Materials and methods

### 2.1. General information

A total of 69 elderly hypertensive patients who visited our hospital from April 2022 to April 2024 were included in the study. They were randomly assigned to an intervention group (n=35) and a control group (n=34). The general information of the two groups is shown in **Table 1**.

**Table 1.** Comparison of general information [( $\bar{x} \pm s$ ), n (%)]

Item	Intervention group (n=35)	Control group (n=34)	$t/\chi^2$	$P$	
Age (years)	75.86 ± 3.45	75.66 ± 4.35	0.212	0.833	
Gender	Male	24	26	0.539	0.463
	Female	11	8	-	-
Mean disease course (years)	7.36 ± 1.26	7.51 ± 1.20	0.506	0.614	

### 2.2. Inclusion and exclusion criteria

#### 2.2.1. Inclusion criteria

- (1) Meet the diagnostic criteria for hypertension [5].
- (2) Age over 60 years old.
- (3) Signed informed consent.

#### 2.2.2. Exclusion criteria

- (1) History of mental illness or dementia.
- (2) Unable to cooperate with this study.
- (3) Long-term bedridden and unable to move.

### 2.3. Methods

The control group received routine community hypertension health management. Regular blood pressure

measurements were arranged, and patients were reminded to seek medical attention and record results once abnormalities were detected during the measurement process. Patients were guided to maintain regular sleep schedules, receive psychological counseling, and adhere to a controlled diet that promotes low salt, low fat, and low sugar intake. Patients were encouraged to exercise regularly, and nursing plans were adjusted through regular visits while closely monitoring drug allergies and side effects.

The intervention group, on the other hand, integrated comprehensive geriatric assessment tools to conduct a comprehensive screening of elderly health issues based on routine management and implemented targeted nursing interventions according to the characteristics of chronic disease trajectories.

### **2.3.1. Comprehensive Geriatric Assessment (CGA)**

- (1) Establish a professional healthcare team consisting of internists, charge nurses, nutritionists, responsible nurses, and department nursing directors. The nursing director serves as the team leader, and the department physician serves as the assistant team leader. Team members undergo training and assessment before taking up their positions.
- (2) Comprehensive assessment: Within 1–2 days of patient admission, team members establish a personal CGA file for the patient according to the CCA manual. Besides conducting medical examinations such as blood pressure, they need to record medications and disease progression. Additionally, they comprehensively evaluate the patient for multiple diseases, polypharmacy, fall risk, depressive symptoms, cognitive function, nutritional status, and audiovisual impairments.

### **2.3.2. Implement targeted nursing care based on the characteristics of chronic disease trajectories**

- (1) Initial stage of the disease: Comprehensively evaluate the patient's medication use, correct irrational drug use, and develop a scientific medication schedule based on the patient's medication status to improve compliance. Arrange multidisciplinary consultations for patients with cognitive impairments and develop targeted treatment plans. Actively communicate with patients who have negative emotions, provide psychological counseling, and share cases for inspiration. Strengthen daily care for patients with physical activity impairments, provide health education to their families, and offer assistive tools. Provide scientific dietary guidance to elderly patients with malnutrition, advising them to reduce intake of high-fat and high-sugar foods and appropriately increase intake of high-quality protein foods to improve their nutritional status.
- (2) Stable phase of disease
  - (a) Cognitive intervention: First, confirm the patient's cognition, feelings, and willingness to accept hypertension. Then use charts, questions, videos, and other forms to help them remember knowledge, pay attention to their understanding, and flexibly adjust the content and duration of education based on the patient's cultural background and psychological state to ensure effectiveness.
  - (b) Diet and exercise intervention: In the initial stage, develop a scientific diet plan based on the CGA scale assessment and the patient's dietary preferences; understand the patient's exercise contraindications and underlying diseases, plan exercise programs, duration, and frequency, and recommend low-intensity exercises such as Tai Chi and jogging, 30–60 minutes per day, weekly, with regular guidance and supervision to help them develop exercise habits.

### (3) Recovery phase of disease

- (a) Regularly organize health education in the community, invite hypertension prevention and treatment experts to give lectures, and mobilize elderly patients to participate. After the lecture, set up a Q&A session and arrange medical staff to answer patients' questions.
- (b) Blood pressure monitoring management: Teach elderly patients to correctly self-measure blood pressure, urge them to measure and record it regularly every day, and seek medical attention immediately if blood pressure continues to rise. Adjust medication or care according to doctor's advice.
- (c) Medication management guidance: Emphasize the importance of taking medication according to doctor's advice to elderly hypertensive patients, illustrate the dangers of not taking medication on time or changing the dosage without authorization with case studies, urge them to take medication on time and in the correct amount, and suggest setting an alarm clock or posting reminder cards to help them remember medication time.

## 2.4. Observation indicators

- (1) Blood pressure: Systolic and diastolic blood pressure were measured three times before and after treatment, with intervals of > 5 minutes between each measurement. The average value was calculated.
- (2) Medication adherence: Medication adherence was assessed using the Morisky Medication Adherence Scale (MMAS-8) <sup>[6]</sup>. The total score ranges from 0 to 8, with scores < 6 indicating non-adherence, 6–7 indicating partial adherence, and 8 indicating full adherence. The adherence rate was calculated as the sum of partial and full adherence rates.
- (3) Self-efficacy: Patients' self-efficacy was quantitatively evaluated before and after the intervention using the General Self-Efficacy Scale (GSES) <sup>[7]</sup>. This scale has a maximum score of 40, with higher scores indicating stronger self-efficacy.
- (4) Quality of life: The 36-Item Short Form Health Survey (SF-36) was used to assess patients' quality of life after nursing care. Scores range from 0 to 100, with higher scores indicating improved quality of life <sup>[8]</sup>.

## 2.5. Statistical analysis

Statistical analysis was performed using SPSS 24.0 software. Measurement data are presented as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ), while enumeration data are expressed as n (%). Intergroup comparisons were conducted using the t-test and  $\chi^2$  test, with a significance level set at  $P < 0.05$ .

## 3. Results

### 3.1. Blood pressure levels before and after intervention

Based on **Table 2**, after the intervention, compared with the control group, the intervention group had a significantly lower degree of blood pressure reduction ( $P < 0.05$ ).

**Table 2.** Comparison of blood pressure levels before and after intervention between the two groups ( $\bar{x} \pm s$ )

Group	<i>n</i>	Systolic blood pressure (mmHg)		Diastolic blood pressure (mmHg)	
		Before intervention	After intervention	Before intervention	After intervention
Intervention group	35	149.06 $\pm$ 4.78	133.31 $\pm$ 3.06*	95.67 $\pm$ 5.38	83.26 $\pm$ 5.22*
Control group	34	149.56 $\pm$ 4.66	137.58 $\pm$ 4.29*	95.18 $\pm$ 5.91	91.35 $\pm$ 5.61*
<i>t</i>		0.440	4.771	0.360	6.204
<i>P</i>		0.662	< 0.001	0.720	< 0.001

Note: Compared with the same group before intervention, \* $P < 0.05$ .

### 3.2. Medication compliance

After intervention, the medication compliance rate of the intervention group was higher than that of the control group ( $P < 0.05$ ), as shown in **Table 3**.

**Table 3.** Comparison of medication compliance before and after intervention between the two groups [n(%)]

Group	<i>n</i>	Full adherence n(%)	Partial adherence n(%)	Non-adherence n(%)	Adherence rate n(%)
Intervention	35	25 (73.53)	8 (23.53)	2 (5.88)	33 (94.29)
Control	34	18 (52.94)	8 (23.53)	8 (23.53)	26 (76.47)
$\chi^2$					4.417
<i>p</i> -value					0.036

### 3.3. Comparison of self-efficacy and quality of life scores

As shown in **Table 3**, after the implementation of the intervention, compared with the control group, the self-efficacy scores and quality of life scores of the intervention group were higher ( $P < 0.05$ ).

**Table 3.** Comparison of self-efficacy and quality of life scores before and after intervention between the two groups ( $\bar{x} \pm s$ , points)

Group	<i>n</i>	Self-efficacy score		Quality of life score	
		Before intervention	After intervention	Before intervention	After intervention
Intervention	35	20.35 $\pm$ 2.26	33.19 $\pm$ 1.87*	80.69 $\pm$ 3.21	90.74 $\pm$ 3.15*
Control	34	20.75 $\pm$ 2.31	26.84 $\pm$ 1.62*	79.55 $\pm$ 3.21	87.65 $\pm$ 3.02*
<i>t</i> -value		0.727	15.058	1.475	4.157
<i>p</i> -value		0.470	< 0.001	0.145	< 0.001

Note: Compared with the self-efficacy score and quality of life score of the same group before intervention, \* $P < 0.05$ .

## 4. Discussion

Hypertension, as a very common chronic disease among the elderly, has a high prevalence rate in this population and is showing a trend of increasing year by year. This disease not only causes symptoms such as dizziness and headache but also may induce cardiovascular and cerebrovascular diseases, posing a significant threat to the health and lives of elderly patients. However, current routine community management focuses on single blood

pressure monitoring and simple education, lacking comprehensive evaluation and consideration of patients' actual situations. The nursing plan is not targeted, leading to poor blood pressure control for patients. Therefore, it is essential to carry out personalized nursing intervention for elderly hypertensive patients in the community. Currently, there are studies combining comprehensive geriatric assessment tools with chronic disease trajectory nursing for diabetic patients, but there are few studies on their use in hypertensive patients<sup>[9]</sup>. Therefore, this study explores its effectiveness.

This study shows that the intervention group had better blood pressure control and medication adherence after nursing implementation than the control group. This indicates that integrating the nursing intervention of this study has significant advantages in both areas for elderly hypertensive patients in the community. This is consistent with the research results of Liu and Li<sup>[10, 11]</sup>. Analysis of the reasons: Based on routine management, the intervention group uses a comprehensive geriatric assessment to comprehensively screen patients' health problems, covering multiple diseases, multidrug use, fall risk psychological status, cognitive function, nutritional status, and audio-visual impairments. This comprehensive assessment provides accurate information for personalized nursing plans. For example, promptly correcting the problem of multidrug use ensures safe and reasonable medication use. At the same time, according to the characteristics of the chronic disease trajectory, targeted nursing is implemented at different stages of the disease. For example, a medication schedule is developed during the initial stage to improve patient adherence to taking medications on time and in the correct amounts; during the stable phase of the disease, a scientific and reasonable diet plan and exercise program are tailored according to the patient's dietary preferences and exercise contraindications, allowing multi-angle intervention in blood pressure and more effective lowering of blood pressure levels.

In terms of self-management efficacy, after the intervention was implemented, the intervention group had higher self-efficacy scores compared to the control group. The reason for this is that through cognitive intervention, patients in the intervention group gained a deeper understanding of hypertension prevention and treatment knowledge, mastered self-management skills such as self-monitoring of blood pressure, reasonable diet, and appropriate exercise, and enhanced their confidence and ability in self-management. Regular community health education activities and Q&A sessions provided a platform for patients to communicate and learn, where they could encourage and support each other, further improving self-management efficacy. Moreover, the quality of life scores in the intervention group were higher than those in the control group after the intervention in this study. This indicates that this nursing model can comprehensively improve the quality of life of elderly hypertensive patients in the community. This is the result of multiple factors such as blood pressure level control, improved medication compliance, and enhanced self-management efficacy. Good blood pressure control can reduce the occurrence of symptoms such as dizziness and headache, improving patients' daily living abilities; reasonable medication use and self-management can reduce the risk of complications and alleviate patients' physical and psychological burdens; and improved self-management efficacy allows patients to better cope with the disease and actively participate in social activities, thereby improving their quality of life.

## 5. Conclusion

In summary, combining comprehensive geriatric assessment with the concept of chronic illness trajectory nursing in the management of hypertension among elderly people in the community can effectively optimize the effectiveness of chronic disease management and has important practical value.



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## Disclosure statement

The authors declare no conflict of interest.

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# Clinical Observation of Xiaochaihu Decoction Combined with Xiaoxianxiong Decoction in the Treatment of Post-stroke Pneumonia

Jun Dai<sup>1</sup>, Erchun Zhu<sup>2</sup>, Jian Liu<sup>1</sup>, Yanan Zhu<sup>1</sup>

<sup>1</sup>Siyang Kangda Hospital, Si Yang 223700, Jiangsu, China

<sup>2</sup>Huaian Second People's Hospital, Huaian 223000, Jiangsu, China

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**Abstract:** *Objective:* To investigate the clinical efficacy of Xiaochaihu Decoction combined with Xiaoxianxiong Decoction in the treatment of post-stroke pneumonia. *Methods:* To complete the sample grouping comparison, all patients with post-stroke pneumonia were investigated, and the number of cases was 60. These patients' diseases were consistent with the dialectical standards of traditional Chinese medicine (phlegm-heat obstructing lungs). The patients were randomly divided into a control group (30 cases, treated with antibiotics and symptomatic methods) and a treatment group (30 cases, treated with Xiaochaihu Decoction and Xiaoxianxiong Decoction on the basis of the control group). Various indicators were compared. *Results:* The total clinical effective rates were 93% and 80% in the treatment group and the control group, respectively, with statistical significance ( $P < 0.05$ ). The improvement of various clinical symptoms was compared, and the values in the treatment group were reduced, showing significance ( $P < 0.05$ ). Analysis of serum factor indicators showed that the overall trend of the treatment group was reduced, and the comparison between groups was below 0.05. *Conclusion:* Xiaochaihu Decoction combined with Xiaoxianxiong Decoction has a significant clinical effect in the treatment of post-stroke pneumonia (phlegm-heat obstructing lungs syndrome), which can reduce inflammatory reactions and has few adverse reactions, worthy of clinical application.

**Keywords:** Post-stroke pneumonia; Xiaochaihu Decoction combined with Xiaoxianxiong Decoction; Traditional Chinese medicine therapy; Cough

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## 1. Introduction

Stroke disease poses significant risks to the body, characterized by high probabilities of disability, morbidity, and mortality<sup>[1]</sup>. For example, lung inflammation, fully known as stroke-associated pneumonia (SAP for short), can lead to death if not treated promptly<sup>[2]</sup>. Relevant studies suggest that SAP patients are in critical condition, which can significantly increase the short-term and long-term mortality rates of stroke patients, with the

mortality rate increasing threefold within one month<sup>[3]</sup>. Domestic research indicates a 35.97% incidence of SAP. This disease can prolong hospital stays and require higher treatment costs. Therefore, while ensuring the control of the patient's condition, intervention measures need to be optimized and adjusted according to the specific situation of the patient. Most Western medicine treatments involve the use of anti-inflammatory and anti-infective drugs to target the patient's condition specifically. However, the long-term effects are not satisfactory, and they can lead to drug resistance in pathogenic bacteria and various complications.

Traditional Chinese medicine has conducted in-depth and meticulous research and analysis on SAP, and relatively satisfactory results can be achieved through integrated traditional Chinese and Western medicine treatment<sup>[4, 5]</sup>. The combination of Xiaochaihu Decoction and Xiaoxianxiong Decoction can achieve the effects of controlling inflammation, suppressing viruses, and adjusting the body's immune function. To demonstrate the effectiveness of the combined treatment with Xiaochaihu Decoction and Xiaoxianxiong Decoction, the following content investigates stroke-associated pneumonia patients and conducts a deep exploration.

## **2. Basic information and methodology**

### **2.1. Basic information**

From January 2023 to May 2024, Si Yang Kangda Hospital conducted a study on patients visiting different departments. A total of 60 patients were selected for the study, coming from the departments of neurology, intensive care unit (ICU), and respiratory medicine. These patients were diagnosed with post-stroke pneumonia according to Western medicine standards, and their TCM syndrome differentiation was phlegm-heat obstructing the lungs. A randomized controlled study was conducted using a random number table based on patient medical record numbers. The patients were divided into a treatment group and a control group, with 30 patients in each group. In the treatment group, the male-to-female ratio was 17:13. The age range was 40-84 years, with a mean age of  $(68.68 \pm 8.35)$  years. The types of underlying diseases included 23 cases of ischemic stroke and 7 cases of hemorrhagic stroke. In the control group, the male-to-female ratio was 16:14. The age range was 39-86 years, with a mean age of  $(69.11 \pm 8.97)$  years. The types of underlying diseases included 22 cases of ischemic stroke and 8 cases of hemorrhagic stroke. All patients in both groups voluntarily participated in the study, and there were no significant differences in their basic characteristics ( $P > 0.05$ ). This study has been ethically reviewed and approved by the hospital's medical ethics committee (Ethics Approval Number: 20221202). Both patients and their families signed informed consent forms for this study.

### **2.2. Inclusion criteria**

#### **2.2.1. Reference standards for Western medicine diagnosis of SAP**

The diagnosis of Western medicine refers to the "Chinese Expert Consensus on the Diagnosis and Treatment of Stroke-Associated Pneumonia (2019 Updated Edition)"<sup>[1]</sup>:

- (1) Combined with fever symptoms, with a body temperature not lower than 38°C.
- (2) Imaging examination reveals the presence of lesions in the lungs, which show infiltrative growth.
- (3) Investigation of patient symptoms reveals frequent coughing, expectoration, chest pain, and severe respiratory conditions.
- (4) Diagnostic examination reveals substantial lesions in the lungs, and auscultation reveals wet rales.
- (5) White blood cell count level in routine blood tests is below  $4 \times 10^9/L$  or above  $10 \times 10^9/L$ .

Criteria (1) is a necessary condition for the diagnosis of SAP, and meeting any two of the remaining criteria is sufficient for a diagnosis of SAP. However, in the diagnostic process, it is necessary to differentiate it from other types of lung diseases, such as pulmonary edema, tuberculosis, and non-infectious interstitial lung diseases.

### 2.2.2. Reference standard for syndrome differentiation of traditional Chinese medicine

The diagnosis of traditional Chinese medicine refers to the “Guiding Principles for Clinical Research of New Chinese Medicines”<sup>[6]</sup>. The patient’s TCM symptoms include “sticky phlegm, excessive phlegm, fever, chest tightness and chest pain”, constipation, abdominal discomfort.

### 2.3. Exclusion criteria

- (1) Patient has lung infection.
- (2) Patient’s disease diagnosis does not match the “Chinese Expert Consensus on the Diagnosis and Treatment of Stroke-Associated Pneumonia (2019 Updated Edition)”.
- (3) Allergic symptoms appear during treatment.
- (4) Abnormal cognitive understanding ability, unable to communicate normally.
- (5) Abnormal function of major organs in the body.
- (6) Accompanied by comprehensive diseases of the blood and endocrine systems.
- (7) Gastrointestinal bleeding.

### 2.4. Therapeutic methods

All patients completed baseline treatment with antibiotics and symptomatic medications, with specific antibiotics selected according to drug susceptibility tests (sputum culture and blood culture)<sup>[7]</sup>. In addition to the control group’s regimen, the treatment group received modified Xiaochaihu Decoction (Minor Bupleurum Decoction) combined with Xiaoxianxiong Decoction (using Tianjiang Pharmaceutical’s standardized granules): *Bupleurum* root (Chaihu) 18g; *Scutellaria* root (Huangqin), *Pinellia* rhizome (Banxia), Ginseng (Renshen), prepared licorice root (Zhigancao), fresh ginger (Shengjiang), and jujube (Dazao) 6g each; *Coptis* root (Huanglian) 3g, and *Trichosanthes* seed (Gualouzi) 10g<sup>[8]</sup>.

Modifications included: for high fever, gypsum (Shigao) granules 30–90g; for constipation, rhubarb (Dahuang) granules 9g; for cerebral infarction, earthworm (Dilong) granules 10g and angelica root (Danggui) granules 6g; for cerebral hemorrhage, leech (Shuizhi) granules (processed by scalding) 3g. The decoction was administered orally or via nasogastric tube twice daily for 1–2 weeks.

### 2.5. Observation indicators

- (1) Record the time of fever resolution, disappearance of lung rales on auscultation, and length of hospital stay.
- (2) Observe traditional Chinese medicine symptoms such as cough, expectoration, sputum volume, and wheezing.
- (3) Monitor changes in blood routine (white blood cells, neutrophils), hypersensitive C-reactive protein, and procalcitonin levels.

## 2.6. Evaluation criteria for therapeutic effect

The evaluation criteria are based on whether the patient's symptoms have improved and whether laboratory test results are within the normal range. The evaluation is divided into three categories: cured, improved, and ineffective. Finally, investigate the total effective rate, calculated based on both cured and improved cases.

## 2.7. Statistical methods

Statistical software used was SPSS version 23.0. Data were counted using two modes: mean and percentage. The corresponding test methods used were *t*-test and chi-square test to verify whether the *p*-value was below 0.05.

## 3. Results

### 3.1. Evaluation of therapeutic effectiveness between groups

The total clinical effective rates were compared between the treatment group and the control group. The survey values were 93% and 80%, respectively, which was statistically significant ( $P < 0.05$ ), as shown in **Table 1**.

**Table 1.** Comparison of clinical therapeutic effectiveness between two groups of SAP patients (%)

Group	Cases (n)	Recovered n(%)	Effective n(%)	Ineffective n(%)	Total efficacy (%)
Treatment	30	28	28	2	93*
Control	30	24	24	6	80

Note: \* $P < 0.05$  compared with the control group

### 3.2. Disappearance time of various symptoms

The improvement of various clinical symptoms was compared, and the numerical values were reduced in the treatment group, which was statistically significant ( $P < 0.05$ ), as shown in **Table 2**.

**Table 2.** Comparison of disappearance time of main symptoms and signs between two groups of SAP patients ( $\bar{x} \pm s$ ,  $n=30$ )

Group	Cough duration (days)	Sputum duration (days)	Fever resolution (days)	Rales resolution (days)
Treatment	$2.12 \pm 0.55^*$	$2.23 \pm 0.63^*$	$3.75 \pm 1.12^*$	$3.37 \pm 0.89^*$
Control	$4.81 \pm 0.77$	$4.18 \pm 0.82$	$4.33 \pm 1.78$	$5.16 \pm 1.18$

Note: \* $P < 0.05$  compared with the control group

### 3.3. Comparative analysis of inflammatory markers (WBC, N%, CRP, PCT) before and after treatment

The comparison between the two groups before and after treatment regarding White Blood Cells (WBC), Neutrophil Percentage (N%), C-Reactive Protein (CRP), and Procalcitonin (PCT) in serum showed no significant difference before treatment, but significant differences were observed after treatment, with a *P*-value within 0.05. Specifically, all indicators in the treatment group decreased, and the comparison between groups yielded a *P*-value below 0.05, as shown in **Table 3**.



**Table 3.** WBC, N%, CRP, PCT (before and after treatment) ( $\bar{x} \pm s$ , n=30)

Group	Time Point	WBC ( $\times 10^9/L$ )	Neutrophils (%)	CRP (mg/L)	PCT (ng/mL)
Treatment	Pre-Tx	14.66 $\pm$ 2.77	84.38 $\pm$ 4.37	68.22 $\pm$ 10.06	0.21 $\pm$ 0.59
	Post-Tx	5.92 $\pm$ 3.12* <sup>#</sup>	62.87 $\pm$ 4.22* <sup>#</sup>	7.18 $\pm$ 2.49* <sup>#</sup>	0.06 $\pm$ 0.02* <sup>#</sup>
Control	Pre-Tx	14.43 $\pm$ 2.58	85.67 $\pm$ 4.29	67.18 $\pm$ 9.78	0.22 $\pm$ 0.62
	Post-Tx	7.78 $\pm$ 4.22 <sup>#</sup>	71.19 $\pm$ 4.56 <sup>#</sup>	16.61 $\pm$ 3.53 <sup>#</sup>	0.10 $\pm$ 0.03 <sup>#</sup>

Note: \* $P < 0.05$  compared with before treatment, <sup>#</sup> $P < 0.05$  compared with the control group after treatment

## 4. Discussion

SAP is a common complication after stroke, influenced by factors such as infection, malnutrition, multiple organ dysfunction, multidrug resistance, sepsis, gastrointestinal bleeding, and other complications. SAP increases economic burden and mortality rate, especially for patients with large-area cerebral infarction or cerebral hemorrhage who have undergone tracheotomy, where the incidence of multidrug-resistant bacteria is increased. Western medicine often uses antibiotics and other comprehensive interventions to treat this disease, along with symptomatic treatment, but the treatment effect is poor. Currently, there is no direct description of SAP in ancient Chinese medical books, but it can be diagnosed and treated as diseases such as fever, cough, and asthmatic syndrome. In the pathogenesis of SAP, phlegm, deficiency, heat, and blood stasis are the main influencing factors<sup>[9]</sup>. In SPA patients with internal deficiency and evil invasion, phlegm and heat evil invade the lungs, leading to typical symptoms such as cough and fever. As the disease progresses, clinical symptoms such as hematemesis and constipation may appear, significantly increasing the difficulty of treatment. In the treatment of SAP with Chinese medicine, based on the patient's pathogenesis, comprehensive use of heat-clearing, blood stasis-removing, meridian-dredging, and strengthening the body and eliminating evil intervention programs can achieve relatively good treatment results<sup>[9]</sup>.

This study shows that the total clinical effective rate, comparing between the treatment group and the control group, was 93% and 80% respectively, with statistical significance ( $P < 0.05$ ). Comparing the improvement of various clinical symptoms, the values decreased in the treatment group, showing significance ( $P < 0.05$ ). Analysis of serum factor indicators revealed that the overall trend in the treatment group decreased, and the comparison between groups was below 0.05. Xiao Chai Hu Tang has a significant effect in eliminating inflammation and resisting viruses, effectively regulating immune function in the body. After treatment intervention, it can control patients' body temperature in a short time and stabilize their condition<sup>[10]</sup>. Chai Hu is a Chinese herbal medicine with anti-inflammatory effects. After administration, it can improve the permeability of capillaries, effectively reduce local inflammatory reactions, regulate the comprehensive permeability of capillaries, and strengthen the interference effect on inflammatory reaction mechanisms. The anti-inflammatory components of Huang Qin are baicalin and its experience in treating acute and critical illnesses such as lung infection and acute exacerbation of chronic obstructive pulmonary disease, as well as baicalein. These components significantly control the release of proinflammatory cells. As the level of anti-inflammatory cytokines increases, various adverse inflammatory reactions in patients improve. Ginseng enhances nonspecific immunity, while licorice root has a significant anti-inflammatory effect. Ginger, like licorice root, can exert an anti-inflammatory effect and promote gradual fever reduction in the body, effectively relieving fever symptoms<sup>[11]</sup>.

Xiaoxianxiong Tang is a classic formula derived from the "Treatise on Febrile Diseases". It consists of

three herbs: Gualou, Banxia, and Huanglian. It is suitable for the treatment of typhoid and diseases related to external evil heat invasion. It can alleviate the treatment of diseases related to phlegm-heat stagnation in the heart, and its efficacy is stable and lasting, with high treatment safety<sup>[12, 13]</sup>. Through pharmacological analysis, it can be found that the main function of Xiaoxianxiong Tang is antibacterial and anti-inflammatory. It can kill pathogenic bacteria infected in patients, reduce local inflammatory reactions, and thereby alleviate the clinical symptoms of respiratory diseases. Clinically, it is often used in the comprehensive treatment of pleurisy, acute bronchitis, and other diseases.

Leech is specifically used to treat blood stagnation, dispel blood stasis, dissipate masses, and unblock meridians. Its nature tends to penetrate deeply, effectively reducing masses and dispelling blood stasis, easily breaking blood without damaging new blood, and attacking phlegm, blood stasis, turbidity, and toxin in the brain. Modern pharmacological studies have shown that this product has anticoagulation, antithrombotic, thrombosis prevention, thrombus dissolution, promotion of cerebral edema absorption, improvement of microcirculation, and protection of brain tissue. Earthworm has the functions of clearing heat, calming wind, and promoting meridian activity. The medicinal properties are wandering, and it is good at activating meridians. Earthworm can activate meridians and collaterals, and also has the effect of dispelling phlegm, treating both phlegm and blood stasis<sup>[14]</sup>.

## 5. Conclusion

In summary, the clinical efficacy of Xiaochaihu Tang combined with modified Xiaoxianxiong Tang in the treatment of SAP (syndrome of phlegm and heat obstructing the lungs) is significant, which can reduce inflammatory reactions with few adverse reactions. Its application value is suitable for further clinical research in the future. For drug treatment methods, doctors need to actively investigate various situations of patients, complete comprehensive management based on the comprehensive condition, inform patients of issues that need attention during treatment, including diet, exercise, and other content, and guide patients to self-monitor their condition and conduct regular check-ups. However, the sample size of this study is small, especially for stroke-associated pneumonia patients with syndrome of phlegm and heat obstructing the lungs. In the future, it is necessary to further optimize and adjust various experimental procedures, increase research time, and add medical records from multiple centers for comprehensive comparative analysis and research. The specific mechanism of Xiaochaihu Tang combined with modified Xiaoxianxiong Tang in the treatment of SAP (syndrome of phlegm and heat obstructing the lungs) still requires further analysis and research.

## Disclosure statement

The authors declare no conflict of interest.

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# Analysis of Clinical Application Effect of Autologous Fat Granule Transplantation in Facial Depression Plastic Surgery

Hangli Wu, Qin Yin, Wenjie Gao\*

<sup>1</sup>Shaanxi Provincial People's Hospital, Department of Burns, Plastic and Cosmetic Surgery, Xi'an 710068, Shaanxi, China

<sup>2</sup>Department of Plastic Surgery, Zhen'an County People's Hospital, Shangluo 711500, Shaanxi, China

\*Author to whom correspondence should be addressed.

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**Abstract:** *Objective:* To explore the clinical application effect of autologous fat granule transplantation in facial depression plastic surgery. *Methods:* A total of 98 patients with facial depression admitted to the plastic surgery department of our hospital from January 2021 to December 2023 were selected and divided into observation group (49 cases) and control group (49 cases) according to the random number table method. The observation group was treated with autologous fat granule transplantation, while the control group was treated with hyaluronic acid filling. The total effective rate of treatment, incidence of postoperative complications, improvement indicators of facial morphology (depth of depression, symmetry), and effect maintenance rate after 6 months of follow-up were compared between the two groups. *Results:* The total effective rate of treatment in the observation group was 93.88% (46/49), which was significantly higher than that in the control group (79.59%, 39/49) ( $P < 0.05$ ). The incidence of postoperative complications in the observation group was 6.12% (3/49), which was lower than that in the control group (20.41%, 10/49) ( $P < 0.05$ ). One month after surgery, the depth of depression ( $1.23 \pm 0.31$  mm) and symmetry ( $1.02 \pm 0.15$  points) in the observation group were better than those in the control group ( $P < 0.05$ ). After 6 months of follow-up, the effect maintenance rate in the observation group was 89.80% (44/49), which was significantly higher than that in the control group (67.35%, 33/49) ( $P < 0.05$ ). *Conclusion:* Autologous fat granule transplantation for the treatment of facial depression can significantly improve facial morphology, enhance treatment effect and patient satisfaction, reduce the incidence of complications, and maintain a more durable effect. It is a clinically preferred facial depression plastic surgery solution.

**Keywords:** Autologous fat granule transplantation; Facial depression; Plastic surgery; Clinical effect; Hyaluronic acid filling

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# 1. Introduction

Facial depression is a condition caused by congenital dysplasia, trauma, aging, and other factors that lead to the loss of facial soft tissue volume, commonly seen in the temporal, cheek, forehead, and apple muscle areas <sup>[1]</sup>. The incomplete facial contour not only affects the aesthetic appearance but may also cause patients to experience psychological issues such as inferiority complex and social avoidance <sup>[2]</sup>. With the development of plastic surgery techniques, facial depression filling has become a common clinical cosmetic procedure. Currently, commonly used filling methods include autologous fat granule transplantation, hyaluronic acid filling, and prosthesis implantation <sup>[3]</sup>. Autologous fat granule transplantation is widely used in facial filling due to its advantages, such as being sourced from the patient's own body, good biocompatibility, natural and long-lasting effects <sup>[4]</sup>. The principle involves purifying fat granules from other parts of the body (such as the abdomen or thighs) and transplanting them into the facial depression area. The surviving fat tissue can maintain the filling effect for a long time <sup>[5]</sup>. Compared to hyaluronic acid filling (which requires repeated injections) and prosthesis implantation (which carries the risk of rejection), autologous fat granule transplantation aligns more closely with the concept of "natural beauty" <sup>[6]</sup>. However, further research is needed to improve the understanding of its long-term effects and complication control in clinical practice. This study aims to provide a reference for clinical decision-making in facial depression cosmetic surgery by comparing the clinical effects of autologous fat granule transplantation and hyaluronic acid filling among patients with facial depression treated in our hospital's plastic surgery department.

## 2. Materials and methods

### 2.1. General materials

Ninety-eight patients with facial depression admitted to the plastic surgery department of the hospital from January 2021 to December 2023 were selected. The patients were randomly divided into an observation group (autologous fat granule transplantation) and a control group (hyaluronic acid filling) using a random number table, with 49 patients in each group. There was no statistically significant difference in general information between the two groups ( $P > 0.05$ ), indicating comparability (**Table 1**). This study was approved by the hospital ethics committee.

**Table 1.** Comparison of general information between two groups of patients

Group	Observation group (n=49)	Control group (n=49)	$t/\chi^2$	$P$
Gender (Male/Female, n)	12/37	10/39	0.213	$> 0.05$
Age (years)	$32.6 \pm 7.5$	$33.2 \pm 8.1$	0.382	$> 0.05$
Depressed area (n)	Temporal	16	0.576	$> 0.05$
	Buccal	17		
	Frontal	9		
	Others	7		
Depression depth (mm)	$3.8 \pm 1.2$	$3.9 \pm 1.1$	0.417	$> 0.05$
History of cosmetic procedures (Yes/No, n)	8/41	6/43	0.289	$> 0.05$

During CVC catheterization, due to the proximity of the puncture site to the neck, patients may turn their heads due to tension or pain. Inclusion criteria: (1) Age 18–55 years, regardless of gender; (2) Clearly defined facial depression (single or multiple areas such as the temples, cheeks, or forehead) with a depression depth



≥ 2 mm; (3) No severe underlying diseases (e.g., diabetes, coagulation disorders); (4) No facial infections or skin ulcers; (5) Patients and their families are informed and have signed a consent form. Exclusion criteria: (1) Insufficient fat volume in the donor area; (2) Allergy to hyaluronic acid or anesthetic drugs; (3) Facial plastic surgery within the past 3 months; (4) Pregnant or lactating women; (5) Patients with mental disorders.

## **2.2. Methods**

### **2.2.1. Observation group (Autologous fat granule transplantation)**

- (1) Fat Acquisition: The patient's abdomen or inner thigh was selected as the supply area, and the liposuction range was marked. Tumescence anesthesia was used (0.9% sodium chloride solution 500mL + 2% lidocaine 20mL + epinephrine 0.5mg). After percutaneous puncture, a 20mL syringe was connected to a 2.5mm diameter liposuction needle, and fat granules were suctioned in a fan shape with negative pressure (-0.5MPa) to avoid excessive negative pressure causing fat cell damage.
- (2) Fat purification: Place the extracted fat particles into a sterile centrifuge tube and centrifuge at 1200r/min for 3 minutes to remove the upper layer of oil, the lower layer of bloody water and fibrous tissue, retaining the pure fat particles in the middle layer.
- (3) Fat injection: Mark the injection range in the facial depression area, and apply local infiltration anesthesia (2% lidocaine). Use a 1mL syringe connected to a 23G blunt injection needle to perform multi-level, multi-tunnel injections along the subcutaneous fat layer and SMAS layer (Superficial Musculo-Aponeurotic System). During injection, use the "withdraw the needle while injecting" technique to avoid excessive injection at a single point. The injection volume is 120% of the expected filling volume (to allow for fat absorption), and gently rub and shape after injection to ensure even distribution of fat particles.
- (4) Postoperative treatment: Apply pressure dressing to the surgical area for 24 hours, avoid pressing and hot compresses, take antibiotics orally for 3 days to prevent infection, and avoid strenuous activities for 1 week.

### **2.2.2. Control group**

Cross-linked hyaluronic acid (model: Restylane SubQ) was selected, and the injection level was adjusted according to the depressed area: for deep depressions (such as the temporal region), it was injected into the upper layer of the periosteum, while for superficial depressions (such as the cheek area), it was injected into the subcutaneous fat layer. After local anesthesia, a 1mL syringe connected to a 27G injection needle was used to slowly inject the hyaluronic acid, shaping it while injecting. The injection volume was adjusted until the depression was filled, avoiding excess that could lead to unnatural contours. After surgery, pressure was applied to the surgical area for 5 minutes to stop bleeding, and patients were instructed to avoid rubbing the area and exposure to high temperatures.

## **2.3. Observation indicators**

- (1) Treatment effect: Evaluated 1 month after surgery. Significant effect: Complete resolution of facial depression, natural contour, and good symmetry; Effective: Improvement of facial depression ≥ 60%, basically natural contour; Ineffective: Improvement of facial depression < 60% or significant asymmetry. Total effective rate = (Significant effect + Effective) / Total number of cases × 100%.
- (2) Facial morphological indicators: The depth of the depression (the vertical distance between the deepest

point of the depression and the surrounding normal skin) and symmetry (morphological difference score of bilateral corresponding sites, 0-3 points, the lower the score, the better the symmetry) were measured using a facial 3D scanner 1 month after surgery.

- (3) Complications: Complications within 1 month after surgery were recorded, including infection, hematoma, fat liquefaction (autologous fat group), hyaluronic acid displacement (control group), local induration, etc.
- (4) Effect maintenance rate: Follow-up for 6 months, assessed by comparing facial photos. If the recurrence of depression is < 20%, the effect is considered well-maintained, and the maintenance rate is calculated.

## 2.4. Statistical methods

Data were analyzed using SPSS 26.0 software. Measurement data were expressed as ( $\bar{x} \pm s$ ), and independent sample t-tests were used for comparisons between groups; Count data were expressed as percentages, and  $\chi^2$  tests were used for comparisons between groups.  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Comparison of treatment effects between the two groups

The total effective rate of the observation group was 93.88%, which was significantly higher than that of the control group, which was 79.59% ( $P < 0.05$ ), as shown in **Table 2**.

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

Group	No. of cases	Markedly effective	Effective	Ineffective	Total effective rate
Observation group	49	32 (65.31%)	14 (28.57%)	3 (6.12%)	46 (93.88%)
Control group	49	20 (40.82%)	19 (38.78%)	10 (20.41%)	39 (79.59%)
$\chi^2$					4.346
$P$					0.037

### 3.2. Comparison of facial morphology indicators between the two groups

There was no statistically significant difference in the depth of depression and symmetry between the two groups before surgery ( $P > 0.05$ ). One month after surgery, both indicators in the observation group were significantly better than those in the control group ( $P < 0.05$ ), as shown in **Table 3**.

**Table 3.** Comparison of facial morphology indicators between the two groups ( $\bar{x} \pm s$ )

Measurement	Time point	Observation group (n=49)	Control group (n=49)	t-value	P-value
Depression depth (mm)	Preoperative	3.81 $\pm$ 1.22	3.92 $\pm$ 1.14	0.417	> 0.05
	1 Month Post-op	1.23 $\pm$ 0.31	1.85 $\pm$ 0.42	8.172	< 0.05
Symmetry score (points)	Preoperative	2.12 $\pm$ 0.51	2.22 $\pm$ 0.41	1.020	> 0.05
	1 Month Post-op	1.02 $\pm$ 0.15	1.43 $\pm$ 0.21	10.683	< 0.05

### 3.3. Comparison of complication rates between the two groups

The incidence of complications in the observation group was significantly lower than that in the control group ( $P$

< 0.05), as shown **Table 4**.

**Table 4.** Comparison of postoperative complications between the two groups [n(%)]

Group	Infection	Hematoma	Fat necrosis	HA displacement	Local induration	Total incidence
Observation group (n=49)	1 (2.04%)	1 (2.04%)	1 (2.04%)	0 (0%)	0 (0%)	3 (6.12%)
Control group (n=49)	3 (6.12%)	2 (4.08%)	0 (0%)	3 (6.12%)	2 (4.08%)	10 (20.41%)
$\chi^2$						4.346
<i>P</i>						0.037

### 3.4. Comparison of effect maintenance rates between the two groups of patients

After 6 months of follow-up, the effect maintenance rate in the observation group was 89.80% (44/49), which was significantly higher than that in the control group, which was 67.35% (33/49) ( $\chi^2=7.333$ ,  $P=0.007$ ).

## 4. Discussion

The theoretical foundation of facial morphological aesthetics originates from the symmetry of facial anatomical structures and the coordination of volume distribution. Essentially, the formation of facial depression is an anatomical morphological change caused by the atrophy of subcutaneous adipose tissue, loss of tissue volume, or abnormalities in facial bone structure. The correction principle is based on the “structure-function” repair theory of tissue engineering, which aims to restore the normal anatomical layers and mechanical balance of facial soft tissue by supplementing the missing volume.

This study shows that the total effective rate of autologous fat granule transplantation for the treatment of facial depression (93.88%) is significantly higher than that of hyaluronic acid filling (79.59%), and the improvement in facial morphology is more pronounced. Its core advantages lie in:

- (1) Good biocompatibility: Autologous fat granules originate from the individual, eliminating immune rejection reactions and avoiding potential allergies or foreign body reactions that may be caused by allogeneic materials such as hyaluronic acid.
- (2) Long-lasting effects: Surviving fat cells can maintain volume for extended periods, whereas hyaluronic acid is degraded and absorbed within 6–12 months, requiring repeated injections<sup>[7]</sup>.
- (3) Skin quality improvement: Stem cells within the fat granules can secrete cytokines, promoting skin collagen regeneration and enhancing facial skin elasticity<sup>[8]</sup>.

Based on the follow-up results of this study, the 6-month effect maintenance rate in the observation group (89.80%) was significantly higher than that in the control group (67.35%), which is consistent with the conclusion of previous studies that “surviving fat after autologous fat transplantation can exist stably for a long time”<sup>[9]</sup>. This is significant in reducing the economic and psychological burden of repeated treatments for patients.

The incidence of complications from autologous fat granule transplantation (6.12%) was lower than that from hyaluronic acid filling (20.41%). The complications were mainly mild (such as 1 case of fat liquefaction), while in the control group, hyaluronic acid displacement (3 cases) and local induration (2 cases) were related to material properties. The reasons for this are analyzed as follows:

- (1) Fat purification process: In this study, the centrifugation method (1200r/min, 3 minutes) was used to purify fat, effectively removing impurities and reducing inflammatory stimulation<sup>[10]</sup>.

- (2) Injection technique: Multi-level injection avoids fat accumulation and reduces the risk of liquefaction, while excessive single-point injection of hyaluronic acid can easily form induration.
- (3) Material stability: The surviving fat integrates with surrounding tissues, while hyaluronic acid is prone to displacement due to gravity and facial expression muscle movement<sup>[11]</sup>. After fat transplantation, pressure should be avoided within 1 week to prevent obstruction of blood circulation in fat cells; after hyaluronic acid filling, exposure to high temperatures should be avoided to slow down the degradation rate of the material<sup>[12]</sup>.

Suggestions for optimizing surgical operations:

- (1) Fat acquisition: Choosing inner thigh fat (with higher fat cell activity than the abdomen) can improve the survival rate; controlling the negative pressure (-0.5MPa) during fat suction to avoid rupture of fat cells.
- (2) Fat injection: Using a “blunt needle + multi-level” injection to reduce blood vessel damage; reserving 20% absorption space in the injection volume to avoid excessive filling leading to bulky contours.
- (3) Combined therapy: For patients with severe depression, fat transplantation can be performed first to improve the basic contour, followed by a supplementary injection 3 months later to enhance the overall effect.

This study was a single-center study with a small sample size; it did not compare the effects of different fat purification methods (such as filtration vs. centrifugation); the follow-up time was only 6 months, and long-term effects require further observation.

## 5. Conclusion

In summary, autologous fat granule transplantation has significant advantages in facial depression plastic surgery. It can effectively improve facial contours, enhance treatment effects and patient satisfaction, and has few complications and long-lasting results. Clinicians should standardize surgical operations (such as optimizing fat purification and precise injection) to further improve fat survival rate and provide patients with better cosmetic results.

## Disclosure statement

The authors declare no conflict of interest.

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# A Study on the Diagnostic Ability of MRI for Modic Changes and Endplate Sclerosis in the Lumbar Spine

Tuanmao Guo <sup>1</sup>, Yuan Xiao <sup>1</sup>, Yanli Xing <sup>2\*</sup>

<sup>1</sup>Department of Orthopaedics, Xianyang Central Hospital, Xianyang 712000, Shaanxi, China

<sup>2</sup>Department of Pharmacy, Xianyang Central Hospital, Xianyang 712000, Shaanxi, China

*\*Author to whom correspondence should be addressed.*

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**Abstract:** *Objective:* To investigate the diagnostic value of magnetic resonance imaging (MRI) in patients with Modic changes and endplate sclerosis of the lumbar spine. *Methods:* A total of 66 patients with lumbar spine diseases who underwent MRI and CT diagnostic examinations at the hospital from May 2024 to April 2025 were included in this study. The MRI findings of Modic changes were compared between Type I and Type II patients, and the presence or absence of endplate sclerosis signals and the HU value ratio on CT were analyzed. The pathological characteristics of Modic changes in Type I and Type II patients were observed. The imaging features of Modic changes in patients with lumbar spine diseases were analyzed. *Results:* Modic changes were present in 34 patients, with a total of 204 endplates evaluated, of which 74 were affected. MRI classification showed: Type I in 8 cases (10.81%), Type I/II mixed in 10 cases (13.51%), Type II in 51 cases (68.92%), and Type II/III mixed in 5 cases (6.76%). In CT reconstruction images, 26 endplates with Modic changes on MRI showed sclerosis in the vertebral body, presenting high-density sclerotic features. These sclerotic areas did not exhibit distinct signal characteristics on MRI but pathologically demonstrated Type II Modic changes concurrently with fatty degeneration and sclerosis; In patients with Modic changes of Type I and Type II, regardless of the presence or absence of endplate sclerosis, the sagittal T1/T2 signal intensity ratio showed no statistically significant difference ( $P > 0.05$ ). However, the HU value ratio in Type II changes with sclerotic regions ( $2.74 \pm 0.61$ ) was significantly higher than that in regions without sclerosis ( $1.16 \pm 0.23$ ), with a statistically significant difference ( $P < 0.05$ ). *Conclusion:* CT reconstruction images of patients with lumbar Modic changes clearly demonstrate endplate sclerosis, a phenomenon closely associated with the bone marrow repair process. MRI has limited sensitivity for detecting sclerosis, potentially due to the following factors: first, differences in the radiographic characterization of endplate mineral content; second, the specific influence of different Modic types on signal intensity. This suggests that MRI classification should be combined with CT features for comprehensive interpretation.

**Keywords:** Magnetic resonance imaging; CT; Lumbar spine; Modic changes; Endplate sclerosis; Diagnostic value

**Online publication:** September 4, 2025

# 1. Introduction

Endplate changes are primarily caused by bone marrow and endplate damage. Existing studies have shown a significant association between endplate changes and intervertebral disc degeneration<sup>[1]</sup>. With advances in imaging technology, MRI has become the primary diagnostic method for assessing Modic changes and endplate sclerosis in the lumbar spine. It can sensitively detect abnormal bone marrow signals in the adjacent endplate region and clearly show signal characteristic changes in the endplate and subendplate bone in patients with disc herniation, providing important imaging evidence for clinical decision-making<sup>[2]</sup>. According to international classification standards, Modic changes are categorized into Type I (oedematous stage), Type II (lipid-rich stage), and Type III (osteosclerotic stage) based on MRI signal characteristics and histopathological changes<sup>[3]</sup>. Given the low clinical incidence of Type III changes, this study focuses on patients with Type I and Type II changes. A total of 66 patients with lumbar spine diseases admitted between May 2024 and April 2025 were selected as the study subjects, systematically analyze the diagnostic efficacy of MRI in identifying Modic Type I and Type II endplate sclerosis, explore the imaging characteristics of different subtypes, particularly the visualization of endplate sclerosis, and clarify the sensitivity of MRI in distinguishing mineralization from fat infiltration during bone marrow repair. The specific details are as follows.

## 2. Materials and methods

### 2.1. General data

The study included 66 patients with lumbar spine disorders admitted to the hospital from May 2024 to April 2025. Among them, 39 were male and 27 were female, with ages ranging from 30 to 72 years, and an average age of  $(47.14 \pm 8.65)$  years. The study was approved by the Ethics Committee of our hospital and conducted in accordance with medical ethical standards.

#### 2.1.1. Inclusion criteria

- (1) Persistent lower back pain symptoms
- (2) Complete clinical records

#### 2.1.2. Exclusion criteria

- (1) Localized structural abnormalities of the lumbar spine
  - (2) Post-spinal fusion surgery or MRI examination results were unsatisfactory
  - (3) Failure to sign the informed consent form.
- 1.2 Methods All enrolled patients underwent MRI and CT examinations.

## 2.2. Methods

### 2.2.1. MRI examination

Imaging was performed using a 1.5T MRI scanner and a phase-array spinal coil. Sagittal T1-weighted images were acquired using a fast spin-echo sequence with the following parameters: repetition time (TR) 420 ms, echo time (TE) 9.4 ms, echo train length 3, number of echoes 4, matrix  $320 \times 192$ , field of view (FOV)  $35 \times 35$  cm, slice thickness 4 mm, and slice spacing 1 mm. Sagittal T2-weighted images were acquired using a fast reverse recovery sequence combined with fast spin-echo technology, with the following parameters: TR 3000 ms, TE 117 ms, echo sequence length 25, number of echoes 4, matrix  $320 \times 224$ , and FOV and slice thickness settings

identical to the T1 sequence. Fat suppression scanning uses chemical shift selective saturation, implemented on the basis of the fast spin echo inversion recovery sequence, with scanning parameters identical to those of the sagittal T2 sequence. All image data are transmitted to the ADW4.4 workstation for post-processing, and signal intensity values of the endplates and bone marrow regions are measured using specialized software.

### 2.2.2. CT examination

During CT sagittal image reconstruction, a 64-slice spiral scanning system with a matching detector was used for axial scanning. The original data reconstruction slice thickness was set to 0.625 mm, and sagittal images were obtained using multi-planar reconstruction (MPR) technology, with the reconstruction slice thickness adjusted to 4 mm. All image data are uploaded to the ADW4.4 workstation for quantitative analysis, thereby obtaining high-resolution sagittal reconstruction images, which provide the technical foundation for measuring CT values of endplate sclerosis.

### 2.3. Observation indicators

Compare the CT manifestations of endplate sclerosis between patients with Modic Type I and Type II changes, measure the MRI signal intensity ratio of the affected endplates and the CT HU value ratio, and systematically analyze the imaging characteristics of patients with Modic Type I and Type II changes.

### 2.4. Statistical methods

Data analysis was performed using SPSS 18.0. Quantitative data were expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ) and analyzed using t-tests; categorical data were expressed as percentages (%) and analyzed using  $\chi^2$  tests.  $P < 0.05$  indicated statistically significant differences.

## 3. Results

### 3.1. Comparison of endplate sclerosis signal intensity on CT between Type I and Type II MRI-involved endplates

Among 66 patients, 34 (51.52%) exhibited Modic changes, involving a total of 74 endplates, accounting for 36.27% of the total assessed endplates. The MRI classification distribution was as follows: Type I: 8 (10.81%), Type I/II mixed: 10 (13.51%), Type II: 51 (68.92%), Type II/III mixed: 5 (6.76%). CT reconstruction revealed high-density sclerosis signs in 26 endplates, with Type II changes simultaneously exhibiting both fatty degeneration and sclerosis features. Comparative analysis revealed: Regardless of the presence or absence of endplate sclerosis, there was no statistically significant difference in the T1/T2 signal intensity ratio in the sagittal plane between Type I and Type II Modic changes ( $P > 0.05$ ), as shown in **Table 1**.

**Table 1.** Comparison of signal intensity between MRI-involved endplates with and without endplate sclerosis in CT scans for Modic Type I and Type II lesions ( $\bar{x} \pm s$ )

Subtype	Number	Sagittal T1 signal intensity ratio		Sagittal T2 signal intensity ratio	
		Sclerosis present	No sclerosis	Hardening present	No sclerosis
Modic change type I	8	0.53 $\pm$ 0.12	0.57 $\pm$ 0.21 *	0.32 $\pm$ 0.04	0.37 $\pm$ 0.14 *
Modic change type II	51	1.50 $\pm$ 0.51	1.53 $\pm$ 0.51 *	0.49 $\pm$ 0.13	0.54 $\pm$ 0.21 *

Note: Compared with the same subtype with sclerosis, \* $P > 0.05$

### 3.2. Comparison of HU value ratios of CT-detected endplate sclerosis in Type I and Type II MRI-involved endplates

In Modic Type I changes, the CT value ratios for endplates with and without sclerosis were ( $1.91 \pm 0.50$ ) and ( $1.76 \pm 0.14$ ), respectively, with no statistically significant difference ( $P > 0.05$ ). In Modic Type II changes, the CT value ratio of endplates with sclerosis was ( $2.74 \pm 0.61$ ), significantly higher than that of the group without sclerosis ( $1.16 \pm 0.23$ ), with a statistically significant difference ( $P < 0.05$ ).

### 3.3. Modic changes in patients with Type I and Type II lesions

In Modic Type I patients, the endplate and subendplate bone appear as low signal intensity on T1-weighted images (T1WI) and high signal intensity on T2-weighted images (T2WI). The edges of the endplate are blurred with thin abnormal signal intensity, and there is no swelling or mass in the surrounding soft tissues. In Modic Type II patients, the endplate and subendplate bone appear as high signal intensity on T1WI and isointense or slightly hyperintense on T2WI. Adjacent vertebral bone marrow shows signs of fat infiltration. Both types of changes exhibit abnormal endplate structure, but there are significant differences in signal characteristics and pathological changes.

## 4. Discussion

Modic changes (MC) of the endplates and subendplate bone in the lumbar spine are important MRI markers of intervertebral disc degeneration and are significantly associated with chronic low back pain. According to the Modic classification, Type I (low signal on T1/high signal on T2) represents bone marrow oedema and fibrosis, Type II (high signal on T1/equal or high signal on T2) represents fat replacement, while Type III changes (low signal on both T1 and T2) clearly correspond to sclerosis of the endplates and subchondral bone<sup>[4]</sup>. However, conventional MRI sequences (e.g., T1WI, T2WI) have inherent limitations in detecting bone sclerosis, with significantly poorer ability to visualize cortical bone and micro-sclerotic lesions compared to CT. Although Type III Modic changes are defined on MRI as low signal intensity on both T1 and T2, distinguishing them from focal calcification of the degenerative endplate and partial volume effect artifacts in actual clinical readings is often challenging, leading to reduced diagnostic consistency and potential misdiagnosis<sup>[5]</sup>. Therefore, a systematic evaluation of conventional and advanced MRI sequences (such as gradient echo sequences and ultra-short echo time sequences) for detecting Modic Type III sclerosis changes, characterizing their features with high accuracy, and distinguishing their diagnostic value has become an urgent need to improve the precise imaging assessment of vertebral endplate degeneration<sup>[6]</sup>. This study aims to investigate the diagnostic efficacy of different MRI sequences (including conventional and optimized sequences) in identifying Modic Type III endplate sclerosis changes in the lumbar spine through rigorous imaging-histology or CT gold standard comparison designs.

The results revealed that although Type II changes exhibit histological features of fat infiltration, CT reconstruction images clearly demonstrated that 35.14% of the affected endplates (26/74) simultaneously exhibited high-density sclerosis signs, confirming that Type II changes actually coexist with both fatty degeneration and sclerosis<sup>[7]</sup>. This study also found that regardless of whether endplate sclerosis was detected by CT, there was no statistically significant difference in the sagittal T1/T2 signal intensity ratio between Modic Type I and Type II changes ( $P > 0.05$ ), further confirming that MRI signal ratios lack sensitivity for endplate sclerosis. The mechanism may be related to the following factors: (1) The interference effect of mineral deposits in the sclerotic area on MR signals is limited; (2) The presence of fatty tissue signals weakens the imaging characteristics of sclerosis; (3) The complexity of tissue composition at different repair stages leads to signal variability<sup>[8]</sup>.



The MRI imaging capability of endplate sclerosis in lumbar Modic changes is directly correlated with bone marrow mineral content. Studies on osteoblastomas have shown that reactive bone sclerosis exhibits low signal intensity in sagittal T1/T2 fast spin-echo sequences. Pathological findings confirm that endplate sclerosis is essentially caused by abnormal calcium deposition in the interstitial tissue. Notably, reactive sclerosis accompanied by bone oedema exhibits a characteristic signal pattern, which is particularly typical in the progression of arthritis: during the acute phase, the anterior margin of the intervertebral joint shows non-sclerotic T1 low/T2 high signal intensity, which transitions to non-sclerotic T1 high/T2 high signal intensity in the chronic phase<sup>[9]</sup>.

Pathology defines osteophytosis as an abnormal increase in bone mass per unit volume of bone. Endplate sclerosis can present two mineralization states: complete mineralization with dense calcium deposition, and partial mineralization with significantly reduced calcium deposition<sup>[10]</sup>. This difference in mineralization directly determines the sensitivity of MRI to detect sclerosis—partially mineralized areas with insufficient calcium deposition exhibit reduced magnetic susceptibility, leading to insufficient signal attenuation in T1/T2 sequences, explaining why Modic Type II, despite histological sclerosis, did not show statistically significant MRI signal ratios in this study. In terms of MRI features of Modic Type I changes, the subendplate bone marrow exhibits well-defined, homogeneous patchy signals, with some cases showing low-signal bands surrounding the lesions; T2WI primarily shows homogeneous high signals, but multiple lesions often present with blurred borders. Modic Type II lesions exhibit abnormal fat deposition within the vertebral body, with typical features including irregular punctate or scattered patchy signal patterns, whose distribution characteristics show no clear association with the anatomical orientation of the endplates. CT and X-ray studies confirm that the endplate sclerosis observed in Modic Type II patients reflects pathological changes in the microenvironment of the vertebral trabeculae within the lumbar vertebrae.

However, this study found that the sclerosis lesions observed in CT images of both Modic Types I and II may correspond to the regenerative state of newly formed bone during the bone marrow repair process. This mechanism establishes an intrinsic link between the progression of intervertebral disc degeneration in patients with low back pain and Modic changes, providing a new pathophysiological perspective for clinical research. It is worth noting that MRI imaging of endplate sclerosis is constrained by two factors: on the one hand, it depends on the mineral content within the bone marrow—completely mineralized regions form typical low signals due to dense calcium deposits, while partially mineralized regions exhibit minimal signal attenuation due to insufficient calcium deposition; on the other hand, it is closely related to Modic classification: in Type II changes, the high T1 signal of fatty tissue masks accompanying sclerosis signs, explaining why the CT value ratio ( $2.74 \pm 0.61$ ) was significantly higher in the Type II sclerosis group in this study, but the MRI signal ratio showed no statistical difference; High-density sclerosis lesions detected by CT can be regarded as biomarkers of the bone marrow repair process, while MRI classification primarily reflects the qualitative changes in bone marrow components. Therefore, comprehensive imaging assessment is crucial—when patients with Modic Type II changes present with persistent lower back pain, CT-confirmed endplate sclerosis may indicate active bone remodelling, providing imaging evidence for targeted treatment.

## 5. Conclusion

In summary, CT reconstruction images of lumbar Modic changes effectively demonstrate endplate sclerosis, a feature closely associated with the bone marrow repair process. MRI has limited sensitivity in visualizing sclerosis, with mechanisms involving two factors: first, endplate mineral content influences signal attenuation; second, different Modic classifications (especially Type II with fat infiltration) introduce specific interference in image contrast.



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## Disclosure statement

The authors declare no conflict of interest.

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# The Mechanism by Which AGE Activates EGFR-mediated Diabetic Kidney Disease Fibrosis by Regulating the Balance of Tyrosine Phosphatase SHP1/SHP2

Lin Li<sup>1,2</sup>, Limin Zhang<sup>1,2</sup>, Juan Ji<sup>1,2</sup>, Qian Zhang<sup>1,2</sup>, Song Li<sup>3</sup>, Qian Wang<sup>1,2\*</sup>

<sup>1</sup>Department of Nephrology, Affiliated Hospital of Hebei University, Baoding 071000, Hebei, China.

<sup>2</sup>Key Laboratory of Bone Metabolism and Physiology in Chronic Kidney Disease of Hebei Provincem, Baoding 071000, Hebei, China.

<sup>3</sup>Department of Urology, Affiliated Hospital of Hebei University, Baoding 071000, Hebei, China.

\*Corresponding author: Qian Wang, 18532671529abc@sina.com

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**Abstract:** *Objective:* To investigate the mechanism by which advanced glycation end products (AGEs) promote diabetic kidney disease fibrosis by regulating the tyrosine phosphatase SHP1/SHP2 balance and activating the epidermal growth factor receptor (EGFR) pathway. *Methods:* Animal experiments and in vitro cell experiments were conducted using Western blot analysis and tissue cell staining to detect the expression of relevant proteins and cellular morphological changes. *Results:* AGEs disrupt the SHP1/SHP2 balance, activate the EGFR and TGFβ pathways, and promote fibrosis in diabetic nephropathy. *Conclusion:* AGEs regulate the balance of tyrosine phosphatases SHP1/SHP2, activate the EGFR-mediated signaling pathway, promote the release of inflammatory factors, and ultimately lead to fibrosis in diabetic nephropathy through a novel mechanism.

**Keywords:** Advanced glycation end products; Tyrosine phosphatase; Epidermal growth factor receptor; Diabetic nephropathy; Fibrosis

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## 1. Introduction

Diabetic kidney disease is one of the common microvascular complications of diabetes, with renal fibrosis as its primary pathological feature, severely threatening patients' health and quality of life<sup>[1]</sup>. The pathogenesis of this condition is complex, and current research generally suggests that its occurrence is primarily associated with multiple factors such as impaired glucose metabolism, haemodynamic changes, endothelial dysfunction,

inflammatory responses, cytokines, oxidative stress, genetic factors, the kinin system, and autophagy<sup>[2]</sup>. Common clinical treatments for diabetic kidney disease include controlling blood glucose and blood pressure, managing blood lipids, and inhibiting the renin-angiotensin system. However, all metabolic control measures and other interventions fail to effectively prevent progressive renal function decline in some patients. Therefore, it is essential to conduct in-depth research into the pathogenesis of diabetic kidney disease to identify new treatment strategies<sup>[3]</sup>. With further research, it is now widely recognized in clinical practice that one of the key factors contributing to the development of diabetic kidney disease is the accumulation of advanced glycation end products (AGEs) in the body, the balance of tyrosine phosphatases SHP1 and SHP2 in cellular signal transduction, and the activation of epidermal growth factor receptors (EGFR) in relation to renal fibrosis<sup>[4]</sup>. However, whether AGEs activate EGFR through regulating the SHP1/SHP2 balance to mediate diabetic kidney disease fibrosis remains unclear. This study will investigate this mechanism through animal experiments and in vitro cell experiments, aiming to provide a theoretical basis for the prevention and treatment of diabetic kidney disease.

## **2. Materials and methods**

### **2.1. Experimental materials**

- (1) Experimental animals: Healthy male C57BL/6 mice, 8 weeks old, purchased from a laboratory animal centre.
- (2) Cells: Human renal tubular epithelial cells (HK-2), purchased from a cell bank.
- (3) Main reagents: Streptozotocin (STZ), AGE, TGF $\beta$ 1, SHP1 antibody, SHP2 antibody, p-SHP1 antibody, p-SHP2 antibody, EGFR antibody, p-EGFR antibody,  $\alpha$ -smooth muscle actin ( $\alpha$ -SMA) antibody, type I collagen (Col I) antibody, etc.
- (4) Main instruments: Microscope, Western blot-related equipment, centrifuge, etc.

### **2.2. Methods**

#### **2.2.1. Animal experiment section**

- (1) Animal grouping and modelling: Ten healthy mice were randomly selected as the control group. The experimental group consisted of model mice, which were modelled by intraperitoneal injection of streptozotocin (STZ) (60 mg/kg). After successful modelling, the experimental group was divided into a negative experimental group (model mice, no special treatment, 10 mice) and a positive experimental group (model mice, treated with AGE intervention, 10 mice).
- (2) Sample collection: After the experiment, the mice were euthanized, and kidney tissue was collected. Part of the tissue was used for histological staining, and the remaining portion was used for Western blot analysis.

#### **2.2.2. In vitro experiment section**

- (1) Cell grouping
  - (a) Cell groups without TGF $\beta$  pathway stimulation: Normal control group (HK-2 cells, normal culture), AGE-treated group (HK-2 cells, treated with AGE).
  - (b) Cell groups with TGF $\beta$  pathway stimulation: TGF $\beta$ 1 stimulation group (HK-2 cells, treated with TGF $\beta$ 1), TGF $\beta$ 1 + AGE treatment group (HK-2 cells, treated with TGF $\beta$ 1 and AGE concurrently).

## (2) Cell treatment

Cells were treated according to their respective groups, cultured for a specified period, and then harvested.

### 2.2.3. Tissue cell staining and morphological observation

Perform HE staining and Masson staining on kidney tissue and cells. Observe morphological changes in cells from each group under a microscope, and collect and analyze images.

### 2.2.4. Western blot analysis

Extract total protein from tissues and cells of each group, perform Western blot analysis, and determine the expression levels of SHP2, p-SHP2, p-SHP1, EGFR, p-EGFR,  $\alpha$ -SMA, and Col I. Use GAPDH as an internal control and analyze protein relative expression levels using grey scale values.

## 2.3. Statistical analysis

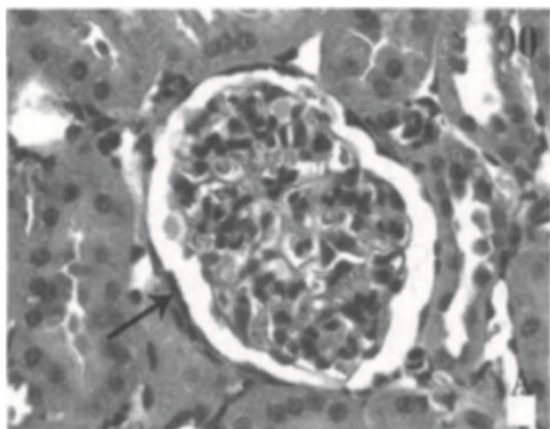
Data analysis was performed using SPSS 22.0 statistical software. Quantitative data were expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ). For comparisons among multiple groups, one-way analysis of variance (ANOVA) was used, and LSD-t tests were used for pairwise comparisons between groups. A  $P$  value  $< 0.05$  was considered statistically significant.

## 3. Results

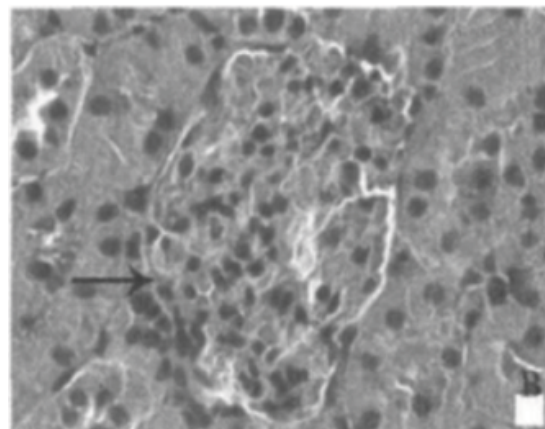
### 3.1. Animal experiment results

#### 3.1.1. Morphological changes in renal tissue cells of mice in different groups

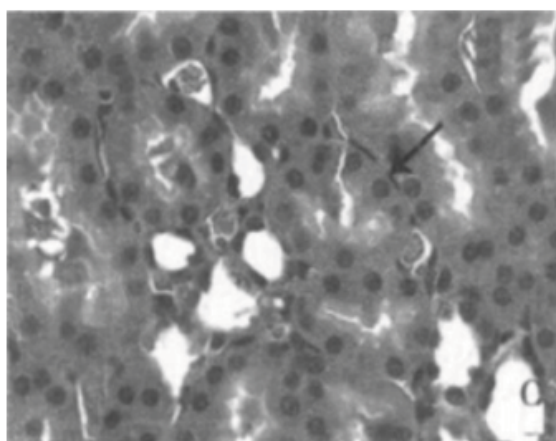
Histological staining revealed that the renal glomeruli, proximal tubules, and distal tubules of the control group mice showed no obvious abnormalities, with intact structures. In the positive experimental group, renal tissue exhibited varying degrees of pathological changes, such as severe swelling of the glomeruli, narrowing of the glomerular capsules, and disappearance of the interglomerular spaces; renal tubular epithelial cells were severely swollen and degenerated, while the distal tubules showed no obvious abnormalities, as shown in **Figure 1**.



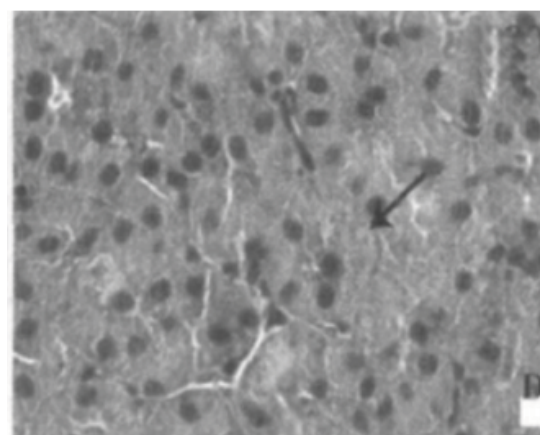
Control group glomeruli



Glomeruli in the positive group



Control group proximal tubules



Positive group proximal tubules

**Figure 1.** Histopathological images of kidney tissues from the two groups of rats stained with HE ( $\times 400$ )

### 3.1.2. Expression levels of relevant proteins in kidney tissues of mice in each group

Western blot analysis revealed that, compared with the control group, the expression levels of SHP2, p-SHP2, p-EGFR,  $\alpha$ -SMA, and Col I were elevated in the kidneys of mice in the negative experimental group, while the expression level of p-SHP1 was decreased. However, some differences were not statistically significant ( $P > 0.05$ ). The trends in the expression levels of the aforementioned proteins in the positive experimental group were consistent with those in the negative experimental group, and the differences were statistically significant ( $P < 0.05$ ). Compared with the negative experimental group, the expression levels of SHP2, p-SHP2, p-EGFR,  $\alpha$ -SMA, and Col I were significantly increased, while the expression level of p-SHP1 was significantly decreased in the positive experimental group ( $P < 0.05$ ). Specific data are shown in **Table 1**.

**Table 1.** Relative expression levels of relevant proteins in kidney tissues of mice in each group ( $\bar{x} \pm s$ ,  $n=10$ )

Group	SHP2	p-SHP2	p-SHP1
Control	1.02 $\pm$ 0.11	1.01 0. $\pm$ 0.09	1.03 0. $\pm$ 0.10
Negative control group	1.21 $\pm$ 0.13	1.25 $\pm$ 0.15	0.85 $\pm$ 0.12
Positive control group	1.89 $\pm$ 0.21	1.95 $\pm$ 0.23	0.42 $\pm$ 0.08
<i>t</i>	3.5282/8.7065	4.3386/8.0614	3.6440/9.4284
<i>p</i>	0.0024/0.0000	0.0004/0.0000	0.0019/0.0000

Note: *t*-value, *p*-value: compared with the control group/compared with the negative control group

## 3.2. In vitro experimental results

### 3.2.1. Expression levels of related proteins in cell groups without stimulation of the TGF $\beta$ pathway

In the absence of TGF $\beta$  pathway stimulation, compared with the normal control group, the expression levels of SHP2, p-SHP2, p-EGFR,  $\alpha$ -SMA, and ColI were significantly increased, while the expression level of p-SHP1



was significantly decreased in the AGE-treated group ( $P < 0.05$ ). Specific data are shown in **Table 2**.

**Table 2.** Relative expression levels of proteins in cell groups without stimulation of the TGF $\beta$  pathway ( $\bar{x} \pm s$ , n=3)

Group	SHP2	p-SHP2	p-SHP1
Normal control group	1.00 $\pm$ 0.07	1.01 ( $\pm$ ) 0.06	1.03 ( $\pm$ ) 0.09
AGE-treated group	1.65 $\pm$ 0.18	1.72 $\pm$ 0.21	0.58 $\pm$ 0.12
<i>t</i>	5.8293	5.6307	5.1962
<i>p</i>	0.0043	0.0049	0.0065

### 3.2.2. Expression levels of proteins associated with TGF $\beta$ pathway stimulation in cell groups

Under TGF $\beta$  pathway stimulation, compared with the TGF $\beta$ 1 stimulation group, the expression levels of SHP2, p-SHP2, p-EGFR,  $\alpha$ -SMA, and ColI were significantly increased, while the expression level of p-SHP1 was significantly decreased in the TGF $\beta$ 1+AGE treatment group ( $P < 0.05$ ). Specific data are shown in **Table 3**.

**Table 3.** Relative expression levels of proteins associated with TGF $\beta$  pathway stimulation in cell groups ( $\bar{x} \pm s$ , n=3)

Group	SHP2	p-SHP2	p-SHP1
TGF $\beta$ 1-stimulated group	1.52 $\pm$ 0.16	1.58 ( $\pm$ , 0.18)	0.72 ( $\pm$ ) 0.10
TGF $\beta$ 1 + AGE treatment group	2.15 $\pm$ 0.22	2.23 $\pm$ 0.24	0.35 $\pm$ 0.07
<i>t</i>	4.0113	3.7528	5.2501
<i>p</i>	0.0160	0.0199	0.0063

### 3.2.3. Morphological changes in cells of each group

When the TGF $\beta$  pathway was not stimulated, the cell morphology of the normal control group was regular and neatly arranged. In the AGE-treated group, cell morphology changed, with varying degrees of deformation and abnormal proliferation. When the TGF $\beta$  pathway was stimulated, the cell morphology of the TGF $\beta$ 1-stimulated group showed some changes, while the cell morphology of the TGF $\beta$ 1+AGE-treated group changed more significantly, with disordered cell arrangement and more pronounced fibrotic features.

## 4. Discussion

Fibrosis, as an important manifestation of chronic inflammation, plays a significant role in the pathological classification of DKD. The histological manifestations of glomerular and tubular fibrosis are similar, primarily characterized by the accumulation of extracellular matrix components (such as type I, III, and IV collagen, as well as fibronectin and desmin) and the proliferation of interstitial fibroblasts<sup>[5]</sup>. Immune cells, as the primary executors of the inflammatory process, also play an important role in the fibrosis process of DKD<sup>[6]</sup>. In recent years, renal cell differentiation and fibrosis-related signalling pathways have received increasing attention<sup>[7]</sup>. Numerous studies have shown that AGE levels are highly correlated with the progression of (sugar) metabolic diseases and play an important role in the pathological mechanisms of these diseases; The EGFR signaling pathway plays a crucial role

in physiological processes such as cell growth, proliferation, and differentiation; studies have shown that EGFR-mediated diabetic kidney disease fibrosis <sup>[8]</sup>; while research into the mechanisms by which AGEs participate in diabetic kidney disease fibrosis may provide new therapeutic targets for the treatment of diabetic kidney disease.

This study investigated the mechanism by which AGEs activate GFR-mediated diabetic kidney disease fibrosis through regulating the SHP1/SHP2 balance via animal experiments and in vitro cell experiments. In animal experiments, it was found that in the positive control group of mice, the expression levels of SHP2 and p-SHP2 in kidney tissue were significantly increased, while the expression level of p-SHP1 was significantly decreased. Additionally, the expression of p-EGFR,  $\alpha$ -SMA, and Col I was significantly increased, and the degree of kidney tissue fibrosis was markedly exacerbated. This suggests that AGEs may promote the fibrotic progression of diabetic nephropathy by disrupting the SHP1/SHP2 balance and activating EGFR <sup>[9]</sup>. In vitro experiments showed that AGE treatment led to similar results regardless of whether the TGF $\beta$  pathway was stimulated or not, with increased expression of SHP2, p-SHP2, p-EGFR,  $\alpha$ -SMA, and ColI, and decreased expression of p-SHP1, with these changes being more pronounced when the TGF $\beta$  pathway was stimulated. The TGF $\beta$  pathway is an important signaling pathway promoting renal fibrosis <sup>[10]</sup>. This result suggests that AGEs may synergistically interact with the TGF $\beta$  pathway by regulating the SHP1/SHP2 balance to further activate EGFR, thereby exacerbating renal fibrosis. SHP1, as a phosphodiesterase associated with tumor suppressor genes, typically exerts negative regulation on cellular signaling pathways; whereas SHP2 often acts as a positive regulator in signal transduction <sup>[11]</sup>. AGE may inhibit SHP1 activity through a certain mechanism while promoting SHP2 activation, disrupting the SHP1/SHP2 balance, thereby lifting the inhibition on EGFR, leading to elevated p-EGFR levels, and subsequently activating downstream fibrosis-related signals, promoting the expression of fibrosis markers such as  $\alpha$ -SMA and Col I, ultimately resulting in renal fibrosis <sup>[12]</sup>.

## 5. Conclusion

In summary, AGE can promote the fibrotic progression of diabetic kidney disease by regulating the balance of tyrosine phosphatases SHP1/SHP2 and activating EGFR, with this effect being more pronounced when the TGF $\beta$  pathway is stimulated. This suggests that regulating the SHP1/SHP2 balance may be a potential therapeutic target for treating fibrosis in diabetic kidney disease.

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# Discussion on the Key Role and Practice of Operating Room Nurses in Infection Control

Meng Wu

Operating Room, Jingzhou Central Hospital, Jingzhou 434020, Hubei, China

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**Abstract:** This paper focuses on the key role and practical paths of operating room nurses in infection control, and studies the difficult problems in the prevention and control of surgical site infections. Analyze the infection risk links in the operating room and the core responsibilities of nurses, reveal the multiple role mechanisms of nurses in infection control, design practical strategies from dimensions such as process optimization, skill improvement, and monitoring feedback, and construct an infection control system involving all staff. Research shows that operating room nurses can effectively reduce the risk of infection, improve medical quality, provide core guarantees for patient safety, and promote the transformation of operating room infection control towards refined management through practical actions such as standardized operation execution, real-time risk monitoring, and team collaboration supervision.

**Keywords:** Operating room nurse; Infection control; Surgical safety; Nursing practice; Risk prevention and control

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## 1. Introduction

As a high-risk medical facility, the quality of infection control in the operating room is directly related to the postoperative recovery and life safety of patients. Surgical site infection can prolong the hospital stay, may cause serious complications, and increase the medical burden. Operating room nurses, as direct participants throughout the surgical process, play a key role in infection control. The standardization of operation and awareness of risk prevention and control directly affect the incidence of infection. This paper deeply explores the mechanism and practical strategies of nurses in infection control. It is of great significance for improving the prevention and control system, enhancing the team's prevention and control capabilities, and ensuring patient safety, providing practical support for the quality management of operating rooms.

## **2. The current situation of infection control in operating rooms and the role positioning of nurses**

### **2.1. The current situation and risk links of infection control**

At present, infection control in operating rooms is confronted with multiple risks and challenges. Incomplete sterilization of preoperative instruments, lack of intraoperative environmental monitoring, and improper disposal of postoperative waste can all lead to infections. Insufficient compliance of hand hygiene among surgical personnel and non-standard implementation of aseptic operations are common risk points. Inadequate skin preparation for patients and overly long operation times can also increase the probability of infection. The current prevention and control system has the problem of emphasizing process formulation over implementation supervision. Some nurses have insufficient understanding of the risks of new infections, and their emergency response capabilities need to be improved. Moreover, infection control mostly relies on personal experience and lacks a standardized and all-staff prevention and control mechanism, making it difficult to meet the infection prevention and control needs of complex surgical scenarios.

### **2.2. The infection control role of operating room nurses**

Operating room nurses play multiple roles as executors, supervisors, and coordinators in infection prevention and control <sup>[1]</sup>. At the implementation level, core prevention and control measures such as aseptic technical operations and instrument sterilization management must be effectively implemented without the slightest oversight. During the supervision process, it is necessary to always pay attention to whether the operations of surgical personnel are compliant and whether there are any changes in environmental risks. Any violations found should be corrected immediately. The coordination work should take into account the prevention and control arrangements for each link before, during, and after the operation, so that the infection control requirements of multiple departments can be precisely connected. The training on infection prevention and control knowledge is also undertaken by nurses, who systematically impart operation norms to newly recruited staff, allowing the prevention and control concept to permeate every detail of the entire surgical process and become the core force supporting the efficient operation of the infection control system.

## **3. The key role mechanism of operating room nurses in infection control**

### **3.1. The guaranteeing role of the implementation of operation norms**

Operating room nurses have built the first line of defense for infection prevention and control with strict operating norms. Before the operation, conduct precise checks on the sterilization effect of the instruments and the integrity of the packaging to ensure that every sterile item meets the usage standards. During the operation, skin disinfection and towel laying should be carried out in a standardized manner to keep the boundaries of the sterile area clear. At the same time, attention should be paid to whether the sterile clothing worn by the surgical personnel is standardized and whether hand hygiene is implemented properly. After the operation, contaminated dressings and instruments should be properly treated, and disinfection, sterilization or harmless disposal should be carried out according to their categories. Every operation was carried out strictly in accordance with the prevention and control guidelines, using standardized actions to reduce human errors and keep the risk of infection at the lowest level, laying a solid foundation for the safety of the surgery.



### **3.2. The real-time monitoring role of risk links**

Operating room nurses rely on their professional sensitivity to conduct real-time monitoring of infection risk links. Before the operation, assess the patient's underlying diseases, nutritional status, and other infection susceptibility factors, and formulate personalized prevention and control plans based on this. During the operation, closely monitor the changes in temperature, humidity, and air cleanliness of the surgical environment, adjust the parameters of the purification system in a timely manner, and at the same time pay attention to the placement and usage status of items on the sterile instrument table to avoid cross-contamination. After the operation, monitor any abnormal manifestations such as bleeding, redness, and swelling of the dressing at the surgical site and report them to the doctor immediately for handling. Full-process risk monitoring can identify potential infection risks at an early stage, buy precious time for the implementation of intervention measures, and effectively reduce the possibility of infection.

### **3.3. The coordinating and supervisory role of team behavior**

As core members of the surgical team, operating room nurses bear the responsibility of coordinating and supervising the infection control behavior of the entire team. Before the operation, an infection risk assessment meeting was organized to clearly define the prevention and control responsibilities of each member <sup>[2]</sup>. During the operation, when non-standard actions such as crossing the sterile area or not replacing damaged gloves in time were found among the surgical personnel, timely corrections were made through gesture reminders and soft prompts. After the operation, the team was organized to jointly review and carefully analyze the weak links in the prevention and control work of the day. Nurses coordinate the prevention and control work of different professionals with effective communication skills, ensuring that surgeons, anesthesiologists, technicians, and other types of personnel strictly follow the unified prevention and control standards, and thus unite the overall strength of the prevention and control work.

### **3.4. The leading and disseminating role of prevention and control culture**

Operating room nurses shoulder the responsibility of leading and disseminating in the construction of infection control culture. In their daily work, they always practice the prevention and control concept of "patient safety first", gradually making standardized operation a professional instinct. During the process of team collaboration, actively share experiences in infection prevention and control, such as the specific application methods of new disinfection technologies, thereby promoting the overall awareness of prevention and control within the team. For intern nurses and trainees, a "one-on-one" teaching model is adopted. Through demonstration operations, key points of prevention and control are conveyed, and implicit practical experience is transformed into clear operational norms. The active participation of nurses can create a cultural atmosphere where "everyone attaches importance to prevention and control and everything implements norms", making infection control the common direction of the entire team's efforts <sup>[3]</sup>.

## **4. Practical strategies for infection control among operating room nurses**

### **4.1. Optimization of preoperative infection prevention and control preparations**

During the preoperative preparation stage, it is necessary to strengthen the prevention and control of all elements of infection. Nurses should check the sterilization monitoring reports of surgical instruments in advance and

confirm the sterilization qualification through dual verification of physical and chemical monitoring. Specialized inspections are carried out on precision instruments to prevent infection risks caused by instrument issues. One day before the operation, patients are guided to complete skin cleaning and skin preparation. Non-invasive shaving methods are adopted to reduce the risk of skin damage. Appropriate antibacterial soap solutions are selected based on the surgical site to ensure the effectiveness of skin preparation. The purification system in the operating room is activated 30 minutes before the operation. Simultaneously monitor the number of air dust particles and the index of settled bacteria, and prepare sterile dressings and protective equipment that meet the specifications to lay a solid foundation for the safety of the surgical environment.

#### **4.2. The aseptic operation norms during the operation were followed**

The entire process of aseptic operation during the operation must be strictly controlled. Nurses assist surgical personnel in completing hand disinfection and wearing aseptic clothing to ensure that the wearing process is standardized and correct. At the same time, they check the integrity and size compatibility of aseptic gloves. Instrument nurses implement precise management of aseptic instrument tables, reasonably place instruments in the order of use, and promptly replace contaminated instrument trays. Always keep the sterile area at the edge of the table clean and dry, and avoid crossing the sterile area during the transfer of instruments<sup>[4-6]</sup>. The mobile nurses closely monitor the flow of people in the operating rooms, restrict the entry of non-essential personnel, strictly control the frequency and duration of opening the operating room doors, closely monitor the compliance of aseptic operations by surgical personnel, immediately stop and correct any violations found, and ensure that each link in the operation meets the specific requirements of infection prevention and control.

#### **4.3. Enhanced control of postoperative infection risk**

Postoperative infection risk control should continue until 72 hours after the operation. Nurses should properly dispose of surgical waste. Contaminated dressings and discarded tissues should be sorted and placed in special medical waste bags. Sharp tools should be placed in puncture-proof containers to avoid contamination during the removal process. Immediately after the operation, conduct a preliminary cleaning of the surgical instruments. Use enzyme washing to remove organic residues. Select appropriate sterilization methods based on the material and precision of the instruments. Record the parameters of the entire cleaning and sterilization process. Terminal disinfection in the operating room must be implemented. Wipe the surfaces of objects with chlorine-containing disinfectants, disinfect the air through ultraviolet light or hydrogen peroxide fumigation, and replace all disposable protective equipment and cleaning tools. Create a sterile environment for the next operation.

#### **4.4. The emergency response for infection prevention and control has been improved**

The emergency response mechanism for infection prevention and control needs to be solidly established. Nurses should formulate response plans in advance for the risk of sudden infection during the operation. When the sterile package is damaged, the spare sterile package should be immediately activated, and the contamination range should be evaluated simultaneously and the disinfection area expanded. When a surgical personnel's skin was accidentally cut, assist in emergency wound treatment and replace the surgical personnel, and track the exposure to contaminants<sup>[7]</sup>. After the operation, suspected infection cases were found. Nurses assisted in tracing the operation records of the entire surgical process, verified data such as instrument sterilization and environmental monitoring, cooperated with the infection control department to conduct root cause analysis, recorded the handling process and

improvement measures, and formed an emergency response closed loop to prevent similar risks from recurring.

## **5. Guarantee for enhancing the infection control capabilities of operating room nurses**

### **5.1. Construction of a professional skills training system**

As a high-risk and high-tech department in a hospital, the operating room has high requirements for the professional ability and emergency response of nurses. Patient safety competence is a core competence that operating room nurses must possess, which is directly related to the success rate of surgeries and the life safety of patients. Operating room nurses must possess comprehensive knowledge, solid skills, and a positive attitude to ensure the maximum protection of patient safety. The construction of a hierarchical infection control training system focuses on the mastery of basic operations, such as aseptic techniques and hand hygiene for new nurses, while for senior nurses, it emphasizes the strengthening of advanced skills, such as risk assessment and emergency response <sup>[8]</sup>. Theoretical teaching is combined with scenario simulation for training. Video analysis and practical operation for identifying violations help enhance capabilities. Specialized training on disinfection techniques and sterilization methods is organized regularly, and experts are invited to interpret guidelines to ensure that nurses' skills are updated in real time to deal with infection risks.

### **5.2. Establishment of infection monitoring and feedback mechanisms**

The establishment of a full-process infection monitoring and feedback mechanism has enabled nurses to record the environmental monitoring data of the operating room every day, including indicators such as temperature, humidity, and colony count. The sterilization parameters of the instruments and the monitoring results are recorded in detail, forming a traceable monitoring file. The infection control registration book is specially set up. The types of intraoperative non-compliant operations, corrective measures, and improvement suggestions are recorded one by one. Data summary and analysis are conducted weekly to identify high-frequency risk points. Infection control meetings are held monthly, where typical cases and prevention and control experiences are shared. Abnormal fluctuations in infection rates are included in special discussions. Monitoring data is transformed into specific improvement measures. Continuous feedback drives the quality of prevention and control to spiral upwards.

### **5.3. Teamwork and cultural construction**

Strengthen the collaboration mechanism of the infection control team. Nurses take the lead in forming an infection prevention and control group, incorporating members from multiple positions such as doctors, technicians, and cleaning staff. Clearly define the prevention and control responsibilities and collaboration paths for each position. Before the operation, organize a collaborative meeting to determine the core points of infection prevention and control during the operation on that day. During the operation, the operational tacit understanding is maintained through non-verbal communication such as gestures and eye contact. Participate in the environmental cleaning quality inspection together after the operation. Promote the cultural construction activities of infection control, carry out activities such as the selection of "Aseptic operation experts" and prevention and control knowledge competitions, enhance the team's sense of identity in prevention and control, make infection control a consensus and voluntary action of the team, and create a collaborative atmosphere where "everyone has a responsibility and everyone fulfills their duties" <sup>[9-11]</sup>.

#### **5.4. The management system and assessment incentives have been improved**

Improve the infection control management system and assessment framework. A special “Operating Room Infection Control Operation Manual” has been formulated, with clear standard procedures and evaluation indicators for each operation. Responsibilities for instrument management, environmental monitoring, etc., have been assigned to specific individuals. A three-level assessment mechanism of “daily inspection + monthly assessment + annual evaluation” has been established. The assessment results are directly linked to performance, and nurses with outstanding performance in epidemic prevention and control work have been commended and rewarded<sup>[12]</sup>. The accountability system for infection control is strictly implemented. In cases where infections are caused by operational violations, responsibility analysis is conducted. Non-punitive root causes are traced and preventive measures are formulated. The combined effect of institutional constraints and positive incentives stimulates the enthusiasm and sense of responsibility of nurses in prevention and control work.

### **6. Analysis of the effectiveness of infection control practices**

#### **6.1. The control of infection risks has achieved remarkable results**

The standardized infection control practices of operating room nurses have effectively curbed risks at each link, and the risk of surgical site infection has decreased accordingly. The preoperative instrument sterilization verification mechanism was strictly implemented, the qualification rate of sterile items increased accordingly, the risk of infection caused by instruments was basically eliminated, the supervision of aseptic operation during the operation was continuously strengthened, the compliance of hand hygiene of surgical personnel and the standardization of aseptic area maintenance were both improved, the incidence of non-compliant operation decreased simultaneously, the terminal disinfection process after the operation was continuously optimized, and the cleanliness quality of the operating room environment always met the standards. The risk of cross-infection is thus effectively controlled.

#### **6.2. The team’s prevention and control capabilities have been comprehensively enhanced**

Under the guidance and initiative of the nurses, the team members’ awareness of prevention and control has shifted from passive acceptance to active practice. Basic norms such as hand hygiene and aseptic techniques have been integrated into daily operation habits. New employees have quickly mastered the key points of prevention and control through systematic teaching. The standardization of team operations has significantly improved, and multi-disciplinary collaboration has become increasingly close. The cooperation and tacit understanding among nurses, doctors, and technicians in infection prevention and control have deepened. The mechanism of jointly assessing risks before the operation, supervising operations collaboratively during the operation and jointly reviewing and improving after the operation operates efficiently.

#### **6.3. The quality of nursing practice has been continuously optimized**

Infection control practices have driven the quality of operating room nursing to a higher level. The professional quality and operational standardization of nurses have been comprehensively enhanced. Nursing work has shifted from focusing on the completion of operations to paying attention to quality and safety. All operations strictly follow infection prevention and control standards, and the accuracy and rigor of operations have been significantly improved<sup>[13, 14]</sup>. The completeness and traceability of nursing records have been improved. Data records on



instrument sterilization, environmental monitoring, etc., are detailed and standardized, providing a reliable basis for quality analysis. Nurses are increasingly actively thinking and innovating in infection prevention and control. By optimizing operation processes and improving working methods, the efficiency of prevention and control has been enhanced, and the professionalism and value of nursing work have been fully highlighted<sup>[15]</sup>.

## 7. Conclusion

The standardized operation execution, real-time risk monitoring, and team collaboration supervision of operating room nurses constitute the core guarantee for reducing the risk of infection. This article analyzes the role positioning and mechanism of action of nurses, and designs practical strategies such as preoperative preparation optimization and intraoperative standardized implementation. It has been verified through practice that it can effectively improve the quality of infection control and reduce surgical risks. The professional competence of nurses and their awareness of prevention and control are directly related to the effectiveness of infection control. Continuously strengthening the cultivation of nurses' infection control capabilities and improving team collaboration and incentive mechanisms are of great value for ensuring patient safety and enhancing medical quality. In the future, it is necessary to further promote the refinement and intelligence of prevention and control practices, so that the core value of nurses in infection control can be fully exerted.

## Disclosure statement

The author declares no conflict of interest.

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# Analysis of the Causes and Management of Choroidal Detachment after Glaucoma Surgery

Hanlin Huang<sup>1,2</sup>, Biyue Tu<sup>1</sup>, Yanxia Tong<sup>1</sup>, Zhen Zhao<sup>1</sup>, Jiapeng Li<sup>1</sup>, Wenwu Liu<sup>1,3</sup>, Shuwen Zhang<sup>1</sup>, Jing Yuan<sup>1\*</sup>

<sup>1</sup>Eye Center, Renmin Hospital of Wuhan University, Wuhan, Hubei, China

<sup>2</sup>Anlu Puai Hospital, Anlu, Hubei, China

<sup>3</sup>Xishui County People's Hospital, Xishui, Hubei, China

\*Corresponding author: Jing Yuan, [xyj711@163.com](mailto:xyj711@163.com)

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**Abstract:** *Purpose:* To summarize and analyze the clinical features and management of postoperative choroidal detachment in glaucoma. *Methods:* Ten cases of choroidal detachment that occurred after glaucoma surgery were collected from March 2023 to February 2024 in the hospital. Their clinical characteristics and treatment effects were observed and their causes were analyzed. *Results:* After the operations, the eyes with choroidal detachment after glaucoma surgery had 2 cases of true microphthalmos, 6 cases of advanced glaucoma, and 2 cases of glaucoma secondary to vitreoretinal surgery. The postoperative manifestations were persistent shallow anterior chamber, the formation of anterior chamber, and then suddenly became shallow or disappeared. Meanwhile, the intraocular pressure was lower than 6 mmHg. Ultrasound and fundusoscopic examination showed that the choroid and retina were partially elevated, and the choroidal detachment recovered after treatment. *Conclusion:* Choroidal detachment is one of the common postoperative complications in glaucoma, especially in some special types of refractory glaucoma. Adequate perioperative management before surgery, cautious and delicate operation during surgery, and close observation and treatment after surgery can obviously decrease the occurrence and damage.

**Keywords:** Glaucoma; Filtration surgery; Choroidal detachment; Ciliary body detachment

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## 1. Introduction

Glaucoma external filtration surgery is a traditional and important treatment for glaucoma patients to control intraocular pressure, and choroidal detachment is one of the common complications after this surgery. Prolonged or severe choroidal detachment may cause a series of complications, such as shallow anterior chamber, cataracts, corneal endothelial malnutrition, non-formation of filtering bubbles, low intraocular pressure macular edema,

etc., leading to structural and functional abnormalities of intraocular tissues, seriously affecting visual function. Therefore, preventing and treating choroidal detachment is an important aspect of successful glaucoma filtration surgery. Based on the clinical data of our hospital in the past year, the clinical characteristics, cause analysis, and treatment of 10 cases of choroidal detachment of 10 eyes after glaucoma external filtration surgery were summarized and analyzed.

## 2. Clinical information

### 2.1. General information

Ten patients with choroidal detachment (confirmed by fundus and ultrasound) after anti-glaucoma surgery in our hospital from March 2023 to February 2024 were collected in 10 cases (6 males and 4 females) and 10 eyes (left eyes and 5 right eyes). The youngest was 41 years old and the oldest was 76 years old with an average age of 61.4 years old. Among the patients, there were 2 eyes with true microphthalmos, 6 eyes with advanced glaucoma, and 2 eyes with glaucoma secondary to vitreoretinal surgery. There were 2 cases of high myopia, 1 case of hypertension, 2 cases of diabetes, and 1 case of ciliary body detachment. Ocular examinations showed that visual function was poor in all eyes on admission, with visual acuity  $\geq 0.3$  in 5 eyes, between 0.1 and 0.3 in 3 eyes, and  $< 0.1$  in 2 eyes. Preoperative intraocular pressure (IOP) ranged from 21 to 30 mmHg in 2 eyes, from 31 to 40 mmHg in 2 eyes, and above 40 mmHg in 6 eyes. After hypotensive and anti-inflammatory treatment, the affected eyes continued to have different degrees of ciliary body congestion or mixed congestion and different degrees of posterior iris adhesion. All patients underwent glaucoma surgery as usual, including conventional Trabeculectomy (TVT) in 5 eyes, Ex-Press implantation (Alcon Laboratories) in 2 eyes, and Amed glaucoma valve implantation (New World Medical Inc., Rancho Cucamonga, CA, USA) in 3 eyes. The demographic characteristics of patients with choroidal detachment is presented in **Table 1**.

**Table 1.** Clinical Characteristics of patients with choroidal detachment after glaucoma external filtration surgery

No.	Gender	Age	Surgical Eye	Preoperative BCVA	Preoperative IOP(mmHg)
1	M	46	OD	0.02	56.4
2	F	41	OS	0.4	28.7
3	M	66	OS	0.3	33.8
4	F	62	OD	0.12	42.3
5	M	70	OD	0.3	31.8
6	M	67	OS	0.1	45.7
7	F	65	OD	0.3	42.2
8	M	51	OD	0.05	51.4
9	M	70	OS	0.3	29.3
10	F	76	OS	0.2	43.6

**Table 1 (Continued)**

No.	Preoperative complication	Surgical approach	Occurrence time Of postoperative choroidal detachment (d)	Occurrence site of postoperative choroidal detachment	Postoperative IOP (mmHg)
1	True microphthalmos, Advanced glaucoma, Ciliary body detachment	Amed glaucoma valve implantation	3	Multiple quadrants on the nasal and temporal sides	5.8
2	High myopia	Conventional Trabeculectomy	3	Multiple quadrants on the nasal and temporal sides	5.5
3	Diabetes	Ex-Press implantation	2	Subnasally	5.1
4	Glaucoma secondary to vitreoretinal surgery.	Conventional Trabeculectomy	5	Multiple quadrants on the nasal and temporal sides	4.5
5	Diabetes, Advanced glaucoma	Amed glaucoma valve implantation	3	Temporally	4.7
6	Glaucoma secondary to vitreoretinal surgery.	Conventional Trabeculectomy	3	Multiple quadrants on the nasal and temporal sides	4.1
7	Advanced glaucoma, Hypertension	Conventional Trabeculectomy	2	Temporally	4.2
8	True microphthalmos, Advanced glaucoma	Amed glaucoma valve implantation	3	Multiple quadrants on the nasal and temporal sides	5.6
9	High myopia, Advanced glaucoma	Ex-Press implantation	3	Subnasally	5.9
10	Advanced glaucoma	Conventional Trabeculectomy	6	Temporally	4.5

M, male; F, female; BCVA, best corrected visual acuity; OD, right eye; OS, left eye

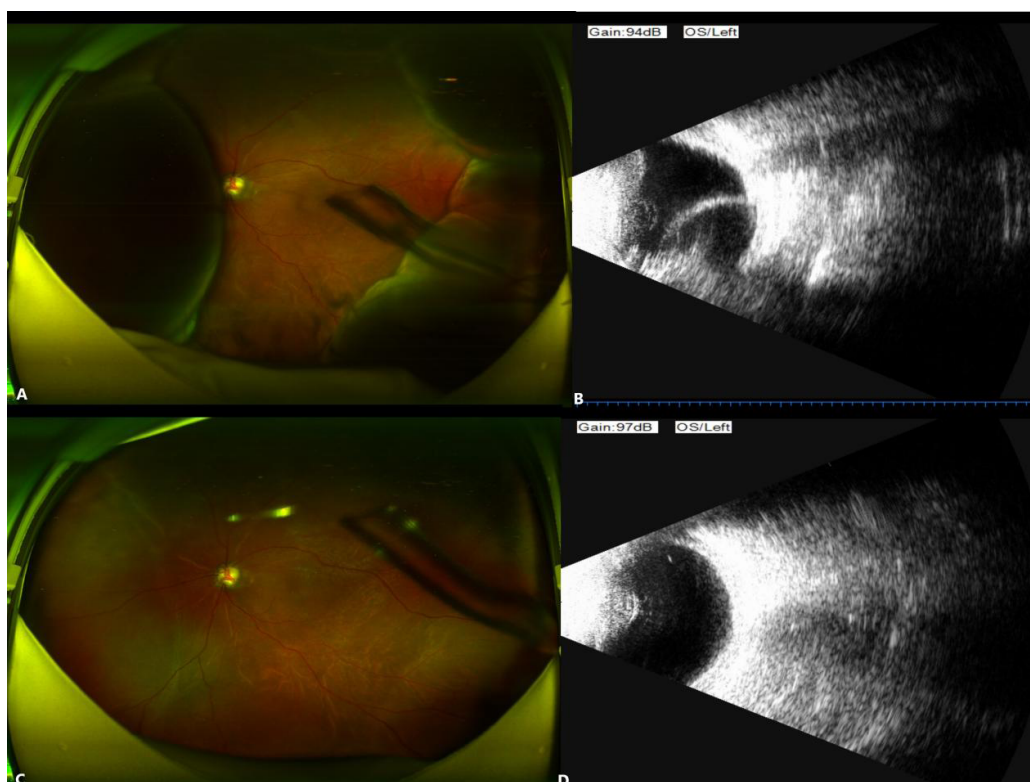
## 2.2. Clinical features and management of choroidal detachment

All the patients underwent glaucoma filtration without anterior chamber hemorrhage or other complications. Most of the choroidal detachments occurred around 3 days postoperatively, as confirmed by ultrasound and funduscopy examination, with 2 eyes occurring 2 days postoperatively, 6 eyes appearing 3 days postoperatively, and 2 eyes appearing 5 or more days postoperatively. Most of the patients complained of a black shadow in front of their eyes blocking part of the visual field, decreased visual acuity, and distorted vision in 2–5 days after the operation, while the rest of the patients did not have any special self-conscious symptoms. Ocular examination showed a persistent postoperative shallow anterior chamber in 6 eyes before the onset of choroidal detachment. In 3 eyes, the anterior chamber suddenly disappeared or became shallow after its formation.

According to Spaeth's shallow anterior chamber grading criteria, irises with only peripheral contact with the corneal endothelium is class I, irises with total contact with the corneal endothelium is class II, and class II plus no gap in the pupillary area is class III. The postoperative anterior chamber depths of the 10 eyes in this paper were grade I in 3 eyes, grade II in 7 eyes, and grade III in 1 eye. The sites of choroidal detachment were all located at the anterior equatorial peripheral part of the fundus. Two eyes were located subnasally, three were located temporally, and five eyes had two or more hemispherical choroidal detachments simultaneously on the nose side (**Figure 1**

and **Figure 2**). IOP was lower than 6 mmHg. With the persistence of a shallow anterior chamber and low IOP, the cornea showed different degrees of edema, decreased transparency, and wrinkling of the Descemet's membrane. Immediately after the patient was diagnosed with 10 eyes, cotrimoxazole was given, and the pupils were dilated every 10 minutes for 4 to 6 times. If the pupils were not dilated and the anterior chamber did not deepen, a pupil-dilating combination of subconjunctival injection (epinephrine injection 1mg + atropine injection 2mg + lidocaine injection 2mg), eye pads cover, hormonal eye drops, periocular injection of dexamethasone injection 2.5mg + lidocaine injection 2.5mg, atropine and hormonal ophthalmic ointment were applied at bedtime.

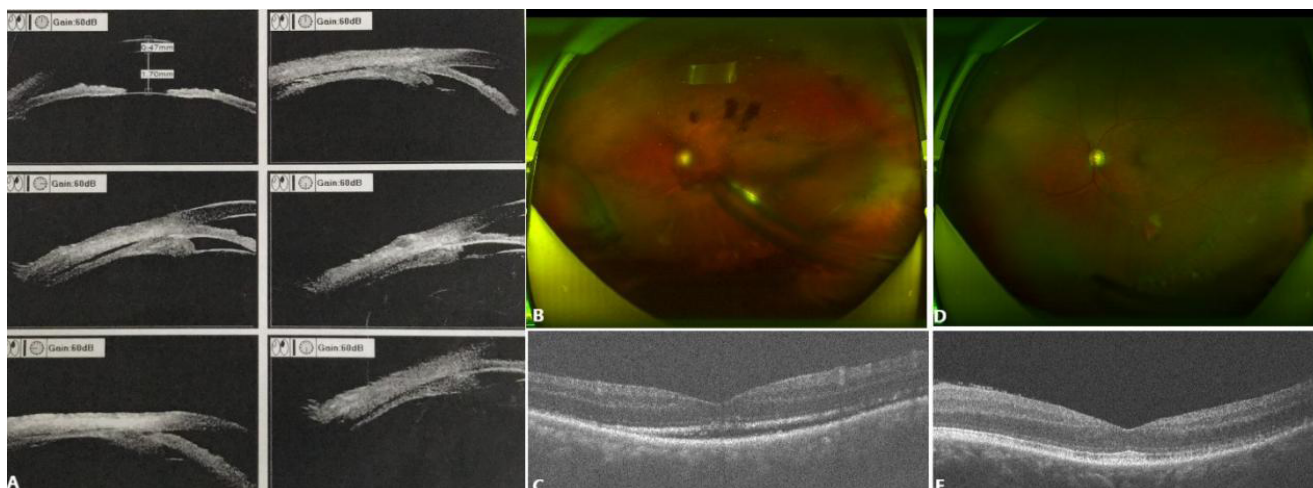
Afterwards, the eye was bandaged with pressure, and the patient was instructed to rest in bed. Systemic hormonal medication was administered as necessary until complete recovery from choroidal detachment. After conservative treatment, choroidal detachment recovered completely within 1 to 2 weeks in 9 eyes. One eye underwent phacoemulsification cataract surgery combined with IOL implantation and anterior chamber plasty due to loss of the anterior chamber and severe corneal haze and lens opacity.



**Figure 1.** Resolution of postoperative choroidal detachment documented by fundus photography and ultrasonography; (A) Panoramic fundus photography on day 5 after combined surgery showed multiple quadrant hemispherical elevated foci; (B) Ultrasound on day 5 after surgery showed choroidal detachment; (C) Fundus panoramic photograph 2 weeks after medication showing flat retinal volvulus; (D) Ultrasound 2 weeks after medication showing retina in place and choroidal detachment recovered.

True microphthalmic advanced glaucoma after cataract surgery still persisted with high intraocular pressure (ocular axis: 17.66 mm) and shallow anterior chamber, 5 days after vitrectomy combined with implantation of glaucoma drainage valve, complaining of decreased visual acuity, sense of occlusion of vision, and low intraocular pressure.





**Figure 2.** Imaging findings of ciliary body and choroidal detachment after glaucoma drainage device implantation and its resolution after medical treatment; (A) Preoperative UBM showed 360° ciliary body detachment; (B) Glaucoma drainage valve Fundus panoramic photography on day 3 after implantation of glaucoma drainage valve showed hemispherical elevated foci in both subnasal and inferotemporal quadrants; (C) OCT on day 3 after implantation of glaucoma drainage valve showed subretinal effusion; (D) Fundus panoramic photography on day 10 after medication showed flat retinal volvulus; and E: OCT on day 10 after medication showed absorption of subretinal effusion.

True microphthalmos advanced glaucoma persistent high intraocular pressure (ocular axis: 19.74 mm), with shallow anterior chamber. After cataract surgery, the intraocular pressure still could not be controlled, shallow anterior chamber. Vitrectomy combined with implantation of a glaucoma drainage valve was performed again after one month, and on the 3rd day after the operation, he complained of decreased visual acuity, a sense of occlusion of the sight, and low intraocular pressure.

### 3. Discussion

The pathogenesis of choroidal detachment is complex and may be related to the following factors. First, preoperative intraoperative and postoperative intraocular pressure are the main factors. Preoperatively, high intraocular pressure will lead to choroidal vascular congestion, tissue edema, and increased permeability, resulting in plasma and fibrous exudation of the pigmented membrane. A sudden decrease in intraoperative intraocular pressure will lead to a certain negative pressure in the suprachoroidal cavity, disappearance of the anterior chamber, anterior shift of the crystalline lens, increase in the permeability of the choroidal capillaries, and leakage of plasma fluid into the suprachoroidal cavity of the ciliary body. A persistent postoperative state of low IOP promotes more fluid accumulation and detachment of the ciliary body choroid. Scheffer noted that any internal eye surgery to open the anterior chamber is characterized by a sudden drop in IOP. In addition, fluid accumulation and choroidal detachment only occurs with persistent low IOP. Therefore, it is very important to decrease IOP sufficiently preoperatively, to puncture the anterior chamber intraoperatively to allow slow outflow of aqueous humor, and closely observe IOP changes in the operated eye postoperatively. In particular, the choice of anesthesia and surgical approach is also very important in the 10 patients with special types of glaucoma reported in this article.

Intraoperative general anesthesia can significantly decrease the fluctuation of intraocular pressure. The

implantation of glaucoma drainage device (GDD) is better than traditional trabeculectomy to prevent an intraoperative sudden drop in intraocular pressure in patients with glaucoma secondary to vitreoretinal surgery, thus lowering the risk of choroidal detachment<sup>[1]</sup>. For such patients, intraoperative injection of viscoelastic agents into the anterior chamber can be conducted to avoid the risk of secondary choroidal detachment caused by a sudden drop in intraocular pressure during and after surgery. Preoperative state of ciliary body detachment refers to the second factor. Ciliary body detachment causes the small arteries supplying the ciliary body to be stretched and blood supply to be reduced, exacerbating ischemia and hypoxia, leading to a decrease in aqueous humor secretion and a drop in intraocular pressure; leakage fluid collects in the supraciliary cavity and causes choroidal detachment; and increased outflow from the uveoscleral pathway disrupts the blood-aqueous barrier, leading to a drop in IOP<sup>[2, 3]</sup>. Therefore, glaucoma patients should routinely undergo preoperative UBM. Besides, those with ciliary body detachment should be treated promptly, thereby reducing the risk of postoperative choroidal detachment.

As reported in this study, one of the cases had choroidal detachment after glaucoma filtration surgery with preoperative ciliary detachment. Notably, in some patients, ciliary choroidal detachment is a stage in the development of malignant glaucoma. Ciliary choroidal detachment can cause anterior displacement of the vitreous and lens, ciliary body edema, and secondary closure of the chamber angle, leading to retrograde movement of aqueous humor and inducing malignant glaucoma<sup>[4, 5]</sup>. At this time, although high intraocular pressure of malignant glaucoma can relieve choroidal detachment, but malignant glaucoma has already occurred and the anterior chamber becomes shallow. However, the intraocular pressure is relatively normal or low, it is easy to be misdiagnosed or underdiagnosed. Thirdly, preoperative vitreous cavity status. Epstein found that shallow anterior chamber occurred less in children or young people than in older people. This stems from the more normal vitreous structure of young people, which resists compression caused by choroidal detachment. In contrast, the elasticity of the vitreous body decreases in patients with elderly or myopia, and the supporting effect on the eyeball wall is weakened. This makes it less resistant to the leakage of choroidal intravascular fluid, weakened, and the risk of choroidal detachment after surgery increases. In addition, a large number of studies have reported that secondary high intraocular pressure after vitreoretinal surgery is common and may lead to progressive glaucoma damage<sup>[6]</sup>.

Under poor drug control, anti-glaucoma surgical treatment should be considered. Because the vitreous cavity of these patients contains water, choroidal detachment or even explosive suprachoroidal hemorrhage is prone to occur during external filtration surgery. Hence, the choice of surgical approach is very important. In the current study, the two patients with secondary glaucoma after vitrectomy experienced choroidal detachment after traditional trabeculectomy. The main reason was that the vitreous cavity was unable to support the eyeball wall. This was associated with the large fluctuations in intraocular pressure during and after trabeculectomy, and it is worth noting. Fourthly, systemic conditions. The elderly, high myopia, advanced glaucoma, true microphthalmia, and other patients with poor microvascular function, hemodynamic compensatory capacity is weak. At the same time, their ocular vortex venous and vascular damage will cause extravasation of fluid from the uveal membrane, which can easily lead to choroidal detachment if combined with diabetes mellitus, hypertension, hyperlipidemia, and other systemic diseases<sup>[7]</sup>.

The cases reported in this paper included 2 cases of true microphthalmos, 6 cases of advanced glaucoma, 8 cases of elderly patients with 2 cases of high myopia, 1 case of hypertension, and 2 cases of diabetes mellitus. It can be seen that the ocular and systemic conditions of the patients increase the risk of choroidal detachment in the postoperative period<sup>[8]</sup>. Finally, if the surgical incision is too far back, it is easy to damage the ciliary body and

make its contact with the scleral protuberance loose or detached, leading to the direct entry of aqueous humor into the suprachoroidal cavity. If the surgical incision is too large, the postoperative closure of the conjunctival incision is poor, the outflow of fluid is too much, the filtration is too strong, and the intraocular pressure is lowered, which can easily cause choroidal detachment. Too long surgical time can make the pressure in the suprachoroidal cavity lower than atmospheric pressure, resulting in fluid leakage to the outside. Insufficiently delicate surgical operation, intraoperative fluid release is too fast, and IOP drops suddenly. In this paper, there were 2 cases of posterior surgical incision and 2 cases of rapid intraoperative fluid release.

There is no uniform conclusion about the choice of treatment for choroidal detachment. Most clinicians prefer conservative treatment with drugs, which should not be rushed<sup>[7]</sup>. Conservative treatment included:

- (1) Glucocorticoid: local and systemic glucocorticoid application can decrease the permeability of the capillary wall, inhibit the release of prostaglandins and histamine, repair the blood-aqueous barrier, reduce fluid extravasation, decrease the release of various inflammatory factors, and decrease the ocular inflammatory response.
- (2) Ciliary muscle paralytic agent: 1% atropine, compound tropine phthalamide are commonly used to paralyze the ciliary muscle, thus the lens-iris septum is shift backward, the anterior chamber is deepened, the pupillary block is lifted, and the posterior iris adhesion is avoided.
- (3) Hemostatic drugs: To prevent the bleeding phenomenon of ciliary body and choroidal blood vessels caused by the sudden drop of intraocular pressure.
- (4) Physiotherapy: Bandage both eyes, rest quietly to decrease the outflow of aqueous humor, wound repair<sup>[9-11]</sup>.

Surgery should be considered if choroidal detachment with anterior chamber loss lasts for about a week, crystals adhere to the cornea, the cornea is cloudy and edematous, and ocular irritation worsens. Surgery is usually performed with anterior chamber plasty or suprachoroidal chamber drainage<sup>[12]</sup>. Of the 10 patients reported herein, 9 eyes with shallow anterior chamber of grade I or II had all detached choroidal reset after conservative treatment for at least 3 days and up to 15 days (all confirmed by ultrasound and ultra-wide-angle fundus imaging). These results further demonstrate the importance of prevention, early diagnosis, and treatment of secondary choroidal detachment after glaucoma surgery. Of course, it must be considered the limitations of the present study. Firstly, the study was retrospective and reported a small number of cases. Second, this study did not analyze the impact of other risk factors, such as preoperative status (acute or chronic), age, gender, genetic factors, etc. on the risk of choroidal detachment after glaucoma filtration surgery. We will further investigate the risk factors of secondary choroidal detachment after glaucoma filtration surgery in subsequent large sample studies.

## 4. Conclusion

In conclusion, choroidal detachment is one of the common complications after external filtration surgery for glaucoma. Although most of them can be recovered by pharmacologic conservative treatment, its occurrence still needs to be emphasized<sup>[7]</sup>. For high-risk patients, adequate preoperative examination, evaluation, perioperative preparation and communication, intraoperative selection of appropriate surgical and anesthetic modalities and careful and delicate operation, and postoperative close observation and management can significantly decrease its occurrence and damage.

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## Disclosure statement

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# Research on the Impact of Preoperative Visits by Operating Room Nurses on Patients' Psychological States

Wu Meng

Operating Room, Jingzhou Central Hospital, Jingzhou 434020, Hubei, China

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**Abstract:** Currently, preoperative visits have problems such as monotonous forms and insufficient humanistic care, which affect patients' psychological states and surgical cooperation. This article analyzes the current situation of preoperative visits and the mechanisms influencing patients' psychology, proposes optimization strategies and safeguard measures, and explores the mechanisms of information transmission, emotional support, trust establishment, and environmental familiarity on patients' psychology. It designs optimization plans from the aspects of personalized content, standardized processes, professional techniques, and diversified forms, supplemented by nurse training, system improvement, and quality evaluation to ensure implementation. Practice shows that the optimized preoperative visit can improve the psychological state of patients, enhance surgical cooperation, and optimize the nurse-patient relationship. The conclusion indicates that scientific and standardized preoperative visits can improve the quality of surgical care through multiple psychological effects and are an important link in perioperative care.

**Keywords:** Preoperative visit; Mental state; Optimization strategy; Humanistic care; Nurse-patient relationship

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## 1. Introduction

Preoperative visits, as a key link in operating room nursing, are related to the perioperative psychological state of patients and surgical outcomes. Currently, in clinical practice, preoperative visits often have monotonous forms, focus on information transmission, but neglect humanistic care, making it difficult to meet the psychological needs of different patients. As a result, some patients have significant preoperative anxiety, which interferes with surgical cooperation and rehabilitation progress. In-depth exploration of the mechanism by which preoperative visits affect patients' psychological states and optimization of the visit mode can not only alleviate preoperative anxiety and reduce the occurrence of complications, but also enhance the trust between nurses and patients and improve the overall nursing level. Exploring the optimization approaches of preoperative visits has significant practical value for improving the operating room nursing system, practicing the concept of humanistic nursing, and ensuring the



smooth progress of surgeries.

## **2. Analysis of the current situation of preoperative visits**

Currently, preoperative visits are often conducted in a centralized manner on the day before the operation. Nurses explain the surgical steps, preoperative preparations, and key points to note after the operation to patients in accordance with standardized procedures, with the content centered on the transmission of medical information <sup>[1]</sup>. The duration of visits is generally limited. Nurses pay more attention to the comprehensiveness of information dissemination rather than the patients' acceptance level. There is a lack of targeted communication. The forms of visits are monotonous, mostly oral explanations combined with written materials, which are not suitable for patients with lower educational levels or the elderly. Some nurses focus on explaining medical risks during visits, ignore the patients' emotional changes, and fail to properly respond to their psychological concerns. The visiting effect is limited to the level of information transmission, and the element of humanistic care is insufficient.

## **3. The mechanism by which preoperative visits affect patients' psychological states**

### **3.1. The reassuring effect of information transmission**

Preoperative visit is an important part of the overall nursing work in the operating room. The American Nurses Association stipulates that the first stage of the benchmark for operating room nursing practice is to conduct preoperative visits to understand the patient's physical, psychological, and social conditions. Studies have confirmed that preoperative visits can not only alleviate patients' anxiety before and after the operation, but also reduce the incidence of perioperative complications, providing a strong guarantee for the smooth progress of the surgery. Preoperative visits alleviate patients' uncertainty and anxiety through systematic information transmission. Nurses specifically explain the surgical procedures, anesthesia methods, and the composition of the medical team, helping patients form a clear understanding of the surgical process, reducing their fear of the unknown, and clearly inform them of the key points of preoperative preparation and the postoperative rehabilitation stage, allowing patients to understand their own cooperation priorities and enhancing their experience of controlling the treatment process <sup>[2]</sup>. Information transmission is presented in a simple and understandable way to avoid comprehension difficulties caused by professional terms. By combining text and images, information memory is strengthened, enabling patients to feel at ease due to full knowledge and laying a solid psychological foundation for surgical cooperation.

### **3.2. The empathy effect of emotional support**

The empathy ability demonstrated by nurses during home visits can directly regulate patients' psychological states. During the process of patiently listening and confiding, they can identify emotional signals such as anxiety and fear, provide targeted emotional responses, and convey care through gentle tones, caring looks, and appropriate body language, allowing patients to feel understood and valued, thereby alleviating feelings of loneliness and helplessness <sup>[3, 4]</sup>. Empathetic communication can establish a secure emotional connection. Patients are more willing to reveal their true concerns. Based on this, nurses can carry out personalized psychological counseling to help adjust negative perceptions and enhance psychological resilience in the face of surgery.

### **3.3. The positive effects of trust building**

Preoperative visits are an important link in building trust between nurses and patients. The display of nurses' professional image, proficient communication skills, and solid professional knowledge can enhance patients' trust in the nursing team. Detailed answers to questions, fulfillment of visit commitments, and implementation of postoperative analgesia measures can gradually shape a reliable image. The establishment of a trust relationship makes it easier for patients to accept nurses' guidance and suggestions, reduces their resistance to surgery, and improves their cooperation in treatment. Good nurse-patient trust can also weaken patients' defensive psychology, enabling them to express their psychological needs more candidly and providing conditions for personalized nursing intervention.

### **3.4. The adaptation effect of familiar environment**

Moderate environmental introduction during preoperative visits can help patients adapt to the surgical scene. Describing the layout of the operating room, the functions of the equipment, and the working methods of the surgical team can reduce the fear of unfamiliar environments. When conditions permit, lead patients to briefly tour the peripheral areas of the operating room, familiarize them with the pick-up and drop-off procedures and the route to enter the room, and reduce the psychological burden caused by the unfamiliar environment. Explain the normal phenomena, such as sounds and lights that may occur during the operation, so that patients can be mentally prepared in advance to avoid sudden stimuli during the operation that may cause tension reactions<sup>[5]</sup>. The transmission of environmental adaptation information can help patients psychologically "enter" the surgical scene in advance, enhancing their experience of environmental control and adaptability<sup>[6]</sup>.

## **4. Practical strategies for optimizing preoperative visits**

### **4.1. Personalized design of visit content**

The content of preoperative visits should be personalized based on the individual characteristics of the patients. Before the operation, medical records should be reviewed to understand age, educational level, disease history, and psychological assessment results, and differentiated visit plans should be formulated. For elderly patients, the information density should be appropriately reduced, with emphasis on rehabilitation expectations and safety guarantee explanations. Increase the postoperative quality of life guidance content for young patients. For those with a higher level of anxiety, the emotional support section should be strengthened. The content structure includes three aspects: medical information, psychological support, and practical preparation. Medical information highlights the core points, psychological support focuses on empathetic responses, and practical preparation clarifies specific operational details to ensure that the content is comprehensive and meets the patient's needs<sup>[7]</sup>.

### **4.2. Standardized construction of the visiting process**

Establishing a standardized visiting process is crucial for the stability of visiting quality. The process begins with preoperative assessment, and nurses need to complete the assessment of the patient's basic situation and psychological state before the visit. The mid-term core visit links cover information transmission, emotional communication, and needs assessment. In the later stage, focus on the immediate evaluation and recording of the visiting effect. The time allocation for each link should be clear, and sufficient communication time should be reserved to avoid the visiting behavior of rushing to complete tasks. The content of the visit records should be

standardized, detailing the patient's main concerns, emotional states, and individualized needs, providing a basis for the connection between intraoperative care and postoperative visits, maintaining the continuity of care, and making the visit truly an organic part of the overall care.

### **4.3. Professional improvement of communication skills**

Improving nurses' communication skills is the key to optimizing the effectiveness of visits. Training nurses to be proficient in active listening methods, responding and encouraging patients to express themselves fully through nodding, eye contact, and other means, and avoiding interrupting their confessions at will during the process. The optimization of the questioning method is equally important. Open-ended questions should be used more often to explore the patient's true thoughts, such as "Which parts of the surgical process do you care about more?" to reduce the limitations of closed-ended questions on the expression space <sup>[8-10]</sup>. The cultivation of non-verbal communication cannot be ignored. A gentle tone, friendly expression, and moderate body language can all convey a sincere attitude of care. Relevant skills for emotional guidance also need to be included in the training. The basic ideas of cognitive behavioral therapy can be used to help patients adjust their negative cognition. For example, excessive worry about surgical pain can be guided and corrected. This further enhances their self-regulation ability at the psychological level <sup>[11]</sup>.

### **4.4. The forms of visits are diversified and innovative**

Diverse visiting forms can enhance the appeal and practical effectiveness of visits. Compiling a visiting manual that integrates text and images, designing standardized process diagrams based on different surgical categories, and combining case narratives to deepen understanding, as well as using digital visiting methods, such as preoperative visiting short videos, can visually present the surgical process and key cooperation points, making it convenient for patients to review multiple times. Special patient groups are suitable for family participation visits, inviting family members to learn about the surgical progress and key points of postoperative care together, highlighting the effectiveness of the family support system. Promote situational simulation-type visits, and use role-playing to demonstrate key points of intraoperative cooperation, enabling patients to become familiar with cooperation methods during the interaction process and relieve psychological pressure.

## **5. The safeguard measures implemented during preoperative visits**

### **5.1. Professional competence cultivation for nurses**

To strengthen the professional quality cultivation of nurses' preoperative visits, a systematic training framework should be established. The training content should include relevant knowledge of psychology, communication skills, surgical specialty knowledge, and humanistic care principles. The implementation of role-playing training activities can simulate the visit scenarios of patients with different personality traits, helping nurses improve their adaptability and empathy. Case studies should be organized regularly. The practical experience of successful visits and the handling methods of typical problems were shared and promoted during the communication <sup>[12]</sup>. Preoperative visiting ability should be included in the performance assessment scope of nurses to stimulate their enthusiasm for actively improving the quality of visits. The promotion of continuous education can ensure that nurses master the latest communication skills and psychological intervention strategies in a timely manner, and better meet the diverse needs of patients.

## **5.2. The management system is perfect**

The improvement of the preoperative visit management system is the foundation for the implementation of quality assurance. The responsibilities and work norms of the visit positions need to be clarified, and the duration, content elements, and record norms of the visits should be defined to ensure that all requirements are effectively implemented. A three-level supervision mechanism for visit quality should be established. The head nurse should conduct random checks on the visit records every day, and the nursing department should carry out regular evaluations of the visit effectiveness. Patient satisfaction is incorporated into the quality management scope of the department. The shift scheduling system has been optimized, and the visiting time has been reasonably planned to prevent nurses from carrying out visiting tasks under high work pressure, ensuring their concentration during the visiting process. A feedback mechanism for visiting effectiveness has been gradually established, and patients' evaluations and suggestions on visits have been collected to serve the continuous optimization of the visiting process and content.

## **5.3. Establishment of a quality evaluation system**

Establishing a reasonable quality assessment framework can comprehensively measure the effectiveness of visits. The assessment dimensions should take into account both the implementation process and the relevant indicators of the final outcome. The implementation process indicators involve the proportion of visit achievement, the completeness of content, and the regularity of records. The final outcome indicators include patient satisfaction, the optimization extent of preoperative anxiety assessment, and the status of surgical collaboration. By applying a diversified evaluation model, patient questionnaires were used to collect subjective experiences, and the quality of the implementation process was verified through nursing records <sup>[13, 14]</sup>. Surgeons were interviewed to understand the performance of intraoperative collaboration. Evaluation data were analyzed regularly to identify deficiencies in visits, and targeted improvement plans were formulated to form a virtuous cycle of implementation, evaluation, and improvement, steadily enhancing the quality of preoperative visits.

# **6. Analysis of the effectiveness of preoperative visit practice**

## **6.1. The improvement effect of the patient's psychological state**

Standardized preoperative visits have a substantial improvement on patients' preoperative psychological state. Negative emotions such as anxiety and fear are alleviated, their concerns about the surgery are reduced, and both sleep quality and emotional stability are enhanced simultaneously. Personalized information transmission and emotional support enable patients to have a clearer understanding of the surgical process, reduce their fear of the unknown, and accordingly increase their psychological resilience to the surgery. Patients can view the surgical risks and treatment effects more rationally, their negative perceptions are effectively adjusted, their confidence in the success of the surgery is enhanced, laying a good psychological foundation for active cooperation with the surgery, and their overall psychological state tends to change positively.

## **6.2. The effectiveness of improving surgical cooperation**

Standardized preoperative visits can enhance patients' surgical cooperation level. After fully understanding the surgical process and key points of cooperation, they are more likely to follow the instructions of medical staff during the operation, and unnecessary nervous reactions will be reduced accordingly. The early awareness of key



links, such as anesthesia coordination and body position placement, enables patients to actively cooperate with the operation, shortening the preoperative preparation time. The nurse-patient trust established through visits makes it easier for patients to accept intraoperative nursing measures, reduces resistance behavior, and lowers the risk of surgical interruption. After the operation, patients will actively cooperate with early activities, pain assessment, and other rehabilitation measures, laying a solid foundation for rapid postoperative recovery, and the overall quality of cooperation during the operation will improve accordingly.

### **6.3. The effectiveness of optimizing the nurse-patient relationship**

The optimized implementation of preoperative visits has brought about a substantial improvement in the nurse-patient relationship. Patients' trust and satisfaction with nurses have increased, and they feel that nurses not only pay attention to disease treatment but also attach importance to psychological needs. Effective communication during visits makes patients more willing to express their true thoughts and concerns. The problem of information asymmetry between nurses and patients has been alleviated, and misunderstandings and conflicts have decreased <sup>[15]</sup>. The professional qualities and humanistic care demonstrated by nurses during visits have established a good image of the nursing profession. Patients' recognition of nursing work has increased, and the harmonious nurse-patient relationship has extended to the postoperative care stage. Patients are more cooperative with rehabilitation guidance, creating favorable conditions for the overall improvement of nursing quality.

## **7. Conclusion**

Preoperative visit, as a key link in perioperative care, its quality is directly related to the psychological state of patients and surgical outcomes. This article analyzes the current situation to reveal the defects of the existing model, clarifies the psychological action mechanisms of information transmission, emotional support, trust establishment and environmental familiarity, and proposes personalized, standardized, professional and diversified optimization paths and supporting guarantee measures. Practice has shown that scientifically optimized preoperative visits can effectively alleviate patients' anxiety, enhance surgical cooperation, and build a harmonious nurse-patient relationship. This fully demonstrates the core significance of preoperative visits in humanistic nursing and provides practical references for improving the quality of operating room nursing. In the future, it is necessary to continuously improve and promote them to achieve the organic integration of physical and psychological nursing.

## **Disclosure statement**

The author declares no conflict of interest.

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# Application Effect of Intelligent Guidance Optimization in Physical Examination Process Management

Fan Li

Deyang People's Hospital, Deyang 618000, Sichuan, China

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**Abstract:** *Objective:* To investigate the application effects of intelligent guidance systems in optimizing health check-up process management. *Methods:* A total of 400 examinees who underwent physical examinations at the hospital's Health Management Center from January to December 2024 were randomly divided into a control group (200 cases) and an observation group (200 cases). The control group used traditional manual guidance methods, while the observation group employed the intelligent guidance system. The study compared two groups in terms of completion time, waiting time for each procedure, check-up efficiency scores, examinee satisfaction, and report issuance time. *Results:* The overall examination time in the observation group ( $85.3 \pm 12.7$  minutes) was significantly shorter than that in the control group ( $142.6 \pm 18.5$  minutes) ( $P < 0.01$ ); average waiting time per procedure decreased by 62.4%; check-up efficiency scores ( $8.9 \pm 0.8$  points) were significantly higher than those in the control group ( $5.2 \pm 1.1$  points) ( $P < 0.01$ ); satisfaction reached 96.5%, significantly higher than the control group's 78.0% ( $P < 0.01$ ); and report issuance time was advanced by 1.5 days. *Conclusion:* Intelligent guidance systems can significantly optimize check-up processes, improve work efficiency, and examinee satisfaction, demonstrating significant clinical application value.

**Keywords:** Intelligent guidance; Check-up process; Health management; Process optimization; Satisfaction

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## 1. Introduction

With the deepening implementation of China's Healthy Nation strategy and growing public health awareness, health checkups have become a vital tool for disease prevention and health management. However, traditional checkup models suffer from cumbersome procedures, lengthy waiting times, and inefficient triage processes, significantly impacting both patient experience and medical resource utilization efficiency. In recent years, the integration of information technology with healthcare has provided innovative solutions for optimizing checkup workflows. The intelligent triage system, leveraging AI algorithms and IoT technologies, achieves precise management and optimized resource allocation through real-time data analysis, smart route planning, and

automated reminders. Research indicates that this system dynamically adjusts examination routes based on real-time patient flow and processing time across departments, effectively avoiding resource idling and congestion caused by rigid protocols. Additionally, the system delivers real-time navigation guidance via mobile devices, reducing unnecessary movement and alleviating patients' anxiety during waits. Currently, empirical studies on intelligent triage systems in checkup optimization remain limited in China, particularly lacking multi-dimensional quantitative evaluations of their effectiveness. This study employs a controlled trial design to systematically assess the practical outcomes of intelligent triage systems in shortening checkup durations, improving operational efficiency, and enhancing patient satisfaction, providing scientific evidence for process optimization and digital transformation in health checkup institutions <sup>[1]</sup>.

## **2. Data and methods**

### **2.1. General information**

A total of 400 participants were selected for this study from those who underwent health check-ups at our hospital's Health Management Center between January and December 2024. Inclusion criteria: aged 18–65 years; choosing the selected health check-up package; voluntarily participating in the study and signing an informed consent form; possessing smartphone operation skills. Exclusion criteria: elderly or disabled individuals requiring special care; emergency check-ups or expedited check-ups; participants who withdrew midway. The subjects were randomly divided into a control group (200 cases) and an observation group (200 cases) using a random number table method. The control group included 102 males and 98 females, aged 22–63 years with an average age of  $(41.5 \pm 10.3)$  years. The observation group comprised 105 males and 95 females, aged 20–65 years with an average age of  $(42.1 \pm 11.2)$  years. There was no statistically significant difference between the two groups in baseline data such as gender, age, and health check-up package type ( $P > 0.05$ ), indicating comparable comparability <sup>[2]</sup>.

### **2.2. Methodology**

The control group adopted the traditional manual guidance mode, in which the guidance nurse guided the subjects to complete each examination step by step according to the fixed process, and the subjects queued up outside each examination department by themselves. The observation group applied the intelligent guidance system to manage the physical examination process, and the specific implementation plan was as follows:

#### **2.2.1. Composition of intelligent guidance system**

- (1) Data Collection Module: Acquire physical examination appointment information through the Hospital Information System (HIS), deploying IoT sensors across departments to collect real-time progress and crowd data.
- (2) Intelligent Algorithm Module: Utilize deep learning algorithms to analyze historical examination data, establishing time prediction models for each test item; employs reinforcement learning algorithms to optimize examination routes in real time.
- (3) Mobile Application Module: Develop a patient-facing app providing real-time guidance, queue updates, department navigation, and report retrieval.
- (4) Management Backend Module: Offers healthcare professionals interfaces for monitoring examination workflows, resource allocation, and handling anomalies <sup>[3]</sup>.

### 2.2.2. System workflow

- (1) Booking stage: The examinee makes an appointment for physical examination through the APP, and the system recommends the optimal time according to historical data.
- (2) Preparation for physical examination: The APP pushes the matters needing attention and preparation instructions, and reminds special requirements such as fasting.

### 2.2.3. On-site guidance

Upon arrival, examinees complete quick registration via facial recognition or QR code scanning. The system generates personalized examination routes based on real-time data, while the APP displays upcoming tests, estimated waiting times, and department locations in real time. Smart reminders prioritize scheduled procedures requiring fasting, such as blood draws and ultrasounds.

- (1) Process monitoring: The management backend continuously monitors departmental workload, dynamically adjusts guidance strategies, and intervenes proactively with patients experiencing delays.
- (2) Report generation: The system automatically consolidates test results, assists doctors in report review, and delivers electronic reports through the APP<sup>[4]</sup>.

## 2.3. Observation indicators

- (1) Time efficiency index
  - (a) Overall test time: The time from registration to completion of all tests.
  - (b) Waiting time for each link: the waiting time for major tests such as blood collection, ultrasound, and radiation.
  - (c) Report time: the interval between completion of tests and availability of reports.
- (2) Quality evaluation indicators
  - (a) Physical examination efficiency score: Researchers used a Likert 5-point scale to evaluate the rationality of the process (1–10 points).
  - (b) Guidance accuracy: The consistency between the route recommended by the system and the actual completed route.
  - (c) Incidence of abnormal events: The number of adverse events, such as missed detection and wrong detection
- (3) Satisfaction index
  - (a) Respondent satisfaction survey: Self-made questionnaire was used to evaluate the guidance service, waiting time, and overall experience.
  - (b) Medical staff work satisfaction: Evaluation of system use experience and workload changes.

## 2.4. Statistical methods

SPSS 26.0 was used for data analysis. The mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ) was used for measurement data, and the independent sample t-test was used for intergroup comparison; the number of cases (percentage) was used for counting data, and the  $\chi^2$  test was used for intergroup comparison.  $P < 0.05$  was considered statistically significant.

### 3. Results

#### 3.1. Comparison of two groups of time efficiency indicators

The observation group's overall examination time was significantly shorter than the control group ( $85.3 \pm 12.7$  minutes vs  $142.6 \pm 18.5$  minutes,  $t=35.672$ ,  $P < 0.01$ ). Across all examination stages, blood collection waiting time decreased from ( $25.3 \pm 6.8$ ) minutes to ( $8.2 \pm 3.1$ ) minutes, while ultrasound waiting time reduced from ( $38.5 \pm 9.2$ ) minutes to ( $14.7 \pm 5.3$ ) minutes—all showing statistically significant differences ( $P < 0.01$ ). The time required for issuing physical examination reports was shortened from 2.5 days in traditional methods to 1.0 day, as shown in **Table 1**.

**Table 1.** Comparison of time efficiency indexes between the two groups ( $\bar{x} \pm s$ )

Metric	Control group (n = 200)	Observation group (n = 200)	t price	P price
Total inspection time (min)	$142.6 \pm 18.5$	$85.3 \pm 12.7$	35.672	< 0.001
Waiting time for blood collection (min)	$25.3 \pm 6.8$	$8.2 \pm 3.1$	32.145	< 0.001
Ultrasound waiting time (min)	$38.5 \pm 9.2$	$14.7 \pm 5.3$	30.876	< 0.001
Waiting time for radiography (min)	$22.7 \pm 7.5$	$9.5 \pm 4.2$	21.543	< 0.001
Date of report (days)	$2.5 \pm 0.8$	$1.0 \pm 0.3$	25.432	< 0.001

#### 3.2. Comparison of two groups of quality evaluation indicators

The observation group demonstrated significantly higher physical examination efficiency scores compared to the control group ( $8.9 \pm 0.8$  vs  $5.2 \pm 1.1$  points,  $t=38.765$ ,  $P < 0.01$ ). The diagnostic accuracy rate reached 97.3%, markedly exceeding the control group's 82.5% ( $\chi^2=25.432$ ,  $P < 0.01$ ). The observation group recorded 1 missed detection and 0 false detection cases, with a non-adverse event incidence of 0.5%; in contrast, the control group experienced 8 missed detections, 3 false detections, and a non-adverse event rate of 5.5%, showing statistically significant differences ( $\chi^2=9.876$ ,  $P < 0.01$ ), as shown in **Table 2**.

**Table 2.** Comparison of two groups of quality evaluation indicators

Metric	Control group (n = 200)	Observation group (n = 200)	Statistic	P price
Physical examination efficiency score (score)	$5.2 \pm 1.1$	$8.9 \pm 0.8$	$t=38.765$	< 0.001
Guidance detection accuracy (%)	82.5	97.3	$\chi^2=25.432$	< 0.001
Number of missed cases (e.g.)	8	1		
Number of cases misread (e.g.)	3	0		
Adverse event incidence (%)	5.5	0.5	$\chi^2=9.876$	0.002

#### 3.3. Comparison of satisfaction between the two groups

The observation group achieved an overall satisfaction rate of 96.5% (193/200), significantly higher than the control group's 78.0% (156/200) ( $\chi^2=32.765$ ,  $P < 0.01$ ). In dimensions such as medical guidance services, waiting time, and overall experience, the observation group demonstrated statistically significant superiority over the control group ( $P < 0.01$ ). Healthcare staff job satisfaction increased from 68.0% to 89.5% ( $\chi^2=15.432$ ,  $P < 0.01$ ), as shown in **Table 3**.



**Table 3.** Comparison of satisfaction between the two groups [n(%)]

Evaluative dimension	Control group (n = 200)	Observation group (n = 200)	$\chi^2$ price	P price
Very satisfied	62(31.0)	135(67.5)	52.342	< 0.001
satisfied	94(47.0)	58(29.0)	13.765	< 0.001
same as	32(16.0)	6(3.0)	19.876	< 0.001
discontent	12(6.0)	1(0.5)	9.543	0.002
Overall satisfaction	156(78.0)	193(96.5)	32.765	< 0.001

## 4. Discussion

### 4.1. The intelligent guidance system significantly improves the efficiency of physical examination process

The research findings demonstrate that the intelligent triage system reduces overall examination time by 40.2% and decreases waiting time for major procedures by over 60%, primarily through real-time data analysis and dynamic path optimization. Traditional physical examinations, relying on fixed workflows and manual scheduling, struggle with unpredictable workload fluctuations across departments, often leading to uneven resource distribution and queue bottlenecks. The system employs IoT technology to monitor queuing conditions in real-time, combining historical data with predictive models to accurately assess current status and forecast future trends. Through reinforcement learning algorithms, it continuously optimizes triage strategies, dynamically adjusting patient flow management based on real-time data to achieve balanced resource utilization. Notably, the system prioritizes time-consuming procedures like ultrasound examinations requiring fasting, effectively preventing discomfort and process interruptions caused by prolonged waits in traditional methods. The significant reduction in report generation time highlights the system's advantages in result aggregation and automated report generation, providing valuable time for subsequent health management <sup>[5]</sup>.

### 4.2. Intelligent guidance improves the quality and safety of physical examination

The intelligent guidance system not only enhances physical examination efficiency but also significantly improves quality through standardized procedures and smart reminders. Research data shows the observation group achieved 97.3% guidance accuracy with a mere 0.5% adverse event rate – notably superior to traditional methods. The system's standardized workflow template ensures every participant completes all required tests through optimal pathways, eliminating potential omissions or sequencing errors in manual guidance. The mobile app's real-time navigation reduces participant confusion and unnecessary movements in unfamiliar environments, lowering misdiagnosis risks. An anomaly retention alert mechanism promptly identifies problematic procedures, enabling staff to intervene proactively and prevent interruptions or result in omissions caused by individual factors. Additionally, the system's automated report generation streamlines information management, reducing human errors and providing digital safeguards for quality control. These combined improvements ensure safer, more reliable examinations with accurate and comprehensive results.

### 4.3. Intelligent guidance and optimization of examinee experience and medical work mode

The participant satisfaction survey demonstrates that the intelligent guidance system significantly enhances physical examination experiences. With 96.5% satisfaction, participants highly appreciate its shortened waiting

times, clear navigation instructions, and user-friendly procedures. In traditional checkups, unpredictable wait durations and complex routes often caused anxiety and dissatisfaction. The real-time queue information and estimated wait times provided by the smart guidance app allow patients to clearly anticipate their progress, effectively reducing waiting stress. The indoor navigation feature helps locate examination departments quickly, minimizing confusion and fatigue during searches. From healthcare professionals' perspective, the system frees guides from repetitive directions, enabling them to focus on handling emergencies and providing personalized services for special needs. The management backend's real-time monitoring and data analysis help administrators scientifically assess departmental workloads and optimize staffing. This operational transformation not only improves service efficiency but also enhances healthcare workers' job satisfaction, with 89.5% of respondents endorsing the system's practicality in daily operations. These advantages make the intelligent guidance system an effective tool for elevating health checkup service quality and patient experience.

## 5. Conclusion

The intelligent guidance system significantly optimizes health check-up process management, reducing examination time and waiting periods while enhancing work efficiency, improving quality of care, and boosting patient satisfaction along with healthcare professionals' job experience. By deeply integrating information technology with health management, this system achieves intelligent, personalized, and efficient check-up procedures, demonstrating significant clinical application value and promising prospects for widespread adoption. Health check-up institutions are advised to adapt the system according to their specific needs, continuously refine its functions, and provide patients with superior medical services through smart guidance technology.

## Disclosure statement

The author declares no conflict of interest.

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