

# **International Journal of General Practice Nursing**

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## International Journal of General Practice Nursing

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# Application of Proactive Risk Intervention Combined with Meticulous Nursing in Neonates with Respiratory Distress Syndrome

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**Abstract:** *Objective:* To analyze the value of proactive risk intervention combined with meticulous nursing in neonates with respiratory distress syndrome (NRDS). *Methods:* 62 NRDS neonates who visited the hospital from August 2024 to August 2025 were selected as samples and randomly divided into groups. Group A received proactive risk intervention combined with meticulous nursing, while Group B received routine intervention. Treatment indicators, blood gas indicators, respiratory rate, heart rate, SNAP-II score, and complications were compared between the two groups. *Results:* The oxygen inhalation time, mechanical ventilation time, time to restore body temperature, and hospitalization time in Group A were shorter than those in Group B ( $P < 0.05$ ). The arterial oxygen partial pressure (PaO<sub>2</sub>), oxygen saturation (SaO<sub>2</sub>), and carbon dioxide partial pressure (PaCO<sub>2</sub>) in Group A were better than those in Group B ( $P < 0.05$ ). The respiratory rate, heart rate, and SNAP-II score in Group A were better than those in Group B ( $P < 0.05$ ). The complication rate of NRDS in Group A was lower than that in Group B ( $P < 0.05$ ). *Conclusion:* NRDS neonates who received proactive risk intervention combined with meticulous nursing had stable heart rate and respiratory rate, improved blood gas indicators, shortened disease duration, and were highly effective and feasible.

**Keywords:** NRDS; Meticulous nursing; Proactive risk intervention; Nursing value

**Online publication:** September 8, 2025

## 1. Introduction

NRDS is a respiratory disease, and its common symptom is dyspnea. Severe cases can lead to secondary CO<sub>2</sub> retention and hypoxemia, which seriously threaten the health of neonates <sup>[1]</sup>. Additionally, due to the poor immunity and compliance of neonates, the difficulty of diagnosis and treatment of NRDS increases, requiring efficient nursing solutions. Conventional NRDS nursing has limitations in reducing NRDS complications due to its passive and singular approach <sup>[2]</sup>. Proactive risk nursing focuses on risk prevention, predicting potential risk factors during diagnosis and treatment to ensure patient safety. Meticulous nursing provides patients with services from

various aspects, which can help shorten recovery time. This article explores the value of proactive risk intervention combined with meticulous nursing using 62 NRDS neonates as samples from August 2024 to August 2025 <sup>[3]</sup>.

## 2. Inclusion and exclusion criteria, methods, observations, and statistical analysis for a study on neonatal respiratory distress syndrome (NRDS)

### 2.1. Materials

62 NRDS neonates who visited the hospital from August 2024 to August 2025 were selected as samples and randomly divided into groups. The baseline data of NRDS neonates in Group A were compared with those in Group B ( $P > 0.05$ ), as shown in Table 1.

**Table 1.** Analysis of baseline data of children with NRDS

Group	n	Gender (%)		Gestational Age (weeks)		Birth Weight (g)	
		Male	Female	Range	Mean $\pm$ SD	Range	Mean $\pm$ SD
Group A	31	16 (51.61%)	15 (48.39%)	30-37	33.36 $\pm$ 1.28	2329-2421	2371.51 $\pm$ 11.29
Group B	31	17 (54.84%)	14 (45.16%)	31-38	33.39 $\pm$ 1.31	2331-2424	2373.68 $\pm$ 11.32
$\chi^2/t$		0.0648 ( $\chi^2$ )		0.0912 (t)		0.7557 (t)	
P-value		0.7991		0.9276		0.4528	

### 2.2. Inclusion and exclusion criteria

Inclusion Criteria: (1) Imaging, blood gas indicators, and blood biochemical indicators suggestive of NRDS; (2) Parental informed consent; (3) Presence of mechanical ventilation indications.

Exclusion Criteria: (1) Abnormal liver and kidney function; (2) Congenital heart disease; (3) Shock; (4) Systemic infection.

### 2.3. Methods

Group A: (1) Active Risk Intervention: 1) Admission assessment: Monitoring heart rate, respiratory rate, blood oxygen saturation, and evaluating Apgar score. If Apgar  $< 7$ , the patient is considered high-risk. 2) Early Warning System grading: NEWBORN-EWS system for grading assessment. Scores  $\leq 1$ , 2–4, and  $\geq 5$  are recorded as low, medium, and high risk, respectively. 3) Warning intervention: a. Oxygen therapy: Initial oxygen concentration  $\geq 40\%$ , subsequently adjusted based on physiological indicators. For medium and high-risk patients, nurses monitor respiratory rate and blood oxygen saturation every 15 minutes and blood pressure every 30 minutes, adjusting ventilator parameters accordingly. 4) Risk prevention and control intervention: For medium and high-risk patients, administration of pulmonary surfactant at 100mg/kg and maintenance of positive pressure ventilation at 5–8 cmH<sub>2</sub>O. Some high-risk patients may require endotracheal intubation due to a critical condition. (2) Refined nursing care: 1) Education: Educating parents of NRDS patients on the dangers of the disease, diagnosis and treatment methods, and nursing procedures through graphics, videos, and verbal communication. Answering parents' questions and enhancing their understanding. 2) Psychological support: Nurses timely share disease management information with parents, explain the necessity of medical procedures in layman's terms, and guide parents to sign consent forms. Deep communication with parents to identify and address negative emotions, sharing successful NRDS management cases to boost confidence. 3) Monitoring signs: Regular monitoring of

arterial blood gas indicators, respiratory and circulatory status. For patients requiring chest drainage, ensure proper drainage tube fixation and bag replacement to prevent retrograde infection. 4) Ventilator management: Checking ventilator connections, adjusting blood gas indicators, and promptly addressing loose connections or leaks. Synchronizing ventilator parameters with the patient's respiratory rate. Changing humidification fluid as prescribed to ensure stable humidification. Additionally, managing skin care for patients with prolonged mechanical ventilation to prevent skin pressure injuries. 5) Airway management: Placing a soft pillow under the shoulders of NRDS patients and elevating the head of the bed in a supine position. Observing excessive phlegm secretion and preparing 0.9% sodium chloride solution for phlegm thinning and suctioning. 6) Complication management: Regular cleaning of respiratory secretions, replacing tubing, and strictly controlling endotracheal intubation indications to prevent ventilator-associated pneumonia during mechanical ventilation.

Group B: Following standard medical practices such as mechanical ventilation, medication, oxygen administration, suctioning, and providing services like turning and draining patients. Cleaning oral secretions with sterile cotton swabs and normal saline.

## 2.4. Observation indicators

Treatment indicators: Recording oxygen inhalation time, mechanical ventilation time, time to restore body temperature, and hospital stay.

Blood gas indicators: Detecting PaO<sub>2</sub>, SaO<sub>2</sub>, PaCO<sub>2</sub>, and other indicators using a blood oxygen analyzer.

Clinical indicators: Recording respiratory rate, heart rate, and evaluating SNAP-II score. The SNAP-II scale ranges from 0–25, with scores positively correlated to the severity of NRDS.

Complications: Recording cases of pneumothorax, pulmonary hemorrhage, nasal mucosa injury, and ventilator-associated pneumonia.

## 2.5. Statistical analysis

Data were processed using SPSS 23.0. Count data were recorded as percentages and analyzed using the chi-square test. Measurement data were recorded as mean  $\pm$  standard deviation and analyzed using the t-test. Statistical differences were considered significant at  $P < 0.05$ .

# 3. Results

## 3.1. Treatment indicators

Group A showed superior treatment indicators compared to Group B, with  $P < 0.05$ . Details are presented in **Table 2**.

**Table 2.** Comparison of treatment indicators (Mean  $\pm$  SD)

Group	Oxygen Therapy Duration (h)	Mechanical Ventilation Duration (h)	Time to Normothermia (h)	Hospital Stay (d)
Group A (n=31)	91.28 $\pm$ 3.82	70.21 $\pm$ 2.79	3.39 $\pm$ 1.06	8.87 $\pm$ 1.45
Group B (n=31)	121.67 $\pm$ 4.29	87.43 $\pm$ 3.11	5.62 $\pm$ 1.18	11.26 $\pm$ 1.68
t-value	29.4563	22.9477	7.8276	5.9963
P-value	<0.0001	<0.0001	<0.0001	<0.0001

### 3.2. Blood gas indicators

After nursing, the indicators such as PaO<sub>2</sub>, SaO<sub>2</sub>, and PaCO<sub>2</sub> in Group A were better than those in Group B, with  $P < 0.05$  (Table 3).

**Table 3.** Comparison of blood gas indicators (Mean  $\pm$  SD)

Parameter	Time	Group A (n=31)	Group B (n=31)	t-value	P-value
PaO <sub>2</sub> (mmHg)	Before care	51.88 $\pm$ 1.82	51.92 $\pm$ 1.79	0.0872	0.9308
	After care	60.93 $\pm$ 2.26	57.33 $\pm$ 2.05	6.5691	<0.0001
SaO <sub>2</sub> (%)	Before care	84.28 $\pm$ 3.26	84.33 $\pm$ 3.31	0.0599	0.9524
	After care	94.51 $\pm$ 4.11	90.59 $\pm$ 4.06	3.7779	0.0004
PaCO <sub>2</sub> (mmHg)	Before care	61.29 $\pm$ 2.49	61.33 $\pm$ 2.51	0.0630	0.9500
	After care	47.62 $\pm$ 1.29	55.11 $\pm$ 1.67	19.7622	<0.0001

### 3.3. Respiratory rate, heart rate, and SNAP-II score

After nursing, the respiratory rate, heart rate, and SNAP-II score in Group A were better than those in Group B, with  $P < 0.05$  (Table 4).

**Table 4.** Comparison of respiratory rate, heart rate, and SNAP-II score (Mean  $\pm$  SD)

Group	Respiratory rate (times/min)		Heart Rate (times/min)		SNAP-II Score (points)	
	Before care	After care	Before care	After care	Before care	After care
Group A (n=31)	61.79 $\pm$ 2.11	40.25 $\pm$ 1.78	152.59 $\pm$ 18.42	138.59 $\pm$ 11.26	13.28 $\pm$ 1.89	4.71 $\pm$ 0.72
Group B (n=31)	61.72 $\pm$ 2.13	50.49 $\pm$ 2.06	152.63 $\pm$ 18.39	145.68 $\pm$ 15.43	13.33 $\pm$ 1.92	6.26 $\pm$ 1.43
<i>t</i>	0.1300	20.9418	0.0086	2.0666	0.1033	5.3903
<i>P</i>	0.8970	0.0000	0.9932	0.0431	0.9180	0.0000

### 3.4. Complication indicators

The complication rate in Group A was lower than that in Group B, with  $P < 0.05$  (Table 5).

**Table 5.** Comparison of complications (n,%)

Group	Pneumothorax	Pulmonary hemorrhage	Nasal mucosal injury	Ventilator-associated pneumonia	Total incidence
Group A (n=31)	0 (0.00)	0 (0.00)	1 (3.23)	0 (0.00)	1 (3.23)
Group B (n=31)	1 (3.23)	1 (3.23)	3 (9.68)	1 (3.23)	6 (19.35)
$\chi^2$	-	-	-	-	4.0260
P	-	-	-	-	0.0448

## 4. Discussion

Neonatal respiratory distress syndrome (NRDS) has a high clinical incidence, manifesting as progressive dyspnea, which requires early diagnosis and treatment. Otherwise, secondary ischemia and hypoxic encephalopathy may occur, affecting the intellectual development of the child. The common pathogenesis of NRDS is the deficiency of pulmonary surfactant (PS), which leads to a decrease in alveolar surface tension at the intersection of alveolar walls. Premature infants, especially, have a lower PS secretion and are at higher risk of developing NRDS<sup>[4]</sup>. Additionally, newborns delivered via cesarean section without passing through the birth canal may have residual fluid in their lungs, affecting the distribution of PS. Moreover, newborns of mothers with diabetes may have increased blood glucose levels and insulin secretion, and insulin can antagonize adrenocortical hormones, damaging lung function and further increasing the risk of NRDS. Clinically, NRDS is often treated with replacement therapy, respiratory support therapy, and nursing intervention to alleviate symptoms. However, conventional nursing, which passively completes various operations with a single content and fails to address the individualized needs of patients, is inadequate. Exploring new and efficient nursing programs is crucial<sup>[5]</sup>. Fine nursing, based on the “people-oriented” concept, provides comprehensive services to NRDS patients from multiple aspects, fully meeting their needs. Active risk intervention, based on the “risk management” concept, requires nurses to proactively assist NRDS patients, assess risks, and improve targeted management strategies<sup>[6]</sup>. The combination of active risk intervention and fine nursing services can effectively alleviate NRDS symptoms and shorten the course of the disease.

Based on the data analysis in this article, the improvement time of symptoms in children after active risk intervention combined with fine nursing is shortened. The reason for this is that during the combined nursing period, emphasis is placed on risk prediction in various aspects of diagnosis and treatment for the children, and nursing strategies are improved based on risk factors that may affect the children’s recovery, which can accelerate their rehabilitation. In addition, during active risk intervention, nurses are required to conduct a comprehensive assessment of newly admitted children, which can cultivate their awareness of risk management and enhance their ability to identify risks. Therefore, the quality of NRDS nursing is improved, and the duration of children’s symptoms is shortened<sup>[7]</sup>. Another set of data indicates that the blood gas indicators of children improve after active risk intervention combined with fine nursing. The reason is that during active risk intervention, real-time monitoring of the child’s physiological state, adjustment of ventilator parameters, and implementation of different standard nursing services can meet the actual nursing needs of different children, thereby reducing airway damage and reducing the risk of respiratory complications. Hence, the blood gas indicators of the children improve<sup>[8]</sup>. Another set of data shows that the physiological state and SNAP-II score of children improve after active risk intervention combined with fine nursing. The reason is that during fine nursing, emphasis is placed on educating the parents of the children, and services such as psychological and emotional counseling, vital sign monitoring, ventilator management, airway management, and complication management are provided, which can improve the safety of diagnostic and therapeutic operations, reduce the harmfulness of NRDS, and shorten the time of weaning from the ventilator<sup>[9]</sup>. Combined with active risk intervention, precise prevention and control of various risk events are conducive to stabilizing the child’s vital signs and delaying the progression of NRDS. The final set of data indicates that complications in children decrease after active risk intervention combined with fine nursing. The reason is that children with NRDS have critical illnesses and complex medical procedures. Based on fine nursing, combined with active risk intervention, analyzing the source of potential risks and carrying out graded management and symptomatic intervention based on the child’s condition can reduce the risk of NRDS



complications<sup>[10]</sup>.

## 5. Conclusion

In summary, children with NRDS who receive active risk intervention combined with fine nursing experience improved blood gas indicators, shortened duration of symptoms, and reduced complications, which has promotional value.

## Disclosure statement

The author declares no conflict of interest.

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### Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



# Qualitative Research on Flight Nurses' Training Needs for Air Transport of Emerging and Virulent Infectious Diseases

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**Abstract:** *Objective:* To explore the characteristics of flight nurses' training needs for nursing management of air transport of emerging and virulent infectious diseases, and to provide a reference for the transport training of infectious disease patients. *Methods:* Based on purposive sampling, 17 flight nurses were selected for semi-structured interviews, and data were collected, sorted, and analyzed using the grounded theory paradigm. *Results:* Four themes were summarized: theoretical knowledge related to emerging and virulent infectious diseases, participation in infectious disease management practices, and training content needs, including knowledge, skills, and personal traits. *Conclusion:* Flight nurses are in the stage of experience accumulation in the management of emerging and virulent infectious diseases, and they lack theoretical knowledge and practical abilities regarding virulent infectious diseases. Establishing a comprehensive training system, combined with regular drills and assessment feedback, will effectively improve flight nurses' emergency response capabilities and mission execution efficiency, ensuring the smooth progress of missions and the safety of personnel.

**Keywords:** Flight nurse; Emerging and virulent infectious diseases; Aviation rescue; Training needs

**Online publication:** September 8, 2025

## 1. Introduction

With the acceleration of globalization and the continuous expansion of the scope of human activities, the frequency and speed of transmission of emerging and virulent infectious diseases are showing an upward trend, posing severe challenges to public health security<sup>[1]</sup>. Based on the increasing incidence and fatality rates of emerging and virulent infectious diseases, as well as the characteristics of no specific vaccines and drugs being available in the early stages of outbreaks, and the general susceptibility of the population, it warns people to pay more attention to the prevention and control of emerging and virulent infectious diseases<sup>[2-3]</sup>. Biosafety is an important component of national security. Virulent infectious diseases spread fast, have a wide range of transmission, and have a high

fatality rate, which can easily cause social panic and affect social stability. Emerging and virulent infectious diseases require rapid identification and centralized isolation for diagnosis and treatment <sup>[4]</sup>. As key members of the air transport team, flight nurses not only bear the responsibility of continuous care for patients during transport but also face the threats of biosafety and the pressure of clinical decision-making brought by high-risk infectious diseases. Due to the advantages of fast speed and high safety, aviation rescue and transport have been proven to meet the transportation requirements of patients with virulent infectious diseases during the Ebola and COVID-19 pandemics, as demonstrated by practices in Europe, Japan, and other countries <sup>[5]</sup>. However, compared with routine transport missions, the air transport of patients with emerging and virulent infectious diseases poses higher professional requirements for flight nurses, including infection prevention and control, isolation techniques, emergency response, psychological coping, and team collaboration <sup>[6]</sup>. This study intends to use qualitative research methods to deeply understand the actual feelings, training experiences, and specific needs for ability improvement of flight nurses involved in the air transport of emerging and virulent infectious diseases, aiming to provide a theoretical basis and practical reference for building a more scientific and systematic training system.

## **2. Subjects and methods**

### **2.1. Subjects**

Based on the principle of maximizing diversity, subjects were selected through purposive sampling to ensure a more diversified background and richer interview content. Inclusion criteria were: (1) Currently engaged in nursing practice or management at an aviation rescue base hospital; (2) Completed flight nurse training and obtained qualification; (3) Have practical and training experience in infectious disease prevention and control; (4) Regularly participate in aviation rescue skills training and are willing to participate in this study. Exclusion criteria were: (1) Took a vacation, went out for study or work exchange in the past 6 months; (2) Actual work does not involve issues related to nursing care for emerging and virulent infectious diseases. Subjects who withdrew midway or did not complete the interview were excluded. The sample size was determined by information saturation, i.e., when data information became repetitive and no new viewpoints emerged during material analysis. A total of 17 individuals were interviewed, including 4 males and 13 females; 13 with bachelor's degrees, 3 with master's degrees, and 1 with a college degree; 1 nurse, 15 nurse-in-charges, 1 associate chief nurse, and 1 chief nurse; aged between 29 and 44 years old, with an average age of 35.05 years (**Table 1**).

### **2.2. Methods**

#### **2.2.1. Interview outline development**

Based on a multidimensional perspective combining nursing, public health, emergency medicine, and other professions and disciplines, a research team was established. A literature search was conducted, and the research team collectively discussed and drafted a semi-structured interview outline, determining the research subjects. According to the inclusion criteria, three subjects who met the criteria were selected for a pre-interview. Based on the interview results and feedback, the research team revised the interview questions. The final interview outline was as follows:

Are you familiar with the nursing work content related to emerging and virulent infectious diseases? What challenges or difficulties have you faced in such tasks? Have you ever felt uneasy or nervous?

Please share an experience of participating in the air transport of a patient with an emerging or virulent infectious disease, and talk about the difficulties and feelings encountered during the mission.

**Table 1.** General information on interview subjects

ID	Gender	Age	Education	Professional title	Transport cases
N1	Female	35	Bachelor	nurse-in-charges	13
N2	Female	29	Bachelor	Nurse	10
N3	Female	32	Master	nurse-in-charges	13
N4	Male	33	Bachelor	nurse-in-charges	14
N5	Female	39	Bachelor	nurse-in-charges	15
N6	Female	37	Bachelor	nurse-in-charges	12
N7	Female	39	Bachelor	nurse-in-charges	10
N8	Female	34	Bachelor	nurse-in-charges	10
N9	Female	36	Bachelor	nurse-in-charges	10
N10	Male	32	Bachelor	nurse-in-charges	11
N11	Male	34	Master	nurse-in-charges	13
N12	Female	31	Bachelor	nurse-in-charges	10
N13	Female	42	Bachelor	Associate Professor Nurse	13
N14	Male	37	Bachelor	nurse-in-charges	00
N15	Female	44	college	chief nurse	16
N16	Female	30	Bachelor	nurse-in-charges	12
N17	Female	32	Master	nurse-in-charges	10

Do you think you were well-prepared in terms of knowledge, skills, or emergency response capabilities when performing such tasks? In what areas did you feel inadequate?

What are your experiences and views on personal protection, team collaboration, emergency response, and psychological pressure management during missions?

Based on your experience, what content do you think should be emphasized in training? Do you have any suggestions for the format or arrangement of the training?

### 2.2.2. Data collection

Before the formal interview, members of the research team explained the purpose, content, interview process, and related rights and interests of the study to the interviewees. They clarified that the interview content would only be used for academic research and would not involve personal privacy information, ensuring that the interviewees were informed, understood, and voluntarily participated in the study. All interviewees signed a written informed consent form. The interview time was negotiated based on the interviewee's work schedule, and a convenient time for them to participate was chosen. The interview location was a quiet, undisturbed office or conference room to ensure privacy and continuity of communication. Each interview lasted between 20 and 40 minutes, adjusted appropriately based on the depth of the communication content. The interviews were conducted in a one-on-one semi-structured format, with two researchers participating. One researcher led the questioning, while the other was responsible for recording and assisting with follow-up questions. Clarification and guidance were provided for

any unclear or ambiguous expressions from the interviewees to ensure comprehensive and in-depth information gathering. The entire interview process was recorded with the consent of the interviewees for subsequent data collation and analysis. Interviewees could discontinue or withdraw from the interview at any time if they felt discomfort, and the researchers respected and cooperated with their decisions.

### **2.2.3. Data analysis**

This study adopted a grounded theory research method from a phenomenological perspective to conduct an in-depth analysis of the experiences and needs of flight nurses in aviation transfer training for emerging and virulent infectious diseases. All interview data were recorded with the consent of the interviewees. Members of the research team used NVivo 14 software to transcribe the audio into text. After initial collation, the interviewees were contacted for content verification and supplementation to ensure the authenticity and integrity of the information. This study adopted the coding method of classical grounded theory. Initial coding: Two researchers studied the transcribed data line by line, extracted keywords, phrases, or key events from the original interviews, and conducted open coding while retaining the original meaning as much as possible. Focused coding: The initial coding results were categorized, filtered, and focused. Similar concepts were merged, and representative important categories were extracted. Theoretical coding: Based on continuous comparison and reflection, the internal connections between various genera or concepts were explored, a theoretical framework was constructed, and a systematic understanding of the research phenomenon was gradually formed. Two researchers independently completed the coding and preliminary analysis, and then compared and discussed the results. If there were disagreements during the coding or theme induction process, other members of the research team were invited to participate in the discussion until a consensus was reached, ensuring the scientific and objective nature of the research conclusions.

### **2.2.4. Quality control**

The establishment of a multi-dimensional professional team ensures the accuracy of research content analysis and the comprehensiveness of collected data. Members of the research team analyze data using a double-person approach, comparing coding and themes to ensure multi-dimensional, deep-level, and high-precision data analysis. Before conducting the investigation, the research group performed a literature search on aviation rescue transport nursing and infectious disease prevention and control. They also studied theoretical knowledge related to qualitative research and techniques to improve the credibility of qualitative research, laying a theoretical foundation for interviews and data analysis. Appointments were made before interviews, and relevant research content was communicated to ensure smooth interviews and content acquisition. Interview content was transcribed into text within 48 hours after each interview. Any unclear content was confirmed and double-checked with the interviewees to ensure the accuracy and completeness of the interview data.

### **2.2.5. Ethical principles**

This study does not involve personal privacy. Interviewers strictly follow ethical principles such as informed consent and confidentiality. They respect participants' rights to autonomous choice and privacy, allowing interviewees to refuse to answer questions or withdraw from the interview. All data is stored anonymously and encrypted, and destroyed after the study is completed.

### **3. Results**

Through analyzing interview data, information themes were formed. Flight nurses who participated in the semi-structured interviews had not received targeted training in aviation transport management for emerging and virulent infectious diseases. Most interviewees were key members of their departments and had experience in infectious disease prevention and control. They expressed high enthusiasm for learning about aviation rescue transport for emerging and virulent infectious diseases. Based on the interview results, flight nurses' training needs for transport management of emerging and virulent infectious diseases are reflected in four thematic areas characterized by competency in infectious disease transport management: relevant theoretical knowledge, systems and process specifications, equipment usage, and training and assessment.

#### **3.1. Knowledge of prevention and control of emerging and virulent infectious diseases**

##### **3.1.1. Disease characteristics and transmission routes**

The onset of infectious diseases has a certain degree of concealment, and it is difficult to clarify their characteristics during the initial outbreak. This poses a greater exposure risk for contacts and a higher safety risk. In the research phase of emerging and virulent infectious diseases, due to the lack of specific vaccines, the population generally does not have resistance, and there are relatively high requirements for the professional knowledge and protection implementation of transport personnel. N3: "We need to update and dynamically learn about the research trends of emerging diseases in real time, and make preparations for health treatment, transport protection, and training to ensure the safe implementation of missions." N5: "Since I started working in nursing, I have experienced the prevention and control of SARS, H7N9, Dengue fever, Hand-foot-and-mouth disease, and COVID-19. It is crucial for our clinical work to timely obtain the latest research results and guidance." N7: "When emerging and highly infectious diseases break out, many prevention and control points are uncertain. We need to strengthen our knowledge of existing virulent infectious diseases while also paying attention to the dynamics of infectious diseases around the world and following up on learning."

##### **3.1.2. Prevention and control guidelines and research trends**

When emerging or highly infectious diseases appear, the National Health Commission will issue relevant notifications and instructions, providing phased updates and guidance on how to conduct scientific management and control. As an important department of health and epidemic prevention, medical institutions can timely obtain relevant prevention and control instructions. Through training, medical staff can acquire cutting-edge knowledge and protective skills about infectious diseases, avoiding unnecessary occupational exposure and spread. N5: "As nursing staff, we are very concerned about the transmission modes of infectious diseases and effective protective measures to ensure safety when contacting patients." N14: "Medical staff must master the basic diagnosis and treatment methods and isolation protection skills for patients with virulent infectious diseases, and be familiar with the procedures and specifications for contact and treatment."

#### **3.2. Professional knowledge and operational norms of aviation transport**

##### **3.2.1. Special requirements for aviation transport**

The particularity of aviation rescue and transport has a significant impact on both medical staff and patients. Learning relevant knowledge about aviation transport is beneficial for medical staff to avoid potential problems during transport and take preventive intervention measures. There is more practice in the aviation transport of patients with emerging and virulent infectious diseases in developed countries, which is completed by professional



infectious disease prevention and control aviation rescue teams. However, there are only a few case reports in China, and experience is severely lacking. With the rapid development of aviation rescue, strengthening the response capabilities and strategies for sudden health emergencies is also an urgent task for improvement. N8: “Relatively speaking, our knowledge of aviation rescue and transport is very lacking. We hope to receive comprehensive aviation knowledge training before accepting missions, understand the characteristics of the impact of different transport situations on patients and medical staff, and be psychologically prepared for transport.”

### **3.2.2. Transfer process and isolation procedures**

The management of infectious diseases has strict requirements. According to these requirements, priority is given to on-site isolation and treatment. For patients with special transfer needs, it is important to ensure that prevention and control measures are in place during the transfer to safely transport them to their destination. The transfer process for emerging or virulent infectious diseases involves coordination and communication among multiple departments. A well-designed isolation and transfer procedure is a crucial foundation to ensure successful transfers. The transfer of highly infectious diseases requires comprehensive management to ensure the implementation of procedural content. N9: “The transfer of severe infectious disease patients is different from that of ordinary critically ill patients. Isolation procedures need to be activated during the transfer, such as boarding, deplaning, and patient handover, which we all need to learn.” N11: “Important aspects of the transfer include precautions, how to place patients, the division of isolation areas, putting on and taking off personal protective equipment, communication procedures, care for special patients, waste disposal, cleaning and disinfection, logistical planning, and follow-up after the mission.” N6: “We also need to learn how to complete deplaning procedures, conduct patient handovers, dispose of waste, and perform cleaning and disinfection.”

## **3.3. Specialized equipment usage and protective measures**

### **3.3.1. Use of transfer isolation equipment**

Emerging and virulent infectious diseases are highly contagious and can spread through various pathways. To ensure the safe transfer of patients with virulent infectious diseases, effective isolation measures should be taken in addition to basic medical treatment capabilities <sup>[7-9]</sup>. In foreign countries, experience with transferring Ebola patients has shown that some patients are transported using isolation pods, and healthcare workers are equipped with multi-layer protective suits to prevent infection. During the air transport of infectious disease patients, the confined space and poor ventilation can increase the risk of infection. The correct application of equipment can reduce this risk. Negative pressure isolation transfer equipment includes negative pressure isolation stretchers, mobile negative pressure isolation transfer rooms, and negative pressure ambulances for long-distance transfers. N6: “Referring to the requirements for COVID-19 prevention and control during transfers, negative pressure vehicles are used for transportation after air transfers to ensure orderly transfers.” N15: “Compared to mature rescue teams, we are lacking in equipment for infectious disease prevention and control, and it is rarely available for us to use in practice.”

### **3.3.2. Use and management of personal protective equipment (PPE)**

The use of PPE is a basic protective measure when dealing with infectious diseases and is key to ensuring that healthcare workers can continue to work safely. The routine PPE includes protective masks, isolation gowns, gloves, and face shields, which are suitable for protection against common infectious diseases. Following the

outbreak of COVID-19, inadequate personal protection has been a significant cause of infection among healthcare workers facing highly infectious respiratory diseases. Currently, in addition to commonly used masks, hats, and protective suits, biochemical protective suits are even used for isolation and protection during the transfer of uncertain infectious diseases abroad <sup>[10]</sup>. Different protective equipment requires continuous adaptation and practice to ensure foolproof operation in practical situations. N4: “The use of protective equipment is very important. It not only requires practice in putting it on and taking it off but also adapting to working in protective suits for extended periods, which has high demands on physical fitness.” N11: “Proficiency in the correct use of PPE among healthcare workers is the most important measure to reduce infections.”

### **3.3.3. Adaptability training for protective equipment**

Flight nurses universally mentioned in interviews that adaptability training for protective equipment is a core skill in responding to air transport missions involving emerging and virulent infectious diseases. Because protective equipment (such as protective suits, masks, gloves, face shields, etc.) is often bulky and wearing it can limit nurses’ movements and work <sup>[11]</sup>, mastering how to adapt to wearing protective equipment for extended periods and ensuring efficient and safe work during high-risk missions is a training aspect they value highly <sup>[12]</sup>. N4: “Wearing protective suits is not easy, especially during high temperatures and long missions, which often make us feel very uncomfortable. Additionally, if the protective suit is too tight or not breathable, it can affect our work efficiency. Therefore, adaptability training is crucial, and we need to get used to working in an environment with protective equipment.”

## **4. Conclusion**

China’s flight nurse training mechanism is not yet perfect, and the professional development of flight nurses still needs continuous improvement. There is still a lack of experience in transporting special medical conditions. Through interviews and analysis with flight nurses, this study reveals the urgent needs of nurses in terms of professional knowledge, skills training, and emergency response during air transport missions for emerging and virulent infectious diseases. Flight nurses generally lack systematic training for emerging infectious diseases, especially in areas such as protective skill updates, mastery of air transport operating procedures, and emergency response capabilities. Nurses emphasize that combining theoretical learning with practical training, especially through scenario simulations and regular drills, can effectively improve their response capabilities during actual missions. Additionally, a regular assessment and feedback mechanism is considered an important means to improve professional ability and ensure mission safety. Overall, establishing a systematic training mechanism, especially targeted training for infectious disease prevention and control, air transport, and emergency management, is significant for enhancing the professional capabilities of flight nurses and ensuring the successful completion of air transport missions.

## **Funding**

Guangxi Zhuang Autonomous Region Health Commission Self-funded Scientific Research Project(Project No.: Z-A20220615).

## Disclosure statement

The authors declare no conflict of interest.

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Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



# A Review of Risk Factors Analysis and Bundle Prevention and Control Strategies for Pediatric PICC Catheter-related Bloodstream Infections

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**Abstract:** The peripherally inserted central catheter (PICC) for children is widely used in clinical treatment due to its advantages, such as long-term indwelling and convenient operation. However, the incidence of catheter-related bloodstream infection (CRBSI) is significantly higher than that in adults, which seriously threatens the lives of children and increases the medical burden. This paper systematically reviews the risk factors and prevention and control strategies of PICC-CRBSI in children. Studies have shown that the high incidence of CRBSI in children is closely related to the following factors: the children's own factors, operation and management factors, and pathogen diversity. Aiming at the above risks, the article puts forward a bundled prevention and control strategy, including professional training of personnel, strengthening aseptic technology, standardizing catheter maintenance, and establishing an infection monitoring and early warning mechanism. Through the synergistic effect of multi-dimensional intervention measures, the incidence of CRBSI can be effectively reduced, providing an evidence-based basis for the safe management of vascular access in children. This paper aims to provide a systematic prevention and control framework for clinical practice and calls for further research to optimize strategies and reduce CRBSI-related complications in children.

**Keywords:** Pediatric catheter-related bloodstream infection; Risk factors; Bundle intervention; Infection prevention and control

**Online publication:** September 8, 2025

## 1. Introduction

In recent years, peripherally inserted central catheters (PICCs) have been increasingly used in pediatric clinical treatment. As an important vascular access technology, PICCs have become a key medical tool for chemotherapy in children with tumors, nutritional support for critically ill children, and neonatal care due to advantages such as long-term indwelling, convenient operation, and stable fixation<sup>[1-2]</sup>. Relevant data show that the utilization rate of PICCs in neonatal intensive care units has continued to increase over the past decade<sup>[3]</sup>. However, this technology

still faces severe challenges in clinical practice: the complexity of pediatric-specific vascular conditions (such as smaller vessel diameter and poor elasticity), immature immune function development (especially the immature reticuloendothelial system in premature infants), and insufficient standardization of nursing operations collectively constitute high-risk factors for catheter-related bloodstream infections (CRBSIs). Studies have shown that the incidence of CRBSIs in pediatric patients is significantly higher than that in adults, severely threatening the safety of children and significantly increasing the medical burden <sup>[4-5]</sup>.

Research on the prevention and control of pediatric PICC-related infections presents two notable characteristics: firstly, risk factor studies mostly focus on single dimensions, such as microbiological characteristics or nursing operation levels, lacking systematic analysis of multidimensional interactions; secondly, prevention and control strategies often adopt isolated measures, failing to form a scientifically integrated bundle intervention system. It is noteworthy that due to significant differences in the immune system between children and adults, their ability to combat bacteria is poor, thus increasing the risk of catheter infection. This article aims to review the risk factors of pediatric PICC-related CRBSI, explore corresponding prevention and control measures and bundle management strategies, and provide references for formulating key interventions to reduce their occurrence risk.

## **2. Characteristics of pediatric PICC-CRBSI: Incidence and pathogenic characteristics**

PICC-CRBSI poses significant clinical harm in neonatal and preterm infant intensive care, with its pathogenic characteristics and risk factors having attracted extensive attention. A study by Yan Hu et al. reported that the incidence of neonatal PICC-CRBSI was as high as 10.62%, with low birth weight, indwelling time  $\geq 21$  days, low Apgar score, and femoral artery insertion identified as major risk factors. Common CRBSI pathogens included *Escherichia coli* and *Staphylococcus aureus* <sup>[6]</sup>. Yan-ping Xu et al. reported a CRBSI incidence of 1.46 cases per 1,000 catheter-days in neonates, with common pathogens such as *Klebsiella pneumoniae*. The risk of PICC-induced CRBSI decreased with increasing gestational age <sup>[7]</sup>. Jeongmin Shin et al. reported a CRBSI rate of 1.3 cases per 1,000 catheter-days in neonates, identifying major contributing factors as prolonged catheter indwelling, unnecessary catheter insertion, extremely low birth weight, and immunodeficiency <sup>[8]</sup>. Shu-Chun Chu et al. reported a CRBSI rate of 6.36 cases per 1,000 catheter-days in extremely low birth weight infants, with pathogens primarily including coagulase-negative staphylococci, while gram-negative bacteria and *Candida albicans* were also relatively common. Risk factors associated with CRBSI included gestational age, birth weight, and PICC indwelling time <sup>[9]</sup>.

It can be seen that the incidence of CRBSI varies significantly among pediatric populations, but extremely low birth weight infants and preterm infants face a higher infection risk. Key risk factors include low birth weight, prolonged catheter indwelling, and specific puncture site selection. Common pathogenic spectra cover *E. coli*, *S. aureus*, coagulase-negative staphylococci, gram-negative bacteria, *C. albicans*, and *K. pneumoniae*.

## **3. In-depth analysis of risk factors for pediatric PICC-CRBSI**

### **3.1. Patient-specific factors**

#### **3.1.1. Physiological developmental characteristics**

Children's developmental status directly affects immune system function. Extremely low birth weight (<1000g) leads to immature immune system development and poor resistance. Additionally, the thin stratum corneum and

fragile barrier function make it more prone to infection during invasive procedures<sup>[10]</sup>. Therefore, extremely low birth weight is typically a high-risk factor for CRBSI. In a clinical study by Pan Jinzhou et al., the incidence of CRBSI in neonates with birth weight <1000g reached 58.8%<sup>[11]</sup>. Furthermore, studies have shown that the smaller the gestational age of newborns, the higher the infection risk, with preterm infants <28 weeks facing the highest risk<sup>[12]</sup>. This may be associated with mechanical barrier defects due to immature development.

### **3.1.2. Disease and treatment status**

Relevant studies indicate that children with chronic underlying diseases such as metabolic disorders, tumors, and heart diseases have a higher risk of CRBSI<sup>[13]</sup>. Among these groups, some children require long-term use of broad-spectrum antibiotics due to their conditions, which can cause dysbiosis, suppress beneficial bacteria, and facilitate colonization by drug-resistant or opportunistic pathogens, increasing the risk of secondary infection<sup>[7]</sup>. Additionally, children unable to meet energy needs through oral intake often rely on long-term PICC for total parenteral nutrition support. During nutrient solution preparation, high-osmolar components (such as glucose and amino acids) may alter the intravascular hemodynamic environment, promoting microbial adhesion and biofilm formation. Incomplete catheter flushing may also leave residual fluid as a breeding ground for bacterial proliferation<sup>[14]</sup>.

## **3.2. Operational and management factors**

### **3.2.1. Risks in catheter insertion**

The standardization of catheter insertion directly affects the incidence of catheter-related infections. Before insertion, healthcare providers' failure to strictly follow hand hygiene protocols is a critical risk factor, as hands are often the direct route of infection. A survey covering 21 tertiary hospitals showed that 11 (52.3%) had inadequate hand hygiene compliance<sup>[15]</sup>. During insertion, operator inexperience is a significant risk factor. For example, inexperienced operators may cause repeated punctures, leading to vascular wall injury, subcutaneous hematoma, and weakened local anti-infection ability, allowing bacteria to invade vessels and cause bloodstream infections. Studies have shown that catheters inserted by less experienced personnel are more prone to bacterial colonization and CRBSI compared to those inserted by senior nurses, highlighting the importance of standardized training and operational protocols<sup>[16–17]</sup>. Additionally, inexperienced operators are prone to mishandling during the operation process when facing severe crying in newborns, resulting in insufficient skin disinfection, promoting skin flora migration and adhesion to the catheter surface, and finally invading through the puncture site. Neonatal crying, unstable positioning, and vascular collapse due to hypothermia increase operational difficulty, prolonging insertion time. Repeated insertion after initial failure extends exposure time of sterile items (e.g., catheter packs, dressings), increasing contamination risk, mainly via microbial contamination of catheters through exposed instruments or operator gloves<sup>[18]</sup>.

### **3.2.2. Catheter maintenance defects**

Good catheter care is crucial for preventing CRBSI, with any oversight potentially causing infection. Dressings and infusion connectors are two key risk factors in maintenance. For dressings, delayed replacement of contaminated dressings, non-sterile operations, or loose dressings can lead to local bacterial colonization and bloodstream entry via the catheter site. Infusion connectors are critical pathways for bacterial entry: needleless connectors, due to structural design, may facilitate microbial invasion and intraluminal contamination—bacteria on

skin or connector surfaces can contaminate the lumen when connecting infusion devices<sup>[19]</sup>. Inadequate connector disinfection allows bacteria to migrate along the catheter lumen, causing infection. Studies also show that high-frequency connector changes increase infection risk, as frequent replacements expose the catheter lumen to air, enabling microbial colonization<sup>[20]</sup>.

### **3.2.3. Catheter dwell time**

Catheter dwell time is a recognized independent risk factor. Prolonged dwell time increases the risk of biofilm formation on the catheter surface, significantly raising infection rates. After insertion, patient movement may cause mechanical friction between the catheter and vascular wall. If dwell time exceeds 20 days, CRBSI incidence significantly increases<sup>[21]</sup>. Dwell time correlates with higher mortality and infection recurrence rates; thus, clinical assessment for unnecessary catheter removal and shortened dwell time is essential to reduce risk<sup>[22]</sup>.

### **3.2.4. Puncture site selection**

Anatomical structures, skin flora distribution, nursing difficulty, and local environment vary by puncture site, influencing infection rates. Yan Hu et al. found that femoral vein insertion in neonates had a significantly higher CRBSI risk than other sites<sup>[6]</sup>. Key reasons include: (1) The femoral vein area near the perineum is prone to contamination, with high skin bacterial density; (2) Lower limb/femoral sites are harder to keep clean and dry, increasing nursing difficulty and infection risk; (3) Blood flow velocity and dwell time at different sites affect bacterial colonization and infection.

## **4. Construction and implementation of bundle prevention and control strategies**

In the prevention and control of pediatric peripherally inserted central catheter-related bloodstream infections (PICC-CRBSI), bundle strategies represent an effective approach. Their core lies in the combined implementation of multiple evidence-based measures covering the entire process of catheter insertion, maintenance, and removal, systematically reducing infection risks.

### **4.1. Core elements of bundle management**

#### **4.1.1. Personnel specialization**

Personnel specialization serves as the foundational guarantee for constructing and implementing bundle strategies. PICC insertion and maintenance involve complex procedures (e.g., puncture techniques, aseptic barriers, catheter fixation), requiring execution by a systematically trained professional team (e.g., PICC insertion team). By establishing a dedicated PICC task force, all operators and maintainers are ensured to possess corresponding qualifications and receive regular professional training to enhance technical proficiency and emergency response capabilities. Thus, personnel specialization ensures that insertion and maintenance are performed by trained healthcare providers, reducing infection risks from operational errors<sup>[23]</sup>.

#### **4.1.2. Strengthening aseptic techniques**

Enhanced execution of aseptic techniques is a critical link in infection prevention and the first line of defense to disrupt the infection transmission chain. Strict adherence to the maximum aseptic barrier principle during insertion—including wearing sterile gowns and using large sterile drapes—minimizes pathogen invasion<sup>[24]</sup>. Additionally, skin disinfectant selection is vital: disinfectants containing chlorhexidine alcohol (>0.5%) significantly improve



disinfection efficacy. Chlorhexidine alcohol exhibits stronger bacteriostatic ability, providing prolonged skin protection and remarkably reducing local infections and bacterial colonization <sup>[25]</sup>.

#### **4.1.3. Standardized catheter maintenance**

Standardized daily catheter maintenance is equally indispensable. Normalized maintenance operations can effectively reduce local contamination, thereby lowering infection risks <sup>[26]</sup>. Dressings should be changed according to standard cycles (e.g., weekly for transparent dressings) and replaced immediately if contaminated or loose. Meanwhile, adopting pulse flushing techniques and heparinized saline positive pressure sealing during infusion and catheter sealing helps clear residual substances, effectively preventing biofilm formation and reducing infection rates.

#### **4.1.4. Infection monitoring and early warning**

To achieve early identification and rapid intervention, a sound infection monitoring and early warning mechanism must be established. Continuous tracking of infection occurrences identifies high-risk patients and operational links for early intervention and continuous improvement <sup>[23]</sup>. Daily assessment of catheter necessity in children, combined with clinical manifestations such as fever and elevated C-reactive protein (CRP), determines whether catheter removal is required. Suspected infections should immediately trigger confirmation procedures, including catheter tip culture and bilateral blood culture to improve diagnostic accuracy. Furthermore, using information technology to set infection warning indicators helps shorten response time and enhance overall prevention efficiency.

### **4.2. Synergistic effects of core elements**

Bundle management represents an evidence-based systematic intervention model, with its core lying in the scientific integration and simultaneous implementation of multiple key prevention strategies. This strategy features: (1) all core elements are evidence-based rather than single empirical operations; (2) simultaneous execution of all elements instead of isolated measures; (3) monitoring data driving strategy optimization to form an “implementation-monitoring-improvement” cycle. In pediatric PICC-CRBSI prevention practice, personnel specialization ensures operational standardization, strengthened aseptic techniques cut off infection sources, standardized maintenance reduces dwell-time risks, and monitoring/early warning enables dynamic management. The synergy of elements constructs a three-level prevention system: front-end prevention (insertion), process control (maintenance), and terminal disposal (infection response), thus minimizing CRBSI incidence.

## **5. Conclusion**

In summary, pediatric PICC-CRBSI poses a significant challenge in pediatric clinical treatment, with notably higher incidence rates among extremely low birth weight infants and preterm infants. Key risk factors include patient-specific conditions (e.g., low birth weight, immunodeficiency, long-term dependence on total parenteral nutrition) and operational/management defects (e.g., inadequate hand hygiene, unskilled catheter insertion, prolonged dwell time, inappropriate puncture site selection). Studies have shown that dwell time >14 days, femoral vein puncture, and nursing oversights (e.g., contaminated dressings, incomplete infusion connector disinfection) are high-risk factors for infection, with pathogens primarily including coagulase-negative *staphylococci*, *Escherichia coli*, and *Staphylococcus aureus*. To address these issues, bundle prevention and control strategies

establish a three-level prevention system—"front-end prevention-process control-terminal disposal"—through professional personnel training, strengthened aseptic practices (e.g., chlorhexidine alcohol-based disinfectants), standardized catheter maintenance (pulse flushing, positive pressure sealing, regular dressing changes), and dynamic monitoring-early warning mechanisms, effectively reducing CRBSI incidence. Future research should prioritize multicenter studies to clarify the combined effects of prevention measures, explore novel antibacterial materials and coating technologies, and enhance long-term follow-up of pediatric CRBSI to optimize strategies, reduce infection-related complications, and provide evidence-based support for safe pediatric vascular access management.

## Disclosure statement

The authors declare no conflict of interest.

## Author contributions

Ruizhi Huang: Responsible for the conceptualization and design of the review, led the literature retrieval and analysis, and made multiple revisions and polishing to the full text.

Shuang Zhang: Participated in the conceptualization, mainly responsible for data collation and interpretation, as well as the writing of partial chapters.

Jialin Ye: Responsible for overall project management and coordination, ensuring smooth communication and collaboration within the team, and conducted the final review of the full text.

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# Analysis of the Impact of Pre-hospital Emergency Rescue Mode on the Prognosis of Patients with Acute Heart Failure

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**Abstract:** The emergency department is the first stop for inpatients in almost all departments of a hospital, and it treats patients with relatively critical conditions. Among them, acute heart failure is a relatively serious type of coronary heart disease, often caused by atherosclerosis. Acute heart failure requires initial diagnosis, initial treatment, and thrombolytic therapy in pre-hospital care. After a rapid assessment and emergency treatment of the patient's condition, they are transferred to the cardiac care unit (CCU) for subsequent in-depth treatment. Patients with acute heart failure are very prone to situations such as death due to the condition during the transfer to the emergency department. If the treatment methods of medical staff are incorrect, the treatment is not timely, and the transfer operation efficiency is low during the pre-hospital rescue and transfer process, it will lead to the delay of the patient's condition treatment.

**Keywords:** Pre-hospital emergency rescue mode; Acute heart failure; Prognosis impact analysis

**Online publication:** September 8, 2025

## 1. Introduction

The transfer time of patients in the hospital is very short, only a few minutes. However, patients with acute heart failure are very prone to aggravated conditions, rapid changes in their condition, which may lead to their death or worsening of their condition. Moreover, clinical medical research has proved that the mortality rate of patients with myocardial infarction who are transferred to other hospitals within the hospital is about 10% higher than that of ordinary patients<sup>[1]</sup>. Therefore, the work quality requirements for medical staff in clinical practice are extremely high. Exploring a more standardized and complete in-hospital transfer process for patients with acute heart failure after admission and optimizing the work quality of each link are of great significance for saving the lives and health of patients with myocardial infarction. Improving the safe transfer efficiency of patients with acute heart failure in the hospital is of great significance for achieving the goal of curing the patients' diseases<sup>[2]</sup>. Therefore, this paper analyzes the severity of the disease in patients with acute heart failure, understands the importance of

emergency treatment for patients with acute heart failure, analyzes the pre-hospital emergency treatment model and application measures, and studies the impact of the pre-hospital emergency treatment model on the prognosis of patients with acute heart failure, providing a reference for the clinical adoption of pre-hospital emergency treatment measures for patients with acute heart failure.

## **2. The dangers of acute heart failure and the importance of first aid**

### **2.1. Risks of acute heart failure**

Heart failure is a serious clinical syndrome that is rather dangerous. It is characterized by a decline in the heart's pumping function and an inability to meet the blood and oxygen demands of various tissues and organs in the body. The symptoms of heart failure are diverse, and the severity is closely related to the progression of heart failure<sup>[3]</sup>. The main symptoms of patients with acute heart failure are as follows: when left heart failure occurs, the congestion in the lungs increases, leading to shortness of breath. Initially, it may only appear after activity or physical exertion. As the disease progresses, it can develop into shortness of breath at rest, and even cause nocturnal paroxysmal shortness of breath and sitting breathing. Severe pulmonary congestion may lead to coughing. The phlegm is mostly white and foamy, sometimes with blood streaks. In severe cases, pink foamy phlegm can be coughed up. Due to the decline in the heart's pumping function and insufficient blood supply to all tissues and organs throughout the body, the patient feels weak and powerless. Physical examination can reveal moist rales in both lungs, which is one of the main signs of left heart failure. When right heart failure occurs, the systemic circulation is congested. The first manifestation is edema of the lower extremities, which gradually spreads upward throughout the body, and even pleural effusion and ascites may appear. Long-term gastrointestinal congestion can cause symptoms such as loss of appetite, abdominal distension, nausea, vomiting, constipation, and upper abdominal pain. During physical examination, distension of the jugular vein can be found, which is an important sign of right heart failure<sup>[4]</sup>. When left heart failure and right heart failure coexist, patients may present with the symptoms of both the aforementioned left heart failure and right heart failure at the same time. Heart failure is a serious heart disease, and it is extremely dangerous. The quality of life of patients with heart failure declines significantly, and the prognosis is poor with a relatively high mortality rate. When left heart failure is severe, patients may develop acute pulmonary edema, presenting symptoms such as severe breathing difficulties and coughing up pink, foamy sputum. At this point, the condition is critical, and immediate rescue treatment is required. Patients with heart failure may suffer from insufficient blood supply to various tissues and organs throughout the body, which may lead to multiple organ failure, such as renal failure and liver failure, further aggravating the condition. Patients with severe heart failure may experience cardiogenic shock, which is characterized by excessive night sweats, low blood pressure, dizziness, apathy, and confusion. At this point, emergency treatment is required<sup>[5]</sup>.

The symptoms of heart failure are diverse and severe, posing a serious threat to the lives of patients. Therefore, once symptoms of heart failure occur, one should seek medical attention promptly and receive standardized treatment to slow down the progression of the disease and improve the quality of life. Meanwhile, strengthening the prevention of heart failure and actively controlling risk factors such as hypertension and diabetes are of great significance for reducing the incidence and mortality of heart failure.

### **2.2. The importance of emergency treatment for acute heart failure**

The condition of patients with acute heart failure is relatively serious and unstable. During the pre-hospital rescue

and transfer process, it is very easy for the condition to deteriorate. If the patient's condition is not accurately evaluated during the transfer process, the related risks are not evaluated and analyzed, the relevant equipment and instruments are not fully prepared, and the correct pretreatment methods are not adopted for the patient. This will lead to adverse events for the patient during the transfer process<sup>[6]</sup>. When the safety issue during the pre-hospital rescue and transfer process is a matter of great concern in clinical practice nowadays, it is necessary to analyze various risks in the pre-hospital rescue and transfer process, make adequate preparations for instruments and materials, equip with experienced professional physicians and nurses, adopt professional pretreatment methods for patients, do a good job in the preparatory work before the event, and control the quality during the pre-hospital rescue and transfer process before the event. Furthermore, quality improvement work should be done well to enhance the quality of pre-hospital rescue and transfer, and reduce the mortality rate of patients<sup>[7]</sup>.

### **3. Pre-hospital emergency rescue models and measures**

#### **3.1. Overview of pre-hospital emergency rescue models**

Pre-hospital emergency care refers to the emergency treatment of critically ill patients outside the hospital. In a broad sense, pre-hospital emergency care refers to the emergency rescue carried out on the spot by medical staff or witnesses when the patient falls ill. In a narrow sense, pre-hospital emergency care refers to professional emergency institutions composed of communication equipment, transportation tools, and basic medical elements. Medical activities such as on-site rescue and in-transit monitoring are carried out before the patient arrives at the hospital<sup>[8]</sup>. Pre-hospital emergency care includes the treatment of critically ill patients outside medical institutions, emergency medical rescue for public emergencies, and medical support for major events, etc. It is an important part of China's emergency medical service system and public health security system. The pre-hospital emergency care system covers institutions engaged in pre-hospital emergency care, relevant pre-hospital legislation, network construction, personnel training, discipline construction, etc. The construction of the pre-hospital emergency care system in the country started later than that in foreign countries. From 1980 to 1987, the state issued documents such as "Opinions on Strengthening Urban Emergency Rescue Work" and "Notice on Using '120' as the Telephone Number of Emergency Rescue Centers (Stations) across the Country", marking the official start of its construction<sup>[9]</sup>. With the continuous development of the economy and society, the concept of putting life first has been deeply rooted in people's hearts. The construction of the pre-hospital emergency medical system has received increasing attention. In 2020, nine ministries and commissions, including the National Health Commission, jointly issued the "Guiding Opinions on Further Improving Pre-hospital Medical Emergency Services", putting forward requirements for how localities can build a pre-hospital emergency medical system that is fast in response, reasonably laid out, and interconnected in information. With the legislation of pre-hospital emergency care, the standardization, scientificity, and rationality of the pre-hospital emergency care model have received extensive attention from all sectors of society<sup>[10]</sup>. At present, the commonly adopted pre-hospital emergency rescue models in clinical practice include the methods of transfer first and then treatment, and treatment first and then transfer.

#### **3.2. Application measures of pre-hospital emergency care in patients with acute heart failure**

For patients with acute heart failure, the best pre-hospital emergency rescue model is to treat first and then transfer.

### 3.3. Research subjects

In this study, 102 patients with acute heart failure admitted to the hospital from January 2024 to December 2024 were selected as the research subjects of this trial. According to the computer random grouping method, they were divided into the experimental group and the control group, with 51 cases in each group. The two groups of patients were treated with the pre-hospital emergency rescue mode and the mode of operation first, and then emergency rescue, respectively. According to the statistical results of the data, among the patients in the experimental group, there were 27 males and 24 females. The age ranged from 55 to 78 years, with an average of  $61.21 \pm 1.21$  years. The course of hypertension ranged from 1 to 15 years, with an average of  $7.62 \pm 1.02$  years. Among the patients in the control group, there were 26 males and 25 females. The age ranged from 56 to 80, with an average of  $61.21 \pm 1.21$  years. The course of hypertension ranged from 2 to 20 years, with an average of  $8.01 \pm 1.13$  years. Inclusion criteria: (1) Meeting the diagnostic criteria for acute heart failure; (2) All are aware of this experimental research; (3) Age 55–80 years old, gender not limited; (4) Serum trimethylamine oxide level  $>18.5 \mu\text{mol/L}$ ; Exclusion criteria: (1) Poor compliance; (2) Severe congenital genetic metabolic diseases, fatal circulatory system diseases, severe neurological abnormalities, respiratory system malformations; (3) Patients lacking clinical data; (4) Those with chronic diseases that make the clinical treatment plan complex; (5) Follow-up failure; (6) Those who quit automatically halfway. All patients signed the informed consent form upon learning the content and methods of the trial study. This experimental study has also been approved by the hospital's ethics committee.

### 3.4. Research methods: Control group

Adopt the treatment mode of operation first and then rescue.

### 3.5. Research methods: Experimental group

Adopt the treatment mode of treating first and then transferring.

#### 3.5.1. Be well-prepared for rescue

After receiving the doctor's order, the nursing staff informed the hospital's logistics department to get it done. The work of unblocking the passage, developing a green channel for the patient, informing the ward where the patient is located to make preparations for rescue, and notifying the patient's family of the relevant matters <sup>[11]</sup>.

#### 3.5.2. Preliminary assessment

Before the transfer, a preliminary assessment of the patient's disease condition should be conducted, and relevant records should be kept. Respiratory system assessment: Evaluate the patient's respiratory rate, respiratory rhythm, oxygenation status, airway patency, risk factors hindering the patient's breathing, suitable ventilation methods for the patient, and the situation of asphyxia caused by aspiration in the patient <sup>[12]</sup>. Circulatory system assessment: Evaluate the patient's blood pressure, central venous pressure, urine output, heart rate, and other conditions; Central nervous system assessment: Examine and evaluate the patient's consciousness and pupil condition; Psychological condition assessment: Evaluate whether the patient has negative psychological emotions such as tension, anxiety, and restlessness.

#### 3.5.3. Pretreatment

Ensure the patient's breathing is unobstructed. At the same time, ensure that the catheter is fixed, the patient inhales sufficient oxygen, and ensure smooth intravenous administration. Secondly, emergency drug treatment



should be given to the patients. During the pre-hospital emergency treatment, emergency drugs should be given according to the specific conditions of the patients to alleviate the symptoms of heart failure<sup>[13]</sup>. Nitroglycerin can be given to the patients to help dilate the coronary arteries and reduce the myocardial oxygen consumption of the patients. Administer diuretics to the patients to reduce the burden on their hearts; Administer thrombolytic agents or antiplatelet drugs to the patients to prevent the occurrence of thrombosis.

#### **3.5.4. Psychological care**

Patients with acute heart failure may experience chest pain and shortness of breath due to sudden breathing difficulties, which can easily lead to psychological conditions such as tension, fear, and a sense of impending death in them<sup>[14]</sup>. As medical staff, one should always maintain composure and confidence. Through proficient nursing skills, help patients relieve their anxiety. Provide patients with sufficient security through language, eye contact, and actions, keeping them in the best condition to smoothly get through the acute stage of the disease.

#### **3.5.5. Prepare the rescue equipment**

Medical staff should prepare all kinds of equipment and drugs for the rescue process, mainly including oxygen, portable ventilators, suction devices, defibrillation instruments, rescue boxes, and other supplies.

#### **3.5.6. Allocation of medical staff**

During the escort and transfer period, it is required to be accompanied by a professional physician and a professional nurse with more than three years of experience<sup>[15]</sup>.

#### **3.5.7. Preparation of treatment plan**

During the transfer process, a contingency plan for possible emergencies should be made. Under the monitoring of an electrocardiogram monitor, the patient's electrocardiogram, heart rate, consciousness, breathing, blood pressure, and other conditions should be monitored throughout the process<sup>[16]</sup>. The patient should be placed in a comfortable flat position, avoiding force and pushing the cart steadily. During the transfer process, electrocardiograms were used to conduct electrocardiogram tests on the patients to evaluate their heart rhythm and the degree of myocardial injury. Once ventricular arrhythmia occurred, emergency treatment was immediately given to the patients, including anti-arrhythmic drugs and electrical cardioversion treatment.

#### **3.5.8. Preparation for handover work**

Nursing staff should do a good job in the handover with the ward, cooperate with the ward to carry out relevant nursing work, and ensure that patients pass through the bed smoothly. After admission, clinicians provide further treatment for patients based on their conditions, such as coronary intervention surgery or thrombolytic therapy<sup>[17]</sup>. During the patient's hospitalization, electrocardiogram monitoring, blood oxygen monitoring, and hemodynamic monitoring were continuously carried out, and appropriate drugs and supportive treatments were given.

### **3.6. Results**

In this experiment, the pre-hospital emergency rescue mode was implemented for the patients. The results showed that the hospital stay of the patients in the experimental group was  $9.89 \pm 2.75$  days, which was significantly lower than that of the control group ( $11.32 \pm 3.78$  days],  $P < 0.05$ ; The time for the coagulation indicators in the observation group to return to normal was  $2.19 \pm 1.78$  days, which was shorter than that in the control group ( $3.72$

$\pm 2.01$  days),  $P < 0.05$ ; The time for inflammatory indicators to return to normal was  $2.45 \pm 1.78$  days, which was shorter than that of the control group ( $4.02 \pm 1.32$ ),  $P < 0.05$ .

#### **4. Research on the impact of pre-hospital emergency rescue mode on the prognosis of patients with acute heart failure**

“First transfer then treatment” and “first treatment then transfer” are two different pre-hospital emergency rescue models. The emergency rescue method of “first treatment then transfer” requires medical staff to immediately provide first aid and treatment to the patient on the spot, giving the patient oxygen, anticoagulant therapy, vasodilator treatment, etc., and then transfer the patient to the hospital<sup>[18]</sup>. This pre-hospital emergency rescue model is of great significance for patients with acute heart failure. It enables timely and necessary measures to be taken to save the patients’ lives. Active treatment with diuresis and hemodynamic support for patients with acute heart failure can reduce the burden on the patients’ hearts, decrease the area of damaged myocardial cells, improve the survival rate of patients, and enhance prognosis. In Xi Xiaoliang’s research, 86 patients with acute myocardial infarction complicated with acute left heart failure who were diagnosed and treated in the hospital from June 2019 to June 2020 were selected for analysis and randomly divided into two groups<sup>[19]</sup>. The control group received emergency treatment by the measure of transfer first and then treatment; The research group adopted the measure of treating first and then transferring for emergency treatment. Analyze the clinical effects of the two groups after their respective first aid measures and the survival rates after 30 days. Result: The total effective rate of clinical treatment in the study group was significantly higher than that in the control group ( $P < 0.05$ ), and the total effective rate of survival in the study group was also significantly different from that in the control group ( $P < 0.05$ ). There were significant differences in clinical evaluation indicators between the two groups. It can be seen from this that treating first and then transferring can significantly improve the treatment effect in the clinical treatment of patients with acute myocardial infarction complicated with acute left heart failure, thereby maximizing the survival rate of patients. It is worthy of promotion and application in clinical emergency rescue. In Dong Junchan’s research, it is advocated to adopt the pre-hospital emergency rescue model for patients with acute heart failure, taking measures such as positioning the patients, maintaining breathing, monitoring their condition and physical signs, opening intravenous access, providing psychological intervention, and contacting the hospital<sup>[20]</sup>. The results showed that in the observation group with intervention, 0 cases died during transportation, and the survival rate was 43 cases (100%), while in the control group, 4 cases died during transportation (9.30%), and the survival rate was 39 cases (90.70%). The difference was statistically significant ( $\chi^2=4.195$ ,  $P < 0.05$ ). The total effective rate of treatment in the observation group was 97.67%, which was higher than 84.62% in the control group ( $P < 0.05$ ). It can be seen that the pre-hospital emergency rescue model of treating first and then transferring can improve the prognosis. In Jin Zhijian’s research, a total of 77 patients with acute myocardial infarction complicated with acute left heart failure who were treated by the center and cooperative hospitals from February 2017 to January 2019 were selected and divided into the control group (37 cases) and the observation group (40 cases) according to the different methods adopted in pre-hospital emergency treatment<sup>[21]</sup>. Patients in the control group were sent to the hospital by their families and then received emergency treatment, while patients in the observation group were first treated on the spot by emergency personnel. The patient’s brief medical history, electrocardiogram, and vital sign data were transmitted to the cardiologist of the cooperative hospital. The professional cardiologist guided the treatment and emergency rescue. The emergency rescue effects of the two methods on the patient were

observed and compared. The results after different treatments showed that in terms of the effective rate of first aid and the overall survival rate, the observation group was higher than the control group, and the differences between each result were statistically significant ( $P < 0.05$ ). There was no statistically significant difference in blood pressure between the two groups of patients after emergency treatment ( $P > 0.05$ ). In terms of indicators such as heart rate and respiration, the observation group was lower than the control group. In terms of the incidence of complications, the observation group was lower than the control group. The differences among all the results were statistically significant ( $P < 0.05$ ). It can be seen that the research results confirm that when rescuing patients with acute myocardial infarction complicated with acute left heart failure, first implementing corresponding rescue measures for the patients and then sending them to the hospital for corresponding treatment can significantly improve the patients' breathing, heart rate and other indicators, enhance the emergency treatment effect and survival rate, with remarkable results and high promotion value.

It can be seen from this that the pre-hospital emergency rescue model of treating first and then transferring can improve the therapeutic effect and prognosis of patients with acute heart failure.

## 5. Conclusion

In conclusion, the pre-hospital emergency treatment measures and key points of care for patients with acute heart failure are summarized. Firstly, the respiratory system function, central nervous system function, circulatory system function, and psychological status of the patients are evaluated. Furthermore, based on the assessment results, in the process of emergency care, it is also necessary to implement emergency care in combination with the patient's condition. Through systematic, scientific, and reasonable care methods, emergency care for the patient's disease is provided to ensure the patient's life and health during the transfer. This can build a better and more harmonious nurse-patient relationship, thus enabling the patient to receive higher-quality care services and avoid the death of the patient. It can be seen that the improved transfer method is more conducive to helping improve the safety of pre-hospital rescue and transfer for patients with acute heart failure, and can be promoted and applied in pre-hospital rescue.

## Disclosure statement

The author declares no conflict of interest.

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# Study on the Application of Stepwise Nursing Intervention in Abdominal Distension after Enteral Nutrition for Elderly Bedridden Patients

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**Abstract:** *Objective:* To explore the effect of stepwise nursing intervention in abdominal distension after enteral nutrition for elderly bedridden patients. *Methods:* Seventy elderly bedridden patients who received enteral nutrition and developed abdominal distension in the hospital from April 2024 to April 2025 were selected and divided into an observation group ( $n=35$ ) and a control group ( $n=35$ ) based on differences in nursing methods. The control group received routine nursing intervention, while the observation group received stepwise nursing intervention. After the same nursing duration, the self-care ability, psychological status, nursing effect, gastrointestinal function, and nursing satisfaction of the two groups were compared. *Results:* After nursing, the self-care ability scores of both groups increased significantly, and the improvement in each dimension of the observation group was better than that of the control group ( $P < 0.05$ ). After nursing, the SDS and SAS scores of the observation group were significantly lower than those of the control group, and the time for abdominal distension relief and anal exhaust was significantly shorter than that of the control group ( $P < 0.05$ ). After nursing, the four indicators of GAS, MOT, neuropeptide Y, and substance P in the observation group were significantly higher than those in the control group ( $P < 0.05$ ). The total satisfaction rate of patients in the observation group was significantly higher than that in the control group ( $P < 0.05$ ). *Conclusion:* Stepwise nursing intervention can significantly improve the self-care ability and nursing satisfaction of elderly bedridden patients, improve their psychological status and gastrointestinal function, shorten the time of exhaust, and accelerate the relief of abdominal distension.

**Keywords:** Stepwise nursing; Elderly; Bedridden; Enteral nutrition; Abdominal distension

**Online publication:** September 8, 2025

## 1. Introduction

Enteral nutrition (EN) is widely used as an important means of life support for elderly bedridden patients. However, numerous studies have shown that the incidence of abdominal distension after enteral nutrition (ADEN) is as high as 30% to 50%, which seriously affects patients' comfort and nutrient absorption<sup>[1]</sup>. Although routine

nursing measures are available, they are mostly single interventions that lack graded management and dynamic adjustment, making it difficult to meet the nursing needs of different stages of illness. The stepwise nursing intervention program is based on condition assessment and utilizes evidence-based nursing theory and intelligent monitoring technology to provide hierarchical and individualized nursing strategies for elderly bedridden patients. This approach may effectively alleviate ADEN and improve nursing quality <sup>[2]</sup>. Therefore, in this study, 70 elderly bedridden patients who received enteral nutrition and developed abdominal distension in the hospital from April 2024 to April 2025 were selected and divided into different nursing groups to explore the application effects of the stepwise nursing intervention program. The report is as follows.

## **2. Materials and methods**

### **2.1. General information**

Seventy elderly bedridden patients who experienced abdominal distension after receiving enteral nutrition in the hospital from April 2024 to April 2025 were selected as the study subjects. The patients and their families signed consent forms. Relevant written materials for this study have been submitted to the ethics committee of the hospital for review, approval, and clearance.

Inclusion criteria: (1) Elderly bedridden patients hospitalized in the hospital; (2) Patients who developed abdominal distension after receiving enteral nutrition; (3) Complete medical records.

Exclusion criteria: (1) Patients with malignant tumors; (2) Patients with severe cardiopulmonary insufficiency; (3) Patients with severe coagulation dysfunction; (4) Patients with consciousness disorders or mental abnormalities.

### **2.2. Methods**

The control group received routine nursing intervention: daily assessment of enteral nutrition tolerance, instructing patients to sit in a 30° semi-reclined position, regular gentle rubbing and hot compresses on the abdomen, monitoring changes in abdominal circumference, recording bowel movements and flatulence, and providing health education and psychological comfort.

The observation group received stepped nursing intervention: On the basis of routine care, a four-step “assessment-grading-intervention-feedback” approach was established. The first step involved early monitoring of gastric residual volume and initiation of low-dose prokinetic agents. The second step combined a bedside ultrasound assessment of gas distribution with intermittent intestinal decompression and vibration exercises for gas expulsion. The third step consisted of high-frequency transcutaneous electrical nerve stimulation and time-segmented abdominal breathing training. The fourth step involved organizing multidisciplinary consultations, dynamically adjusting nutritional formulas and infusion rates, and conducting rolling evaluations of intervention effectiveness every 6 hours to ensure precise nursing care.

### **2.3. Observation indicators**

(1) Self-care ability: Evaluated using the Self-Care Ability Scale, which includes four dimensions with a total score of 100 <sup>[3]</sup>. A higher score represents stronger ability, while a lower score represents weaker ability. (2) Psychological state and nursing effect: Assessed using the SDS and SAS scales <sup>[4]</sup>. The SDS has a maximum score of 80, with scores below 53 indicating lower depression. The Cronbach’s  $\alpha$  coefficient is 0.782, indicating good reliability. The SAS has a maximum score of 80, with scores of 50–59 considered mild, 60–69 moderate, and

>70 severe. The Cronbach's  $\alpha$  coefficient is 0.777, indicating good reliability. The nursing intervention effects, including time to relief of abdominal distension and time to anal exhaust, were recorded. (3) Gastrointestinal function: Before and after nursing, 4 ml of fasting venous blood was collected from patients and centrifuged (3000 r/min, 10 minutes, radius 10 cm). Gastrin (GAS), motilin (MOT), neuropeptide Y, and substance P were measured using radioimmunoassay, with a GC-911  $\gamma$  radioimmunoassay counter<sup>[5]</sup>. (4) Nursing satisfaction: Evaluated and compared using a self-made nursing satisfaction survey questionnaire. The questionnaire validity was 0.896, with a maximum score of 100. Satisfaction results included very satisfied (over 90 points), satisfied (75–89 points), and dissatisfied (below 75 points). Satisfaction was calculated as 1 - dissatisfaction rate.

## 2.4. Statistical methods

Analyzed using SPSS 21.0, normally distributed measurement data were expressed as (Mean  $\pm$  SD), and the t-test was used for comparison between groups. Count data were expressed as relative numbers and tested using  $\chi^2$ ;  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Comparison of baseline data between the two groups

There was no statistically significant difference in baseline data between the two groups ( $P > 0.05$ ), as shown in Table 1.

**Table 1.** Comparison of baseline data between two groups [Mean  $\pm$  SD, n(%)]

Group	n	Gender (%)		Age (years)	Disease duration (weeks)
		Male	Female		
Control	35	19 (54.29)	16 (45.71)	68.92 $\pm$ 3.46	3.41 $\pm$ 1.06
Observation	35	18 (51.43)	17 (48.57)	69.25 $\pm$ 3.42	3.48 $\pm$ 0.99
$t/\chi^2$		0.164		0.401	0.286
$P$ -value		0.685		0.690	0.776

### 3.2. Comparison of self-care ability between the two groups

After nursing intervention, the self-care ability scores of both groups increased significantly, and the improvement in various dimensions of the observation group was better than that of the control group ( $P < 0.05$ ), as shown in Table 2.

**Table 2.** Comparison of self-care ability between the two groups (Mean  $\pm$  SD, score)

Group	n	Self-concept		Self-care skills		Self-care responsibility		Health knowledge	
		Pre-care	Post-care	Pre-care	Post-care	Pre-care	Post-care	Pre-care	Post-care
Control	35	13.36 $\pm$ 2.28	16.57 $\pm$ 2.25*	16.12 $\pm$ 2.13	20.23 $\pm$ 2.08*	9.52 $\pm$ 3.25	14.56 $\pm$ 1.48*	15.68 $\pm$ 2.23	18.57 $\pm$ 2.29*
Observation	35	13.34 $\pm$ 2.29	21.05 $\pm$ 2.38*	15.89 $\pm$ 0.15	25.41 $\pm$ 2.11*	9.46 $\pm$ 3.28	19.37 $\pm$ 2.25*	15.61 $\pm$ 2.28	23.46 $\pm$ 2.24*
t-value		0.037	8.092	0.637	10.343	0.077	10.566	0.130	9.031
$P$ -value		0.971	<0.001	0.526	<0.001	0.939	<0.001	0.897	<0.001

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

### 3.3. Comparison of psychological state and nursing effect between the two groups

After nursing, the SDS and SAS scores of the observation group were significantly lower than those of the control group, and the time of abdominal distension relief and anal exhaust was significantly shorter than that of the control group ( $P < 0.05$ ), as shown in **Table 3**.

**Table 3.** Comparison of psychological state and nursing effect between the two groups (Mean  $\pm$  SD, score)

Group	n	SDS Score		SAS Score		Abdominal Distension Relief Time (h)	Time to First Flatus (h)
		Pre-care	Post-care	Pre-care	Post-care		
Control	35	50.07 $\pm$ 6.38	27.45 $\pm$ 5.21*	55.28 $\pm$ 7.45	30.85 $\pm$ 5.04*	28.94 $\pm$ 4.25	31.76 $\pm$ 4.81
Observation	35	50.89 $\pm$ 7.05	39.49 $\pm$ 5.08*	54.96 $\pm$ 8.17	40.35 $\pm$ 5.37*	18.23 $\pm$ 3.67	17.62 $\pm$ 3.94
t-value		0.510	9.789	0.171	7.631	11.284	13.454
P-value		0.612	<0.001	0.865	<0.001	<0.001	<0.001

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

### 3.4. Comparison of gastrointestinal function between the two groups

After nursing, the four indicators of GAS, MOT, neuropeptide Y, and substance P in the observation group were significantly higher than those in the control group ( $P < 0.05$ ), as shown in **Table 4**.

**Table 4.** Comparison of gastrointestinal function between the two groups (Mean  $\pm$  SD, pg/ml)

Group	n	GAS (pg/mL)		MOT (pg/mL)		Neuropeptide Y (ng/mL)		Substance P (ng/mL)	
		Pre-care	Post-care	Pre-care	Post-care	Pre-care	Post-care	Pre-care	Post-care
Control	35	17.24 $\pm$ 3.23	32.85 $\pm$ 4.12*	225.37 $\pm$ 19.44	296.85 $\pm$ 27.71*	1.36 $\pm$ 0.35	1.97 $\pm$ 0.42*	34.31 $\pm$ 5.22	41.79 $\pm$ 4.38*
Observation	35	17.15 $\pm$ 3.26	39.47 $\pm$ 4.21*	225.64 $\pm$ 20.17	331.42 $\pm$ 30.05*	1.39 $\pm$ 0.42	2.35 $\pm$ 0.63*	34.24 $\pm$ 5.12	45.20 $\pm$ 5.53*
t-value		0.116	6.649	0.057	5.003	0.325	2.969	0.057	2.860
P-value		0.908	<0.001	0.955	<0.001	0.747	0.004	0.955	0.006

Note: Compared with before nursing in the same group, \* $P < 0.05$

### 3.5. Comparison of nursing satisfaction between the two groups

The overall satisfaction rate of the observation group was significantly higher than that of the control group ( $P < 0.05$ ), as shown in **Table 5**.

**Table 5.** Comparison of nursing satisfaction between the two groups [n(%)]

Group	n	Very Satisfied n (%)	Somewhat Satisfied n (%)	Dissatisfied n (%)	Total Satisfaction Rate n (%)
Control	35	18 (51.43)	10 (28.57)	7 (20.00)	28 (80.00)
Observation	35	26 (74.29)	7 (20.00)	2 (5.71)	33 (94.29)
$Z/\chi^2$			1.828		9.114
P-value			0.068		0.003

## 4. Discussion

Abdominal Distension after Enteral Nutrition (ADEN) refers to a syndrome characterized by abdominal fullness, difficulty in passing gas, and gastrointestinal discomfort during continuous enteral nutrition support, primarily caused by weakened intestinal motility, gas retention, and increased osmotic pressure <sup>[6]</sup>. Elderly bedridden patients are particularly susceptible to ADEN due to decreased metabolic rate, declining gastrointestinal motility, weakened hunger reflexes, and reduced abdominal blood perfusion associated with underlying diseases and prolonged immobility <sup>[7]</sup>. For ADEN management, nursing care should focus not only on symptom relief but also on integrated physiological and psychological interventions to improve overall prognosis in elderly patients.

The results of this study showed that the stepped nursing intervention significantly improved patients' self-care ability scores in four dimensions and was superior to the control group. The analysis indicated that the stepped nursing intervention program incorporated individualized assessment and graded intervention based on basic nursing care. From the early intervention of prokinetic drugs in the first level, to bedside ultrasound and decompression exercise in the second level, to transcutaneous electrical nerve stimulation combined with abdominal breathing training in the third level, and finally to dynamic adjustment through multidisciplinary consultation in the fourth level, this model not only broadened nursing methods but also strengthened patients' sense of participation and responsibility. The combination of prokinetic drugs and electrical stimulation accelerated gastrointestinal motility. After patients' self-perceived symptom improvement, they were more willing to cooperate with nursing staff in self-training, forming a virtuous cycle. Simultaneously, health knowledge education and real-time feedback mechanisms enhanced patients' trust in their own care strategies, thereby improving self-care compliance and satisfaction <sup>[8]</sup>.

The SDS and SAS scores, as well as the time to relieve abdominal distension and anal exhaust time, were significantly better in the observation group than in the control group ( $P < 0.05$ ). The analysis showed that, on the one hand, psychological counseling and multidisciplinary consultation provided patients with channels to understand their condition and express emotions, effectively improving their anxiety and depression levels. On the other hand, timely abdominal decompression, vibration exhaust exercise, and nerve stimulation could rapidly relieve abdominal pressure and reduce discomfort, thus breaking the vicious cycle of "abdominal distension— anxiety—abdominal distension." Dynamic adjustment of nutritional formulas and infusion rates allowed precise medication based on patient tolerance, avoiding a new round of abdominal distension caused by too fast or excessive nutrient infusion and improving the safety and comfort of the intervention <sup>[9]</sup>.

Additionally, the levels of GAS, MOT, NPY, and SP in the observation group were higher than those in the control group after nursing ( $P < 0.05$ ). The combined effect of prokinetic drugs and transcutaneous electrical nerve stimulation promoted the secretion of motilin and gastrin, enhancing intestinal smooth muscle contraction. Vibration, exhaust, and abdominal breathing training could activate the parasympathetic nervous system, further enhancing intestinal motility and eliminating gas retention based on the synthesis and secretion of neuropeptide Y and substance P <sup>[10]</sup>. Furthermore, ultrasound evaluation enabled the healthcare team to accurately locate gas accumulation areas and implement targeted intermittent decompression, reducing the risk of secondary bloating caused by blind nursing care. This approach optimized gastrointestinal dynamics at both the molecular and functional levels.



## 5. Conclusion

In summary, the stepped nursing intervention program has a significant effect on abdominal distension after enteral nutrition in elderly bedridden patients. It balances physiological treatment and psychological support, significantly improving patients' self-care ability and satisfaction, and enhancing gastrointestinal function.

## Disclosure statement

The author declares no conflict of interest.

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# The Impact of De-escalation Technique Intervention on Violent Events in Patients with Schizophrenia

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**Abstract:** *Objective:* To evaluate the effect of de-escalation technique intervention on the prevention and treatment of violent events in schizophrenia (SCH). *Methods:* 120 patients with SCH who were admitted to the hospital from January 2024 to December 2024 were selected. Based on the time of admission, the reference group consisted of 60 patients admitted from January to June 2024, who received routine intervention. The experimental group consisted of 60 patients admitted from July to December 2024, who received the de-escalation technique intervention. Both groups were evaluated using the Chinese version of the Broset Violence Checklist (BVC) to compare the incidence of violent behavior and BVC risk levels before and after intervention. *Results:* The incidence of violent events in the experimental group was lower than that in the reference group, and the violence risk level was lower than that in the reference group ( $P < 0.05$ ). *Conclusion:* Adopting the de-escalation technique intervention for patients with SCH can prevent violent events, reduce patients' violence risk level, and improve their disease symptoms and quality of life.

**Keywords:** De-escalation technique intervention; Schizophrenia; Violent events

**Online publication:** September 8, 2025

## 1. Introduction

Schizophrenia (SCH) is a highly prevalent psychiatric disease characterized by hallucinations, perceptual disturbances, and logical confusion. Long-term psychological support and antipsychotic medication are needed to control the condition and prevent other complications<sup>[1]</sup>. However, patients with this disease often exhibit violent tendencies, which may lead to self-harm or harm to others, thereby reducing treatment safety. De-escalation technique intervention is a newer intervention method aimed at preventing violent events. It covers clinical communication, risk assessment, and safety assurance for both doctors and patients. Cognitive behavioral therapy or enhanced communication can be used to improve patients' treatment cooperation and facilitate their recovery. The Chinese version of the Broset Violence Checklist (BVC) is a commonly used assessment tool for violent

events, which can simply and intuitively evaluate the violence risk of SCH patients. The assessment takes about 5 minutes, has high acceptance among patients, and provides authoritative results <sup>[2]</sup>. Therefore, this study selected 120 SCH patients to evaluate the implementation effect of combining the BVC scale with the de-escalation technique intervention.

## **2. Materials and methods**

### **2.1. General information**

A total of 120 patients with SCH admitted between January and December 2024 were included in this study. They were randomly divided into two groups using a random number table: the experimental group (60 patients, including 32 males and 28 females) and the control group (60 patients, including 34 males and 26 females). The mean age of the experimental group was  $45.16 \pm 3.97$  years, with a mean duration of illness of  $3.85 \pm 0.78$  years. The mean age of the control group was  $45.27 \pm 3.81$  years, with a mean duration of illness of  $3.92 \pm 0.83$  years. There were no significant differences in baseline characteristics between the two groups ( $P > 0.05$ ).

Inclusion criteria were: patients admitted to the psychiatric department, adult patients aged  $<80$  years, complete clinical data, and basic communication skills. Exclusion criteria were: presence of substance or drug dependence, comorbidity with cardiovascular, liver, or kidney diseases, abnormal mental development or other types of mental illnesses, and withdrawal from the study.

### **2.2. Methods**

The control group received routine interventions, including 24-hour monitoring of patients' daily activities during disease episodes, assessment of risk factors, predictive interventions, assessment of risk levels after stabilization of the condition, determination of appropriate visitation frequencies, understanding of patients' psychological changes, improvement of negative psychology through language counseling and cognitive therapy, timely distribution of medication, explanation of medication precautions, and monitoring of patients' medication behavior.

The experimental group underwent intervention with de-escalation techniques, including the following steps: (1) Violence Risk Assessment and Intervention: The BVC scale was used to assess patients' risk of violence, which included six items such as noise, chaotic state, and harmful behavior. A score of 0 was assigned for the absence of such behavior, while a score of 1 was given for the presence of the behavior, with a total possible score of 6. Higher scores indicated a higher level of risk for aggressive behavior events within 24 hours. Specifically, a score of 0 represented low risk, 1–2 represented medium risk, and 3–6 represented high risk. For patients with low risk, their disease condition was evaluated. Patients with medium risk were reported to doctors and could be restrained using one hand or one foot. Their condition was assessed intermittently, and blood circulation at the restraint site was observed to prevent skin damage, and a medium-risk sign was posted. Psychological support therapy was provided, explaining the necessity of restraint to the patient, inquiring about their individual needs, and making every effort to meet them. High-risk patients required restraint of both hands and feet, and a high-risk sign was posted. At the same time, the frequency of communication was increased, various methods were used to stabilize their psychological state, or medication was administered as prescribed. (2) Implementation of de-escalation techniques: 1. Communication skills: When communicating with patients, it was necessary to maintain an appropriate distance, preferably more than 1 meter. Therapeutic operations were carried out with gentle

movements, explanations were provided, and attention was paid to having a kind attitude and euphemistic tone. Eye contact could be appropriately made with patients to give them encouragement. 2. Personalized solutions: Patients' family backgrounds, past medical histories, treatment plans, and other information were evaluated to predict the triggers and risk factors of violent events. The opinions of patients and their families were inquired about, and solutions were discussed together. 3. Establishment of a comfort room: A dedicated comfort room was set up in the department, equipped with books, a TV, and refreshments. When patients exhibited aggressive behavior, they were led to the comfort room by a psychologist, where mindfulness-based stress reduction therapy was used to improve their psychological state, allowing them to receive mindfulness training in a quiet environment. The psychologist accompanied the patient throughout the process, observing their emotional and behavioral changes and providing timely guidance. 4. Insight education: Patients were divided into three groups, with about 15 people in each group, and classes were held 1 to 2 times per week, with each class lasting 2 hours. In the first week, patients were encouraged to introduce themselves, a name chain game could be organized, and the definition of mindfulness therapy was explained. Patients were allowed to experience treatment techniques for 5 minutes each. In the second week, mindfulness breathing methods were demonstrated, with each training session lasting 10 minutes and being repeated twice, followed by 15 minutes of mindfulness stretching training. Patients were organized to discuss SCH disease conditions and were provided with relevant disease knowledge. In the third week, mindfulness breathing training continued, and body scan meditation training methods were demonstrated (15 minutes each), with the two training methods alternating. In the fourth week, mindfulness breathing and stretching training were alternated, and the benefits of mindfulness training were discussed collectively to improve patients' adherence to training. In the fifth week, mindfulness breathing training was combined with mindfulness yoga, demonstrating yoga movements for 15–30 minutes each time, while guiding patients to accept their own condition and recognize their symptoms. In the sixth week, patients were assisted in identifying their misconceptions, relevant cases were introduced to illustrate the differences between false beliefs and facts, and patients were empowered to have insight into reality. In the seventh week, patients were encouraged to independently identify physical discomfort, and knowledge about medication usage, side effects, and coping measures was provided. A patient exchange meeting was organized to encourage them to share treatment experiences. In the eighth week, patients were given mindfulness care, invited to share self-management methods, and discuss discrimination encountered in daily life and coping strategies. At the same time, patients were guided to practice mindfulness eating and walking methods, helping them learn social skills so that they could actively return to society.

### **2.3. Observation indicators**

- (1) Incidence of violent events: Observe the probability of SCH patients engaging in unarmed confrontation with objects, attacking others, self-harming, and destroying property.
- (2) Violence risk level: Based on the BVC score, it is subdivided into low/medium/high risk.

### **2.4. Statistical analysis**

Data processing software is SPSS 26.0. Measurement data is represented as [Mean  $\pm$  SD], compared, and tested with the t-value. Count data is represented as [n/%], compared and tested with the chi-square value. Statistical significance is indicated by  $P < 0.05$ .

### 3. Results

#### 3.1. Comparison of the incidence of violent events between the two groups

There were 2 cases of violent behavior in the experimental group and 6 cases in the reference group. There was no difference between the two groups ( $P > 0.05$ ).

**Table 1.** Comparison of the incidence of violent events between the two groups [n/%]

Group	Cases	Resisting objects	Attacking others	Self-harm	Property destruction	Incidence rate (%)
Test group	60	1 (1.67)	1 (1.67)	0	0	3.33 (2/60)
Control group	60	2 (3.33)	2 (3.33)	1 (1.67)	1 (1.67)	10.00 (6/60)
$\chi^2$						2.143
$P$						0.143

#### 3.2. Comparison of violence risk levels between the two groups

The proportion of low-risk violence in the experimental group was higher than that in the reference group ( $P < 0.05$ ).

**Table 2.** Comparison of violence risk levels between the two groups [n/%]

Group	Cases	Low risk	Medium risk	High risk
Test group	60	45 (75.00%)	12 (20.00%)	3 (5.00%)
Control group	60	35 (58.33%)	15 (25.00%)	10 (16.67%)
$\chi^2$		3.750	0.430	4.227
$P$ -value		0.053	0.512	0.040

### 4. Discussion

SCH patients have a longer hospitalization period and exhibit more pronounced violent tendencies. The incidence of violent attacks or property destruction is relatively high, and they may violently attack medical staff, causing accidental injuries<sup>[3]</sup>. Therefore, it is necessary to strengthen the prevention and treatment of violent incidents among these patients and actively carry out mitigation skill interventions<sup>[4-5]</sup>. These measures can comprehensively assess patients' violence risk and utilize effective communication skills and personalized solution models to improve patients' psychological comfort and maintain a peaceful state of mind. The establishment of a comfort room can promptly control patients' impulsive thoughts, while self-awareness education can guide patients to vent their emotions correctly, master relaxation techniques, and thus maximize the prevention of violent incidents<sup>[6]</sup>.

The results showed that the incidence of violent incidents in the experimental group was 4.55%, while that in the control group was 18.18%. Among the violence risk levels in the experimental group, the proportion of low risk was 79.55%, while that in the control group was 56.82% ( $P < 0.05$ ). The reason for this is that BVC allows for quantitative assessment of violence risk, considering six behaviors within 24 hours as indicators for evaluating violence risk, thereby defining risk areas and implementing targeted intervention measures to standardize various violence risk management procedures. Additionally, BVC can accurately predict the incidence of violence risk within the next 24 hours. The training duration is approximately 2–3 hours, and the assessment can be completed



in about 5 minutes, making it highly convenient. If a patient has a high risk of violence, a BVC assessment can be conducted during the reception process, allowing reception staff to quickly assess the patient's violence risk level in a timely manner. Protective isolation measures can then be implemented to prevent violent behavior, thereby enhancing the self-efficacy of reception staff and ensuring a safe reception environment. The BVC score reasonably categorizes patients' violence risk, enabling the scientific selection of de-escalation techniques to fundamentally prevent violent incidents<sup>[7]</sup>. Clinical communication can provide humanistic care while respecting patients' privacy, reducing their resistance to the communication process<sup>[8]</sup>. Using a euphemistic tone and patiently assessing patients' individual needs can help fully analyze the internal causes of violent incidents and develop effective solutions. Additionally, de-escalation techniques can gradually introduce mindfulness-based cognitive therapy to patients, helping them focus on their emotions, proactively improve symptoms such as delusions or hallucinations, and learn to accept themselves, thereby preventing violent behavior<sup>[9]</sup>. The disease symptom scores and quality of life scores in the experimental group after intervention were lower than those in the control group ( $P < 0.05$ ). The reason for this is that de-escalation techniques can emotionally resonate with patients, respecting their personal thoughts and appropriately applying protective restraints. This reduces patients' resistance and encourages them to actively cooperate with treatment. Furthermore, activities such as mindfulness breathing, stretching exercises, and mindfulness yoga can fully relax patients' minds and bodies, enabling them to master relaxation techniques, rationally face their illnesses, and learn to coexist with them, resulting in a higher quality of life<sup>[10]</sup>. During the intervention process of de-escalation techniques, communication skills can help avoid a lack of trust in nursing due to misunderstandings or a sense of oppression, bringing the nurse and patient closer. Mindfulness-based stress reduction training and setting up a comfort room can utilize psychological counseling measures or environmental optimization programs to buffer patients' negative emotions and reduce the frequency of acute emotional outbreaks. Additionally, insight education can improve patients' misconceptions about disease knowledge, allowing them to view their condition rationally. Case analysis can reconstruct patients' cognition, reduce the incidence of symptoms such as delusions, and improve their cooperation in treatment.

## 5. Conclusion

In summary, de-escalation intervention can prevent violent incidents among patients with SCH, reduce their violence risk level, assist in alleviating their disease symptoms, and effectively improve their quality of life in the future, demonstrating high intervention effectiveness.

## Funding

Kangning Scientific Research Project (KN2024006)

## Disclosure statement

The authors declare no conflict of interest.

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# Practice and Analysis of “Being Patient-oriented” Cancer Patient Management Model in Oncology Center of One Private Hospital

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**Abstract:** *Background:* In the current Chinese medical environment, the doctor-patient relationship is not harmonious, patient satisfaction is not optimistic, and there are more problems for cancer patients. Under the circumstances, in order to increase patients' satisfaction, suggest providing a “patient-oriented” services model. Many healthcare organizations have used patient satisfaction survey (PSS) measures such as Net Promoter Score (NPS), Consumer Quality Index (CQI), or Hospital Consumer Assessment of HealthCare Providers and Systems (HCAHPS) to monitor staff performance quality. In this study, the author has used annual aggregated NPS scores and patient interview results to assess changes in quality of oncology service delivery over a two-year period, and by doing so, to infer the success or failure of improvement interventions in response to these NPS and patient interview data. *Methods:* A single-center retrospective review of NPS scores over 2023–24 was conducted in the department of oncology in one private hospital in Beijing. Following receipt of each year's NPS results, specific interventions for service improvements had been implemented. Increases in NPS scores over time were interpreted as indicating the success of such intervention(s), whereas NPS decreases were interpreted as failed interventions. Meanwhile, results of patient interviews increase over time, presenting the success of interventions; the opposite result indicates failed interventions. *Results:* A progressive trend of rising NPS scores was documented. All NPS single questions have increased the satisfaction rate. A progressive trend of rising patient interview results was listed, and questions have increased satisfaction. *Conclusion:* These results strongly suggest the success of improvement interventions in the department based on NPS score results and patient interview results. The study concludes that NPS scores and patient interview results can provide valuable administrative guidance for the introduction of clinical service improvement interventions.

**Keywords:** Patient satisfaction; Cancer patient; Patient experience; Hospital management

**Online publication:** September 8, 2025

## **1. Introduction**

### **1.1. International, domestic, one private hospital oncology center background introduction**

#### **1.1.1. Cancer surge and healthcare strains in China**

With the deterioration of the living environment and the change of living habits in recent years. The incidence of cancer is increasing year over year. According to statistics, Cancer is a leading cause of death in the world, and is the second leading cause of death in China. The huge cost of tumor treatment will not only cause great economic losses to patients, but also bring great difficulties and suffering to patients and their families, and have a profound impact on the whole society. In China, although the Chinese government has made great efforts to provide more health benefits to its citizens, poor health-care services and inefficiencies in their delivery are still widely criticized. Patient dissatisfaction is on the rise, even resulting in serious violence against doctors in recent years. The policemen need to make regular visits to hospitals to ensure the safety of medical staff.

#### **1.1.2. Comprehensive and compassionate cancer care: A private hospital legacy**

The private hospital was established in 1997 as the first private international hospital in China. Oncology center, as one of the satellite clinics, was established in 2010, is committed to being patient-oriented and providing individualized screening, diagnosis, and treatment. Established various clinics such as surgical, medical, radiation oncology, pathology, nutrition, rehabilitation, traditional Chinese medicine, and physiological health services etc. In addition to the pursuit of therapeutic benefits, the patient experience and satisfaction are also very important parts of the consideration. So, a “patient-oriented” cancer patient management model is implemented.

## **1.2. Challenges and opportunities**

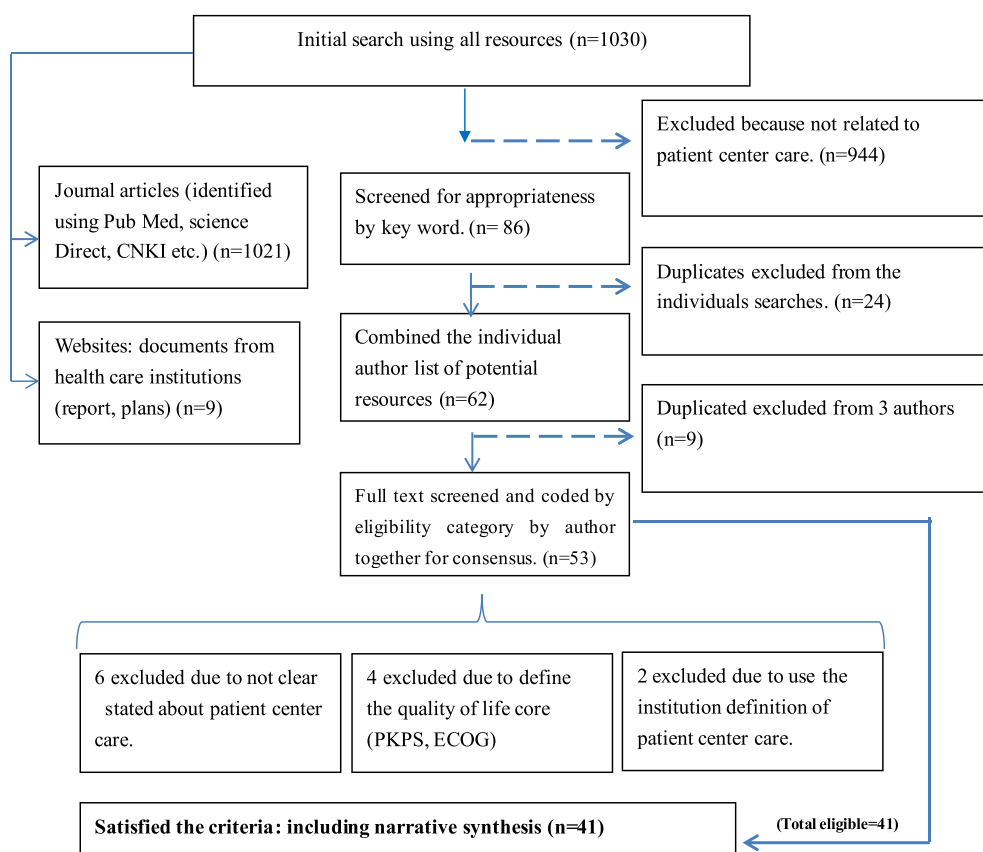
Cancer is one of the most important diseases threatening human life. Cancer patients are facing more pressure than patients who are diagnosed with other diseases like diabetes or heart problems. When a patient learns that he has a tumor, he is terrified, leading to persistent bad emotions. Cancer patients need long-term treatment and multiple hospitalizations, making them more anxious and uncooperative. Psychosocial services are essential components of comprehensive cancer care and are provided to patients with cancer and their caregivers throughout the continuum of care; meanwhile, those oncology patients come from all over the world and have different cultural backgrounds. Implement a patient-centered management model for cancer patients, so that patients and medical staff can have more contact, better service delivery, and patients can feel the security and credibility of the medical staff. Improve their medical experience and satisfaction. At the same time, help cancer patients face life changes, reorganize, and calmly face life challenges without distractions and fear. Allowing patients a release from the concept of having a “serious illness”, from the fear and mental pressure of cancer color, and willing them to accept the reality and strive forward, and ultimately returning to their family, to society, and survival with a tumor.

## **1.3. Objective of this thesis**

The objective of this study is to evaluate the impacts of the “patient-oriented” cancer patient management model on patient experience and satisfaction, and propose suggestions for improvement based on this. While alleviating the conflicts between doctors and patients, at the same time, it can also provide guidance and reference for patient-centered cancer management.

## 2. The literature reviewed for this project

Literature was reviewed from 2010 to 2023, using the Chinese and English languages, searching using Science Direct, PubMed, WELCH Medical Library, and CNKI database. There is a total of 41 resources identified for this paper. 15 English resources and 26 Chinese resources were referred to. Comprehensive findings are extracted and summarized. Those data are from both international and domestic perspectives; they give us a complete concept of cancer patient management. In order to have appropriate data, the author has gone through a search process (**Figure 1**)



**Figure 1.** Article searching process

Overall impact of patient-oriented management, benefits associated with the consideration of their needs and preferences in health matters, including improvements in the quality of care provided better outcomes, and increased patient satisfaction.

### 2.1. Aligned with “being patient-oriented” principles

Nine articles argued that patients’ experience and satisfaction related to the hospital’s “being patient-oriented” principle. One article, “Cancer Treatment Should Be People-Oriented”, said cancers have brought great hazards to people. It is difficult to effectively control cancers and improve the prognosis with the existing treatments. Based on holism, Chinese medicine stresses the people-oriented treatment idea and insists on the integration of multiple treatment modes, including overall regulation, individualized treatment, and comprehensive treatment. It is of great inspiring significance for the development of cancer treatment ideas and methods <sup>[1]</sup>.

In 2001, Beijing Cancer Hospital put forward the “people-oriented” concept, patient-centered, with good medical ethics, superb medical skills, beautiful environment, to provide high-quality services for patients, and patient satisfaction. According to the results of the internal survey, more than half (55.4%) believe that the core concept of hospital culture construction is people-oriented<sup>[2]</sup>. Patient-centered quality care can improve the clinical efficacy of cancer chemotherapy treatment, improve the quality of life and patient satisfaction, which is worthy of clinical promotion<sup>[3]</sup>. In the process of tumor care, medical personnel are not only caregivers, educators, and consultants, but also health managers who provide a full range of patient-centered services<sup>[4]</sup>. Another article said through data comparison, “people-oriented” nursing mode is significantly higher than the general nursing mode in terms of doctor-patient communication satisfaction, environmental satisfaction, service satisfaction, and operation satisfaction, which is worth promoting<sup>[5]</sup>.

Zhu Yeqin from the Air Force Medical Aviation Medical Institute-affiliated hospital said in her research article, “Medicine is the science of studying human health and disease and their mutual transformation. The essence of medicine is human science, and human nature is the core and starting point of medical practice. People-oriented is patient-centered, from the perspective of human characteristics to fully consider the survival of patients, comfort, and emotional needs”<sup>[6]</sup>.

Health news weekly (December 3, 2018, Edition 005) published an article, “Value medical treatment calls for integrated service”, which said that only by establishing a people-oriented integrated service system can people improve the efficiency of China’s medical and health services as a whole<sup>[41]</sup>.

## 2.2. Continuity of care

Several authors argued for the continuity of care. In one article mentioned, paying attention to the improvement of the ward environment can improve the comfort level of patients and eliminate strangeness and resistance to the hospital. Psychological nursing can improve compliance and relieve pain. Strengthen medication guidance, can ensure clinical safety, reduce the incidence of toxic side effects; Continuous nursing is the important content of the new high quality nursing mode, so that patients get out-of-hospital care is conducive to the cultivation of good living habits, and can improve the effectiveness of disease prevention and control, and the current medical requirements<sup>[7]</sup>. After more than two years of practice, the Sichuan provincial people’s hospital in combination with the practical situation of tumor specialized subject daytime treatment mode, changing ideas, the original ways to continuously improve and expand health care services, to provide patients with the whole, comprehensive, high quality health care services, to obtain the patient’s identity and satisfied, satisfactory results have been achieved<sup>[8]</sup>.

Another article from Sichuan Jian yang people’s hospital stated that “whole-process and active service: develop standard procedures for daily nursing service and disease care, especially for the nursing of patients’ toxic and side effects, so as to realize seamless whole-process service; Centered on the health of patients, it provides humanized, personalized and refined services to achieve seamless active services”<sup>[9]</sup>.

Wang Guo ping and Huo Shijun said “Operation mode positioning: oriented to the medical needs of cancer patients, the “chain” of cancer is “basic research, physical examination, early detection, early prevention, early diagnosis, early treatment, middle and late treatment, hospice care, post-discharge rehabilitation, health intervention”, And gradually the pre-hospital, after the courts, the court of the trinity “of integration, standardization, humanization services” in “Strategic management of modern cancer hospital”<sup>[10]</sup>.



### 2.3. Focus on patient satisfaction

Some articles focus on patient satisfaction. The satisfaction of patients is affected by their own quality of life. Through the evaluation of quality of life, body quality, body function score, etc., evaluation and intervention can improve the satisfaction of patients <sup>[11–12]</sup>. One article expressed that the satisfaction degree of patient care service refers to the patient's expectation of hospital medical care based on the requirements of health, disease, quality of life, and other aspects, and the evaluation of the service process. It is the core index to measure the quality of hospital medical service and the sum of theoretical knowledge, technical level, working attitude, and nursing effect of medical staff <sup>[13]</sup>.

One article from Sweden argued that patients' satisfaction with care is highly affected by patient-centered handover in the oncology ward <sup>[14]</sup>. Another article from the New England Journal of Medicine focuses on the patient feedback is not credible because patients lack formal medical training, they believe that patient-satisfaction measures actually capture some aspect of "happiness" which is easily influenced by factors unrelated to care <sup>[15]</sup>.

### 2.4. Patient experiences

One author from a viewpoint expressed that patient experience is a unique and vital aspect of hospital quality; HCAHPS is used in Hospital Value-Based Purchasing (HVBP). In 2015, the Patient Experience of Care domain accounted for 30% of the HVBP program's Total Performance Score (TPS), which affects 1.5% of CMS payments to hospitals. This domain is based on 8 equally weighted dimensions: nurse communication; physician communication; staff responsiveness; pain management; communication about medicines; discharge information; cleanliness and quietness of the hospital environment; and overall rating of the hospital <sup>[16]</sup>.

Some articles said that in recent decades, patient experiences have gained a prominent place in research on quality of care <sup>[17–20]</sup>. In the search for a simpler and straightforward way of assessing patient experiences and satisfaction in surveys, there is growing interest in including a Net Promoter Score (or NPS) <sup>[21]</sup>. One author said in the McKinsey analysis that the key to satisfying customers is not just measuring what happened but also using the data to drive action throughout the organization.

Another article in a patient experience journal focuses on defining patient experience. The 2009 Health Leaders Media Patient Experience Leadership Survey 3 discovered that when it comes to defining patient experience, there are widely divergent views within the healthcare industry. They found that 35% of respondents agreed that patient experience equals "patient-centered care." 29% agreed it was "an orchestrated set of activities that is meaningfully customized for each patient", and 23% said it involved "providing excellent customer service." The remaining responses reflected patient experience meant "Creating a healing environment", being "consistent with what's measured by HCAHPS", or "other" than the options provided in the survey <sup>[22]</sup>.

One article shows that patient experience includes good communication with hospital staff (doctor, nurse, pharmacist, receptionist, cashier, etc.); Convenient and reasonable workflow; Efficient and accessible medical resources; Warm and comfortable environment; Quality of care provided <sup>[23]</sup>.

### 2.5. Other information

Some articles argued that insufficient health-care service causes long waiting time; expensive medical charges; poor staff skills, poor medical service environment; difficulty of access to care, etc., which caused patient dissatisfaction badly <sup>[1]</sup>.

### **3. Methodology**

#### **3.1. Implementation of “patient-oriented” cancer patient management model**

According to the current domestic medical environment, the patient experience, the pressure of social medical services, the current tense doctor-patient relationship, and the decreased trust between doctors and patients are deeply felt. On the one hand, the oncology professional personnel face great work pressure and high risk. On the other hand, patients' medical experience is not good enough to meet individual needs. In response to the above problems, the hospital integrated resources, advocated and implemented the “patient-oriented” cancer patient management model, and thereby improved patients' experience and satisfaction.

##### **3.1.1. Ambulatory cancer care**

The oncology center provides ambulatory cancer care, so the chemo patient is no longer restricted to waiting for a bed and complex hospital formalities. Outpatients are booked in advance, no matter the patient came for consultation or an oncology procedure, this treatment starts in the morning, and on the same day of the treatment, the patient can go home. For each appointment, the study is going to look at the patient's time and find the most convenient and appropriate time for them. Minimize patient waiting time. This gives patients more freedom to arrange their daily lives and makes it easier to maintain their social roles.

##### **3.1.2. A warm and comfortable medical environment**

The oncology center is a two-story independent building. From the clinic hall to the waiting area, and then to the consulting room and treatment room, the French windows are used to break the closed space, bringing the outdoor sunshine, green, and natural atmosphere into the room. The indoor environment is pleasing to the eye, giving the patient a bright and comfortable look, allowing the patient to see green vegetation, blue sky, and white clouds during the treatment, strengthening the patient's connection with nature, obtaining healing power from nature, and relaxing body and mind. At the same time, all the staff are gentle, polite, and serve with smiles. This provides a one-stop problem-solving service principle for non-medical issues.

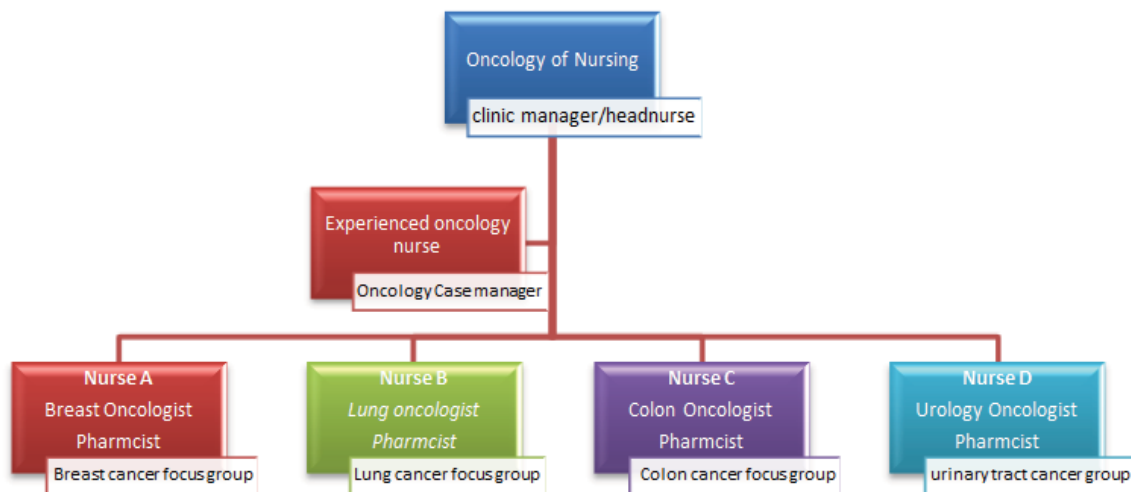
##### **3.1.3. Multidisciplinary team clinic**

Individualized treatment plans with an effective multidisciplinary team approach. Time is life for cancer patients, and seizing the best time is conducive to achieving better treatment results. The multidisciplinary diagnosis and treatment model is exactly to solve such concerns of patients, and to focus on multidisciplinary wisdom to provide efficient and complete treatment plans. Avoid misdiagnosis and treatment. The multidisciplinary outpatient service brings together experts in oncology, surgery, radiotherapy, imaging, pathology, and other disciplines to make treatment plans for patients from different perspectives. To maximize the benefit of patients and increase patient experience. People all know the quality of medical care is patients' first basic need, significantly affecting their satisfaction. While bringing convenience to seek medical advice, model innovation also improves the curative effect of medical treatment and reduces costs by reducing duplication and waste. From this point of view, the construction of a people-oriented integrated medical service system can effectively solve the problem of difficult access to medical services.

##### **3.1.4. Case manager role**

The oncology center implemented a case management model that provides a clinical focus group (**Figure 2**), aiming to provide the same standard continuity care to patients. A case manager is a nursing staff member with the

knowledge and skills to provide specialized care. The case manager assigns patients to different disease groups. Focus group staff will do this part of patient management as a whole. Meanwhile, the case manager provides whole-process management and coordination for the treatment of tumor patients, coordinates the time of experts, and arranges the consultation. At the end of the consultation, the patient continued to be hospitalized, examined, treated, and followed up to provide efficient and professional assistance.



**Figure 2.** Clinical focus group charter

### 3.1.5. Oncology after-hours nurse triage hotline

Senior oncology nurses take turns on the 24-hour hotline. Even at the end of treatment, after the patient leaves the oncology center, the patient can feel the protection and care of their nurse by being able to contact them by telephone when needed, solving any issues with side effects and other emergencies in an efficient manner <sup>[24]</sup>. Post chemotherapy on day 3 and day 5, the patients may present the most serious side effects; the oncology nurse will take the initiative to do follow-up calls to the patient, truthfully record side effects in the medical system, and let side effects present a coherent dynamic record, in order to provide targeted and individualized prevention measures. Release the patient's anxiety of not having medical staff around if any complications occurred.

### 3.1.6. Comprehensive education

Effective communication enables people to understand the status and psychological burden of patients, which is very important for us to provide high-quality health education for patients. Before treatment, the nurse will make an appointment with the patient for health education and provide a comprehensive health education according to the needs of the patient. This includes an introduction to the oncology center environment, treatment patterns, chemotherapy workflow, drug side effects, adjuvant drugs, and diet and lifestyle guidelines. If the chemotherapeutic agent is a vesicant or irritant, the oncologist and nurse will arrange to place a central venous catheter, such as a port catheter or PICC, before treatment, in accordance with the guidelines of the Intravenous Infusion Therapy Committee (IITC). Before, during, and after treatment, the pharmacist will provide comprehensive education on medicine-related issues, not limited to current medication, but also including the drugs for potential therapeutic complications. Assess the patient's acceptance of the health message. Assess the

patient's acceptance in the form of role reversal, with the medical staff asking questions, the patient answering, or retelling.

### 3.1.7. Patient experience journal mapping project

The patient-oriented cancer management model project methodology has involved patient experience journal mapping, with the aims of decreasing unnecessary workflow, minimizing duplication of tasks, making staff more efficient, and increasing patient satisfaction. To achieve these aims, New Hope Oncology Center has drawn a mapping of a patient's visit journal (**Figure 3**). The study identifies unnecessary processes and bottlenecks and makes corresponding improvements. Meanwhile, encouraged patients to give feedback about what they see and what they feel, encouraging individual communication and positive responses. Interview the patient with 10 questions, analyze the feedback, and start an improvement plan accordingly, then do an evaluation. Form a closed loop to constantly improve the quality of care.



**Figure 3.** Patient visit journal

## 3.2. Data/information collection

In this study, data on patient experience and satisfaction were collected from January to December 2024. Data on patient experience and satisfaction from a previous record in 2023 were used for comparison.

### 3.2.1. Setting

A single-center retrospective review of NPS scores and patient interviews over 2023–24 was conducted in the Oncology Center of one private hospital in Beijing. Following receipt of each year's NPS results and patient interview results. Specific interventions for service improvements had been implemented. Increases in NPS scores and patient interview results over time were interpreted as indicating the success of such intervention(s), whereas NPS or patient interview results decreases were interpreted as failed interventions.

### 3.2.2. Patients

NPS: Patient with cancer >18 years old, who has a first visit to the Oncology Center, were invited to participate. Cognitively impaired patients and patients with a severely reduced general condition were excluded. Each patient

could only participate once.

Patient interview: Patients with cancer >18 years old, who have completed the first cycle of chemotherapy in New Hope Oncology Center, were invited to participate. Cognitively impaired patients and patients with a severely reduced general condition were excluded; each patient could only participate once.

### 3.2.3. Data collection

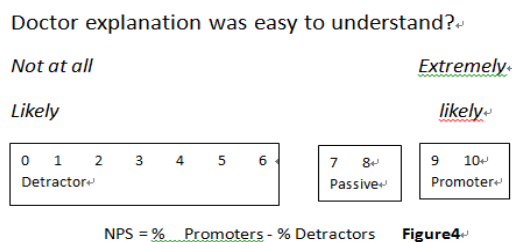
NPS: Patient who fulfilled the criteria received written and oral information about this study from the oncology service coordinator. Patients who were interested in participating in the study received questionnaires and were invited to respond within a week by email. A completed questionnaire was regarded as informed consent for participation.

Patient interview: Patient who fulfilled the criteria received written and oral information about this study from an oncology nurse. Patients who were interested in participating in the study received questionnaires and were invited to respond on the day of their treatment.

## 3.3. Questionnaires

### 3.3.1. Net promoter score

Many healthcare organizations have used patient satisfaction survey (PSS) measures such as net promoter score (NPS) to monitor staff performance quality. In the research for a simpler and straightforward way by assessing patient experience and satisfaction in a survey, there is growing interest in including an NPS. The NPS stems from management research and was introduced in 2003 by Fred Reichheld<sup>[25]</sup>. The NPS is based on a single question: Is the doctor's explanation easy to understand? Participants can give an answer ranging from 0 (not at all likely) to 10 (extremely likely) (**Figure 4**). The assumption is that individuals scoring a 9 or a 10 will give positive word-of-mouth advertising<sup>[21]</sup>; they are called "promoters." Individuals answering 0–6 are likely to be dissatisfied customers and are labelled as "detractors." The net promoter score is then calculated as the percentage of "promoters" minus the percentage of "detractors" as shown below.



**Figure 4.** NPS question sample

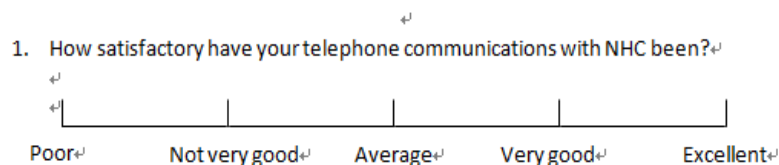
The NPS questionnaires were designed by the patient service department according to hospital characteristics, approved by the quality & safety department, and the hospital management team.

### 3.3.2. Patient interview

Patient interview survey questionnaires were referred from the literature and amended by oncology department chair Richard Epstein, who is a professor at the University of New South Wales, Australia. The patient satisfaction survey is based on a single question: "How satisfactory have your telephone communications with New Hope Oncology Center been?" Participants can give poor, not very good, average, very good, and excellent (**Figure 5**).



The data above “average” will be considered a positive response, and if lower than “Average” will be considered not satisfied.



**Figure 5.** Patient satisfaction survey question sample

### 3.3. Analysis of data

This study has used annual aggregated NPS scores to assess changes in the quality of Oncology service delivery over a one-year period, and by doing so, to infer the success or failure of improvement interventions in response to these NPS data. Following receipt of each year’s NPS results, specific interventions for service improvements had been implemented. Increases in NPS scores over time were interpreted as indicating the success of such intervention(s), whereas NPS decreases were interpreted as failed interventions.

Patient interview data, if a positive response is gradually more than negative feedback, will reflect that the “patient-oriented” cancer management model is good and could be copied in other institutions.

## 4. Result

NPS data: There are 680 patients fulfilling the inclusion criteria during the study period, 238 chose to participate in the study, and the NPS overall response rate is 35%. Of the responding patients, the mean age was 53 years in the total sample, ranging from 18–76 years. The patient in the previous study used for comparison was similar in terms of age.

Patient interview data: There are 50 patients fulfilling the inclusion criteria during the study period. 36 actively participated in the study. It was reaching an overall response rate of 72%. The mean age was 49 years in the total sample, ranging from 18–65 years. The patients in the previous study used for comparison were similar in terms of age.

### 4.1. NPS result

The major outcome of this study was that patient satisfaction significantly improved after New Hope Oncology Center implemented a “patient-oriented” cancer patient management model. It can be clearly understood by comparing the bar chart with the NPS data of different years in 2023 and 2024 (**Figure 6**).

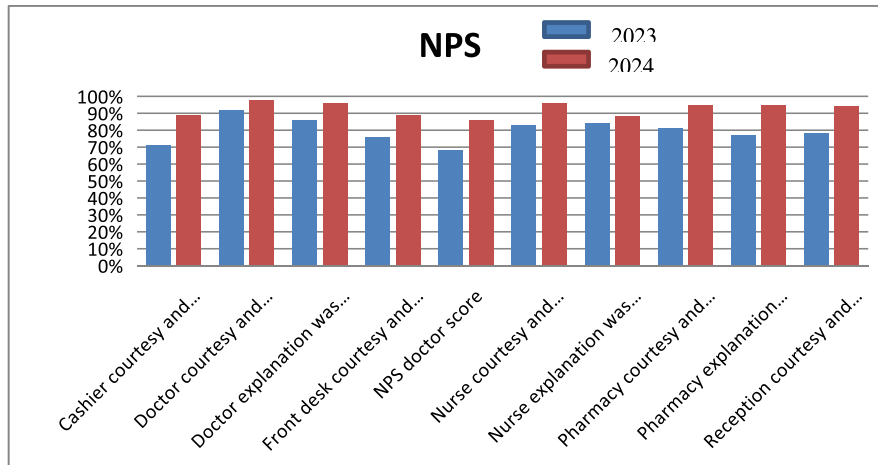


Figure 6. NPS data

## 4.2. Patient interview result

The comparison data from the patient interviews in 2023 and 2024. It shows the patient's experience improvement in all aspects of a single question (Figure 7).

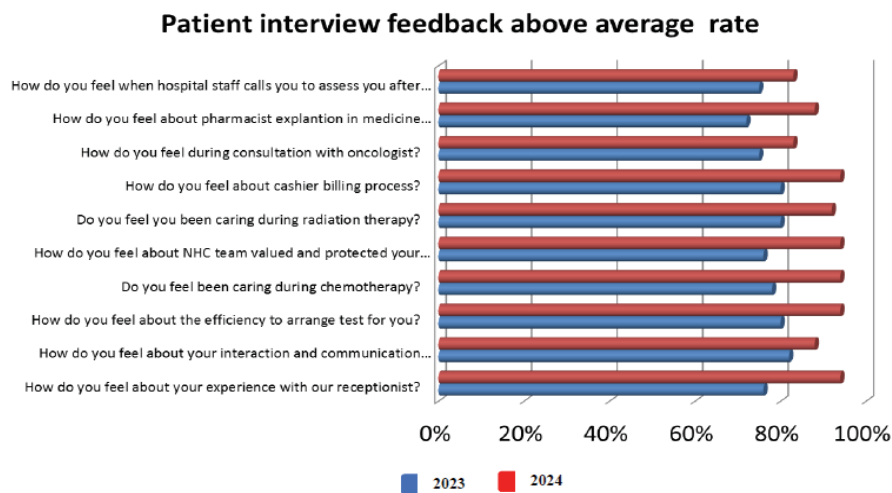


Figure 7. Patient interview data

## 5. Discussion

In this study, patient experience and satisfaction are investigated two years before and after the new hope oncology center implemented a “patient-oriented” cancer patient management model. There are several key aspects been identified which could affect patient experience and satisfaction.

### 5.1. Communication

Communication among human beings is complex and often is neither linear nor necessarily accurate. Hence, communication skill is described as the most important required feature for people working in the healthcare

sector. Statistics show that insufficient communication between doctors and patients leads to about 2/3 of the total medical disputes. According to a survey on doctor-patient relationship cognition, 85.3% of doctors believe that the reason for the poor relationship between doctors and patients is too little communication, while 58.5% of patients believe that there is a lack of communication. Medical staff who are working in an oncology center require more patience and care when communicating with patient and their family. As one question lists “how do you feel about your interaction and communication with the NHC nurse?”, this is evaluating the effectiveness of communication. The satisfaction rate is gradually increasing from 82% in 2023 to 88% in 2024. This is all due to the training of medical staff in communication courses.

## **5.2. Service consciousness**

“Patient-oriented” cancer patient management service philosophy is not a slogan. Instead, it is embodied in concrete and practical actions in daily work. Put ourselves in the patient’s shoes and consider the service needs. The hospital set up a case manager role who works as the patient’s advocate or disease manager. Arrange all medical-related work. Maximize the benefit to the patient. The questionnaire “How do you feel about the efficiency of arranging a test for you?” evaluates the efficiency of case management. The growth trend is from 80% to 94%. Another two questionnaires of “Do you feel you have been caring during chemotherapy?” “Do you feel you have been cared for during radiation therapy?” evaluates the patient’s real feelings. It can well reflect the service consciousness of medical staff. The data are 78% (2023)–94% (2024), and 80% (2023)–92% (2024).

## **5.3. Disease characteristics**

Cancer patients are facing more pressure than patients who are diagnosed with other diseases like diabetes or heart problems. By providing a “patient-oriented” management model, the hospital aims to improve patient experience and satisfaction <sup>[26]</sup>. For the high degree of disease malignancy, the patient is under great psychological pressure, a heavy economic burden, and other characteristics. Oncology provides an individualized treatment plan with an effective multidisciplinary team approach. Those treatment plans will be carried out in the outpatient service. This gives patients more freedom to arrange their daily lives and makes it easier to maintain their social roles. On the other hand, it could reduce medical costs. To help patients through value-added hospital services and to help patients manage complications. Like oncology after-hours Nurse Triage hotline; post-treatment calls on day 3 and day 5. This was evaluated through a simple questionnaire of “how do you feel when hospital staff call you to assess you after chemotherapy?” The patient interview data shows that it has significantly affected patient satisfaction from 75% (2023) to 84% (2024).

## **5.4. Medical quality**

Quality of medical care is patients’ first basic need, significantly affecting their satisfaction. The oncology center provides a multidisciplinary team discussion for all cancer patients who need treatment <sup>[27–28]</sup>. This will ensure the quality of medical care. Compared the 5-year survival in stage IV head and neck cancer when treatment was or was not determined in a multidisciplinary team discussion. 5-year survival was significantly improved by the multidisciplinary team discussion <sup>[29]</sup>. In 2012, one article showed reduced relative risk of death in oral cavity cancer patients with versus without therapeutic discussion in multidisciplinary team discussion <sup>[30]</sup>. Multidisciplinary team discussion recently became mandatory, but its interest for the patient and benefit in terms of survival has been demonstrated <sup>[29]</sup>. Patients are not to be treated wherever they go. Instead, patient-oriented,

internal medicine, surgery, radiotherapy, pathology, social psychology, and other related disciplines participate together to make comprehensive treatment decisions according to the specific situation of patients<sup>[19, 31]</sup>. This form can break down the barriers between disciplines, reduce the deviation of judgment caused by a doctor's insufficient understanding of the disease, and maximize the benefit of patients.

### 5.5. Waiting time

The length of waiting time greatly affects the satisfaction of patients<sup>[32]</sup>. One article stated patients were not bothered by waiting time, and waiting time was largely considered stressful<sup>[29]</sup>. To quantify feedback, interviewed all 2024 new patients using a satisfaction survey comparing experiences with previous data. There is one questionnaire related to waiting time, and the patient satisfaction rate ranges from 50% to 89%. There is a big improvement.

## 6. Conclusion

The oncology center implemented a “patient-oriented” cancer management model. This integrated service aims to maximize the benefit of patients. Net promoter score (NPS) is one important measurement of patient satisfaction. The survey results offer data from different angles, comparing the data before intervention in 2023 and after intervention in 2024. Meanwhile, in parallel with the rising quality of oncology treatment and nursing care, patient volume in NHC has increased briskly over the past years. These results strongly suggest the success of improvement interventions in the department based on NPS score and patient interview results. The study concludes that NPS scores and patient interview results can provide valuable administrative guidance for the introduction of clinical service improvement interventions. This can bring the value of medical services to patients. First, providing a comprehensive and full-cycle health service system; second, implementing the integration of people-oriented services; third, carrying out a quality and efficient service system.

In patient-oriented care, health care providers play a key role in inviting and encouraging patients to plan an active role in their care and the decisions that affect their health and well-being. This “patient-oriented” cancer management model is a sustainable method to improve patient satisfaction that has a demonstrable impact on important clinical outcomes, and can be spread across different regions and hospitals<sup>[33–34]</sup>.

## 7. Recommendations

In the medical oncology work, “people-oriented” care mode better reflects the concept of humanization, fully embodies the patient-centered, this new care mode can not only effectively improve patient satisfaction, but also help medical staff to improve their ability to perform their duties, reflecting the concept of harmonious society<sup>[35]</sup>. “People-oriented” mode of nursing work, medical personnel to the interests of the patients in a more prominent position, also providing care and help to patients, respecting patients with respect personal dignity, protecting the rights of patients' needs, providing a good medical environment for patients. Initiate and implement “people-oriented” model of care, is the traditional care concept and mode of innovation and reform, to help medical staff work in further establish taking patients as the center of the service concept, and further improve their role and ability in comprehensive care, further improve the quality of nursing of the patients with, improve the satisfaction of the patient and family, building a good image<sup>[36–37]</sup>.

Always be people-oriented, pay attention to the importance of the whole in the process of disease, and pay

attention to the overall adjustment. Adhere to individualized and comprehensive treatment while being people-oriented. Reduce the pain of patients, improve the quality of life, and improve satisfaction<sup>[38–40]</sup>.

## 8. Limitations

The author recognizes that this study has a number of limitations. First, this study was conducted in just one of the institutions located in the capital of China, so the patients in the study sample were not selected with a specific probability. Patients who met the study inclusion criteria were included in the study sample. Therefore, the study results cannot be generalized to all patients. Second, a single indicator about general satisfaction is used, and the patient expectation measures are not included in this study. Thus, future research based on more comprehensive instruments for better measurements may provide a more robust and comprehensive study framework.

## Disclosure statement

The author declares no conflict of interest.

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# The Effect of Empowerment Education-Based Pulmonary Rehabilitation Exercise on Pulmonary Rehabilitation in Elderly Hospitalized Patients with Chronic Obstructive Pulmonary Disease (COPD)

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**Abstract:** *Objective:* To explore the application effect of lung rehabilitation exercise based on empowerment education on lung rehabilitation of elderly patients with chronic obstructive pulmonary disease (COPD) during hospitalization. *Methods:* Elderly patients with COPD admitted to the First Hospital of Hohhot from June 2024 to December 2024 were selected and divided into an intervention group (50 cases, receiving conventional treatment and nursing + lung rehabilitation exercise based on empowerment education) and a control group (50 cases, receiving conventional treatment and nursing) using the random number table method. The lung function, exercise endurance, and dyspnea scores of the two groups were compared and analyzed. *Results:* After 14 days of nursing, the lung function of the intervention group was higher than that of the control group ( $P < 0.05$ ). There was no difference in exercise endurance between the intervention group and the control group ( $P > 0.05$ ). The dyspnea score of the intervention group was lower than that of the control group ( $P < 0.05$ ). *Conclusion:* Lung rehabilitation exercise based on empowerment education has a definite therapeutic effect, which can improve lung function, exercise endurance, and dyspnea symptoms in elderly patients with COPD.

**Keywords:** Lung rehabilitation exercise based on empowerment education; Chronic obstructive pulmonary disease; Research effect

**Online publication:** September 8, 2025

## 1. Introduction

Chronic obstructive pulmonary disease (COPD) is a common respiratory disease, referring to a type of obstructive lung disease related to emphysema and chronic bronchitis<sup>[1]</sup>. Elderly people are at high risk of developing this disease, and they are more prone to lung function impairment. The decline in lung function is significantly higher in elderly patients compared to other age groups with the same disease duration<sup>[2]</sup>. Studies have pointed out that the prevalence of COPD in China is increasing, with rates of 21.2% for those aged 60–69

and 35.5% for those aged 70 and above <sup>[3]</sup>. Medication is a commonly used treatment for COPD patients. Selecting medications based on the patient’s condition can quickly control the symptoms and signs caused by COPD and delay disease progression. However, COPD has a long course and is difficult to cure. Even during stable periods, there is a risk of recurrent episodes and acute exacerbations. To improve the treatment effect of COPD, it is necessary not only to provide treatment based on the patient’s condition but also to supplement it with high-quality nursing services to enhance disease control, improve lung function, and prevent complications. Lung rehabilitation exercise is an economical, sustainable, practical, and scientific intervention method. Following the doctor’s advice and exercising accurately and on time can continuously improve respiratory function. However, most patients lack accurate knowledge about COPD and lung rehabilitation exercises. Therefore, it is essential to provide health education as a foundation for lung rehabilitation exercises to ensure patient compliance. Empowerment education, based on the patient-centered principle, can scientifically empower patients, mobilize their potential, increase their interest, and motivate them to actively exercise. This can help patients develop long-term habits that promote healthy behaviors and improve their prognosis. Based on this, our study analyzes the effects of lung rehabilitation exercises based on empowerment education, focusing on their application value to provide some guidance for clinical practice.

2. Materials and methods

2.1. General information

In this study, 100 elderly patients with COPD admitted to the First Hospital of Hohhot from June 2024 to December 2024 were selected. They were divided into a control group and an intervention group using the random number table method, with 50 patients in each group. Continuous variables were compared using the *t*-test, and categorical variables were assessed using the chi-square test to evaluate differences between groups. The data showed that there were no statistically significant differences between the two groups in baseline characteristics such as age, BMI, gender, and smoking history, with *P* > 0.05, indicating comparability. Details are shown in **Table 1**. This study was approved by the Medical Ethics Committee of the First Hospital of Hohhot.

**Table 1.** General information of the two groups [*n*=50 cases, *n*/(Mean ± SD)]

Group	Gender (Male/Female, <i>n</i> )	Age (years)	BMI (kg/m <sup>2</sup> )	Smoking History (Yes/No, <i>n</i> )
Intervention	38/12	69.08 ± 6.53	21.72 ± 3.65	15/35
Control	33/17	71.58 ± 7.11	22.11 ± 4.42	14/36
<i>t</i> / <i>χ</i> <sup>2</sup> value	1.214	1.831	0.481	0.048
<i>P</i> -value	0.271	0.070	0.632	0.830

Inclusion criteria: (1) Meet the diagnostic criteria for elderly COPD in the “Guidelines for the Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease (2021 Revision)” <sup>[4]</sup>; (2) Age ≥60 years old; (3) Stable condition and in remission phase; (4) Voluntary participation in this study and signed informed consent.

Exclusion criteria: (1) Combined with severe cardiac, liver, kidney, and other organ dysfunction; (2) Suffering from mental illness or cognitive impairment; (3) Recent acute exacerbation or history of lung surgery; (4) Severe motor dysfunction.

## 2.2. Methods

The control group received routine treatment and nursing care: Routine treatment included anti-asthmatic drugs, oxygen inhalation, cough relief, and anti-infection measures. Routine nursing care encompassed condition assessment, health education, dietary management, and psychological counseling.

The intervention group, on the basis of the control group, underwent lung rehabilitation exercises based on empowerment education: (1) Empowerment education: a. Identifying problems through one-on-one communication between nurses and patients, three times a week, 20 minutes each time, conducted by responsible nurses who had undergone empowerment education and communication skills training. Open-ended questions were used to understand health needs, lifestyle, and habits, analyze factors affecting disease recovery, and guide patients to accurately express their problems and negative emotions, and actively participate in rehabilitation. b. Setting goals to improve patients' accurate understanding of disease treatment and lung rehabilitation exercises through empowerment education, guiding patients to recognize the impact of unhealthy behaviors on rehabilitation effects, stimulating subjective initiative and interest in lung rehabilitation, and changing rehabilitation plan behaviors. One-on-one communication with patients was used to investigate patients' cognition of the disease, lifestyle after illness, whether they performed lung rehabilitation exercises, and compliance with lung rehabilitation. The patients' willingness to perform lung rehabilitation exercises and current behavior development status were evaluated. If patients achieved the expected goals, lung rehabilitation exercises were initiated. Lung rehabilitation exercises consisted of respiratory training, exercise training, and exercise rehabilitation guidance. (2) Respiratory training included pursed-lip breathing and abdominal breathing training. For pursed-lip breathing, patients were instructed to close their mouths, inhale through their noses, purse their lips as if blowing a whistle, and exhale slowly. The exhalation: inhalation ratio was 1:2 or 1:3, with each session lasting 10–15 minutes and performed 2–3 times a day. Abdominal breathing training required patients to lie in a supine or semi-reclining position, relax all muscles, place their hands on their abdomen and chest, and inhale slowly while allowing their abdomen to rise without moving their chest. They were then instructed to exhale slowly while allowing their abdomen to fall without moving their chest. Each session lasted 10–15 minutes and was performed 2–3 times a day. (3) Exercise training involved assessing the patient's overall condition and exercise function, and developing a rehabilitation plan based on the assessment results. Patients were guided to perform upper body resistance exercises in the rehabilitation area of the hospital room, using 1–2 kg dumbbells to complete resistance movements such as front raises and lateral raises. The exercise intensity was adjusted to achieve a heart rate of 60%–80% of the maximum heart rate, which was calculated as 220 minus the patient's age. Each exercise session lasted 10–15 minutes and was performed once a day. (4) Exercise rehabilitation guidance: A rehabilitation nurse provided one-on-one guidance, including warm-up before rehabilitation exercises, precautions during exercises, and full-body relaxation after exercises. The nurse also urged patients to complete various activities according to the doctor's advice to ensure the safety of exercise rehabilitation.

The two groups received continuous care for 14 days.

## 2.3. Observation indicators

### 2.3.1. Lung function

The forced expiratory volume in the first second (FEV1) and forced vital capacity (FVC) were detected by a lung function tester, and FEV1/FVC was calculated.



### 2.3.2. Exercise endurance

Evaluated through a 6-minute walk test, recording the patient's straight-line (walking) distance within 6 minutes.

### 2.3.3. Dyspnea

The degree of dyspnea was evaluated using the modified Borg scale, which has 0–4 grades with a total score of 0–10<sup>[5]</sup>. The lower the score, the less severe the dyspnea.

## 2.4. Statistical methods

SPSS 26.0 software was used to process the data. Count data were expressed as percentages (%) and tested using  $\chi^2$ . Measurement data followed a normal distribution and were expressed as Mean  $\pm$  standard deviation, tested using *t*-test (or F-test);  $P < 0.05$  indicated a statistically significant difference.

## 3. Results

### 3.1. Comparison of lung function between the two groups.

The comparison of lung function between the two groups is shown in **Table 2**.

**Table 2.** Comparison of lung function between two groups ( $n=50$  cases, mean  $\pm$  SD)

Group	FEV <sub>1</sub> (L)		FVC (L)		FEV <sub>1</sub> /FVC (%)	
	Pre-intervention	Post-14d	Pre-intervention	Post-14d	Pre-intervention	Post-14d
Intervention	2.98 $\pm$ 1.14	4.56 $\pm$ 0.89 <sup>a</sup>	3.08 $\pm$ 1.45	4.89 $\pm$ 0.94 <sup>a</sup>	0.71 $\pm$ 0.14	0.85 $\pm$ 0.10 <sup>a</sup>
Control	2.95 $\pm$ 1.21	4.02 $\pm$ 0.97 <sup>a</sup>	3.01 $\pm$ 1.57	4.27 $\pm$ 0.79 <sup>a</sup>	0.69 $\pm$ 0.21	0.79 $\pm$ 0.12 <sup>a</sup>
<i>t</i> -value	0.128	2.901	0.232	3.570	0.560	2.716
<i>P</i> -value	0.899	0.005	0.817	0.001	0.577	0.007

Note: Compared with the same group before nursing, <sup>a</sup> $P < 0.05$ ; the control group received routine exercise nursing, while the intervention group received pulmonary rehabilitation exercise nursing; FVC refers to forced vital capacity, FEV<sub>1</sub> refers to forced expiratory volume in the first second, and FEV<sub>1</sub>/FVC refers to the ratio of forced expiratory volume in the first second to forced vital capacity; compared with before nursing,  $P < 0.05$

### 3.2. Comparison of exercise endurance and dyspnea between the two groups

The comparison of exercise endurance and dyspnea between the two groups is shown in **Table 3**.

**Table 3.** Comparison of exercise endurance and exercise intensity between the two groups ( $n=50$  cases, mean  $\pm$  SD)

Group	Exercise tolerance (m)		Dyspnea score (points)	
	Pre-intervention	Post-14d	Pre-intervention	Post-14d
Intervention	207.47 $\pm$ 89.63	265.79 $\pm$ 63.52 <sup>a</sup>	6.55 $\pm$ 2.38	3.54 $\pm$ 1.62 <sup>a</sup>
Control	205.21 $\pm$ 95.05	250.65 $\pm$ 92.59 <sup>a</sup>	6.46 $\pm$ 1.16	4.22 $\pm$ 1.59 <sup>a</sup>
<i>t</i> -value	0.122	0.953	0.240	2.118
<i>P</i> -value	0.903	0.343	0.811	0.037

Note: Compared with the same group before nursing, <sup>a</sup> $P < 0.05$

## 4. Discussion

COPD progresses slowly but is prone to recurrent attacks, inducing various discomforting symptoms, damaging lung function, and affecting normal life <sup>[6]</sup>. Clinically, routine treatment and nursing intervention are often implemented, which can quickly control symptoms and signs and delay the progression of the disease. However, this intervention method cannot continuously play an ideal role, making it difficult to quickly restore lung function and reduce the frequency of recurrent attacks, acute exacerbations, and readmission rates after discharge. Some patients lack accurate cognition of COPD, do not follow medical advice for continuous and effective intervention, and do not actively participate in disease rehabilitation training. As a result, the disease recurs in a short period of time, seriously affecting physical and mental health and increasing economic burden. Studies have pointed out that implementing rehabilitation training during routine treatment and care for elderly COPD patients can accelerate the stabilization of the disease, delay disease progression, eliminate disease-related symptoms, and improve patient rehabilitation effects <sup>[7]</sup>.

Pulmonary rehabilitation exercise is a currently advocated COPD rehabilitation training that is simple, economical, and non-pharmacological. It emphasizes patient-centeredness and requires comprehensive improvement of cardiopulmonary function and enhancement of exercise endurance through respiratory training and exercise training based on COPD symptoms and pathological features <sup>[8]</sup>. However, there are individual differences in the cultural level, comprehension ability, and disease cognition among elderly COPD patients <sup>[9]</sup>. Some patients lack accurate cognition, resulting in low compliance with pulmonary rehabilitation exercises and difficulty ensuring exercise effectiveness. Empowerment education has been applied in the rehabilitation of various chronic diseases in recent years, which can effectively combine passive receipt of health knowledge with active acquisition of health concepts. It has distinct characteristics that stimulate rehabilitation confidence and compliance, enhance patients' self-management abilities, and encourage active participation in pulmonary rehabilitation exercises.

This study involved lung function, exercise endurance, and dyspnea indicators. The lung function index data could correspond with exercise endurance and dyspnea symptom data, verifying the comprehensive improvement effect of the experimental program on patients' respiratory system function. The results showed that after 14 days of nursing, the lung function of the intervention group was higher than that of the control group ( $P < 0.05$ ), reflecting that the intervention measures optimized the efficacy by adjusting small airway resistance rather than simply increasing lung volume. The research results provided new data support for the precise treatment of airway obstructive diseases, but further validation of the intervention mechanism was needed in combination with bronchodilator tests. There was no difference in exercise endurance between the intervention group and the control group ( $P > 0.05$ ), but the exercise endurance of both groups after nursing was higher than that before nursing ( $P < 0.05$ ), indicating that both interventions could effectively improve exercise function, but the experimental program might have a better effect on sustainability. The dyspnea score of the intervention group was lower than that of the control group ( $P < 0.05$ ), suggesting that the intervention group had a better relief effect, which was consistent with the research results of Zhou Xiaoxia et al., indicating that the experimental measures had more advantages in improving dyspnea symptoms <sup>[10]</sup>. The reason was that empowerment education was a new educational model that could inject new resources, vitality, and capabilities into education, improve educational effectiveness and quality, promote innovative development of education, cultivate talents using various techniques and methods, provide more opportunities and abilities for the educated, and better achieve educational goals. Empowerment education could adjust patients' psychology

and behavior, promote their mental health development by building empathetic relationships, establish a positive attitude and optimistic emotions, enhance their ability to resist frustration, and adjust treatment and nursing behaviors. Performing lung rehabilitation exercises assisted by empowerment education could precisely empower patients, enhance their enthusiasm and initiative in disease management, stimulate rehabilitation potential, and further improve rehabilitation compliance with the guidance and help of professional medical staff. It could also strengthen patients' self-management awareness and encourage them to follow doctors' advice to perform lung rehabilitation exercises regularly. Among them, respiratory training could effectively exercise the respiratory muscle groups, promote the diaphragm to participate in normal breathing movements, enhance the activity function of the muscle groups, relieve the symptoms of respiratory muscle fatigue, increase the pressure in the bronchi, expand the inner diameter of the bronchi, prevent the shortening of lung ventilation time caused by premature bronchial occlusion, improve lung ventilation function, reduce lung damage, and alleviate dyspnea symptoms. Exercise training could enhance muscle oxygen uptake capacity, improve the phenomenon of over-reliance on lung ventilation during activity, reduce discomfort symptoms such as lung fatigue and dyspnea, and accelerate recovery.

## 5. Conclusion

In summary, lung rehabilitation exercises based on empowerment education had a definite effect on elderly patients with COPD, which could significantly improve lung function and dyspnea symptoms, assist in controlling the disease, improve symptoms and signs, and have a more prominent effect in improving patients' exercise endurance, with more clinical application value.

This study had limitations. It did not objectively analyze the limitations that existed during the research process, such as the small sample size that might lead to insufficient test efficacy, and the short research period that could not observe long-term effects. These limitations were not conducive to a comprehensive and objective evaluation of the research results by readers, requiring further clinical research based on this.

## Funding

Hohhot Health Science and Technology Planning Project (2024-HHK-041)

## Disclosure statement

The authors declare no conflict of interest.

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# Analysis of Risk Factors Associated with Obstructive Sleep Apnea Based on a Classification Tree Model

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**Abstract:** *Objectives:* To explore the effects of various factors on the risk of obstructive sleep apnea (OSA) based on a classification tree model, in order to provide a scientific basis for the prevention of OSA in high-risk groups. *Methods:* Patients from the outpatient department, inpatient department, and physical examination center of the First Affiliated Hospital of Guilin Medical University who were treated for OSA-related symptoms from 2010 to 2022 were continuously included as study subjects. All study subjects received overnight polysomnographic monitoring (PSG), and were divided into the OSA group and control group based on PSG monitoring results. The demographic characteristics, lifestyle, blood pressure index, and laboratory index of the two groups were compared and analyzed. An undersampling method was applied to the OSA group to generate a case group, and the case group and control group were used as research objects to construct a classification tree model to screen the risk factors of OSA, and a cross-validation method and ROC curve were used to evaluate the model. *Results:* There were 1053 subjects after undersampling, including 517 in the case group and 536 in the control group. Compared with the control group, the age, male prevalence rate, smoking rate, and alcohol consumption rate of the case group were increased, and the levels of UA, TG, CHOL, LDLc, and FPG were increased, while the levels of HDLc were decreased, with statistical significance ( $P < 0.05$ ). A total of 7 explanatory variables affecting OSA were included in the classification tree model, which were obesity, smoking history, age, drinking history, hypertension, abnormal glucose metabolism, and gender, among which obesity was the most important influencing factor. The re-substitution estimators and cross-validation estimators of the model were 0.192 and 0.200, respectively, and the standard errors were both 0.012. The area under the receiver operating characteristic (ROC) curve (AUC) value was 0.880 (95%CI:0.860~0.901), indicating that the model had a good prediction effect. *Conclusions:* (1) The main influencing factors of OSA were obesity, smoking history, age, drinking history, hypertension, abnormal glucose metabolism, and gender. (2) Although men are an independent risk factor for OSA, in the context of no obesity and no smoking history, people should pay more attention to pre-menopausal women with hypertension with OSA-related symptoms and middle-aged and elderly women above the age of perimenopause without a history of alcohol consumption. (3) Among



the metabolic diseases associated with OSA, glucose metabolism abnormalities may be the most important, and this association is independent of the confounding effects of obesity and metabolic syndrome.

**Keywords:** OSA; Risk factors; Classification tree model

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**Online publication:** September 8, 2025

## 1. Introduction

Obstructive sleep apnea is a clinical syndrome caused by repeated upper airway collapse during sleep, resulting in apnea and hypoventilation, and the most important pathophysiological trait is Chronic intermittent hypoxia (CIH), which can lead to multi-organ and multi-system damage, such as cardiovascular and cerebrovascular diseases, diabetes mellitus, and so on. Currently, the complications caused by OSA, including cardiovascular and cerebrovascular diseases, diabetes mellitus, and so on, have become a serious public health problem<sup>[1]</sup>. According to the data from the global phenotypic study of OSA prevalence risk conducted by Benjafield et al, the overall global prevalence rate of OSA reaches up to 12.8%–13.7%<sup>[2]</sup>. From now on, polysomnography (PSG) is still the gold standard for diagnosing OSA<sup>[3]</sup>. However, it is unable to meet the huge demand for OSA diagnostics due to its disadvantages, including the need for expensive instrumentation and a long time to test and analyze. The complexity and diversity of clinical symptoms and metabolic profiles of OSA patients have created an urgent need to explore the intrinsic links between various clinical symptoms and metabolic profiles. The classification tree model can automatically produce feature importance, divide the total study population into several relatively homogeneous subintervals according to the features, and display them in a tree diagram, with a clearer and more direct result of the output. Then, to decrease the economic burden associated with OSA, the application of classification tree models to the analysis of risk factors for OSA may provide a new, concise, and efficient way for the initial screening and diagnosis of high-risk groups for OSA in clinical practice<sup>[4]</sup>.

## 2. Methods

### 2.1. Research subjects and experimental design

The authors conducted a retrospective case-control study, and continuously collected 2258 patients who visited the First Affiliated Hospital of Guilin Medical University (including the outpatient department, inpatient department, and physical examination center) from 2020 to 2022 because OSA-related symptoms and had complete information. All patients received PSG, and according to the results, 1722 patients who met the diagnostic criteria of OSA were divided into the OSA group; 536 patients who did not meet the diagnostic criteria of OSA during the same period of consultation were divided into the control group. Because the sample size of the OSA group was significantly higher than control group, and in order to avoid classification models having a bias towards the majority class and ignoring the minority class, which could reduce the classification accuracy, the study data were undersampled to improve the predictive accuracy of the model<sup>[5–6]</sup>. Selecting about 30% of the samples randomly from the OSA group by the sample function of R (Version 4.1.3) to generate the case group, in order to achieve a 1:1 match in the number of cases between the case group and the control group. At the same time, 70% of the remaining samples from the OSA group after sampling were used as the post-sampling residual group. Compared the two independently split samples after sampling (the

case group and the post-sampling residual group), which demonstrated that the difference in the data generated from the sampling error in the undersampling process was not statistically significant. Then used the pre-sampling inter-group comparison (OSA group and control group), post-sampling inter-group comparison (case group and control group) to prove that the OSA group and the case group in the process of comparing with the control group, respectively, their assessment of the results of the differences between the indicators were consistent, hence proved that the sampling results could be a better representation of the total sample, namely, the case group could be representative of the OSA group. Finally, using the case group and the control group as the research subjects, the classification tree algorithm was used to establish the OSA primary screening model for data analysis. The included criteria for OSA patients were (1) age $\geq$ 18 years, (2) male or female, and (3) diagnosis of OSA made by a pulmonologist. The excluded criteria for OSA patients were (1) being treated for OSA, (2) having other sleep apnea, (3) having obstructive pulmonary disease, or (4) taking sedative or hypnotic medicine.

The included criteria for controls were (1) age $\geq$ 18 years, (2) male or female, (3) without a history of chronic disease, (3) without dysfunction of the heart, liver, or kidney. The excluded criteria for controls were (1) having sleep apnea, (2) having obstructive pulmonary disease, or (3) taking sedative or hypnotic medicine.

## **2.2. Survey and measurement methods**

The OSA was diagnosed according to the American Academy of Sleep Medicine Clinical Practice Guideline<sup>[7]</sup>. OSA was diagnosed based on the record from standard polysomnography (PSG) in the hospital. The mild and moderate OSA was identified when the apnea-hyponea index (AHI) was between 5 and 15, whereas the severe ones were more than 30.

The study protocol was approved by the institutional review board at the Affiliated Hospital of Guilin Medical University and conformed to the Declaration of Helsinki. Written informed consent was obtained from each subject.

## **2.3. Statistical methods**

The data were handled by statistical software such as SPSS 26.0 and R (Version 4.1.3), and measurement data were expressed as mean  $\pm$  standard deviation (Mean  $\pm$  SD) or median (lower quartile, upper quartile) [M (P25, P75)], and comparisons were made by *t* test and rank sum test; count data were expressed as constituent ratio or rate (%). The  $\chi^2$  test or the exact test of Fisher was used to compare. The difference was statistically significant, while  $P < 0.05$ , and the sample function of R (Version 4.1.3) was used to accomplish the undersampling process of the OSA group. A classification tree model was constructed, and the fitting effect and predictive efficacy of the model were evaluated by 10-fold cross-validation and receiver operating characteristic (ROC) curve.

# **3. Results**

## **3.1. Basic situation**

This study collected relevant data of 2258 patients completely, including 1533 males and 725 females. All patients were divided into the OSA group and the control group by polysomnography results; the OSA group consisted of 1722 patients, including 1242 males and 480 females; the control group consisted of 536 patients, including 291 males and 245 females. The results of univariate analysis showed that, compared with the control group, the levels of age, male prevalence rate, smoking rate, alcohol consumption rate in OSA group were

increased, and the levels of indexes included UA, TG, CHOL, LDLc and FPG were increased, while the levels of HDLc were decreased, with statistical significance ( $P < 0.05$ ). But the comparisons of the indicators of BUN, Cr, AST, ALT, and  $\gamma$ -GT between the two groups were statistically insignificant ( $P > 0.05$ ), as shown in **Table 1**.

**Table 1.** Comparison of study data between the OSA group and the control group

Variable	OSA group (n=1722)	Control group (n=536)	Z/ $\chi^2$ -value	P-value
Gender	1242 (Male) 480 (Female)	291 (Male) 245 (Female)	59.643	<0.001
Age (years)	47.00 (41.00,53.00)	43.00 (35.25,51.00)	7.243	<0.001
BMI (kg/m <sup>2</sup> )	28.05 (25.75,29.05)	23.70 (21.80,25.66)	23.069	<0.001
Smoking history, n (%)	933 (54.2%)	67 (12.5%)	287.82	<0.001
Drinking history, n (%)	811 (47.1%)	47 (8.8%)	254.88	<0.001
BP (mmHg)				
Systolic	124 (114,135)	117 (107,129)	8.545	<0.001
Diastolic	78 (71,86)	75 (67,82)	6.394	<0.001
UA ( $\mu$ mol/L)	370.00 (305.30,434.00)	335.30 (266.10,390.73)	8.214	<0.001
BUN (mmol/L)	4.85 (4.15,5.62)	4.71 (3.96,5.65)	1.574	0.115
Cr ( $\mu$ mol/L)	77.50 (67.80,86.80)	74.75 (65.13,88.78)	1.213	0.225
AST (U/L)	19.10 (16.70,22.20)	19.10 (16.00,23.28)	0.468	0.64
ALT (U/L)	19.9 (14.9,26.9)	19.3 (13.6,26.9)	1.697	0.09
TG (mmol/L)	1.50 (1.07,2.18)	1.31 (0.88,1.85)	6.13	<0.001
CHOL (mmol/L)	4.76 (4.24,5.25)	4.26 (3.77,4.75)	12.391	<0.001
LDLc (mmol/L)	3.17 (2.67,3.63)	2.90 (2.51,3.38)	5.785	<0.001
HDLc (mmol/L)	1.23 (1.06,1.44)	1.37 (1.16,1.62)	-9.309	<0.001
FPG (mmol/L)	5.90 (5.50,6.30)	5.30 (5.10,5.80)	16.538	<0.001
$\gamma$ -GT (U/L)	30.45 (21.20,48.50)	31.00 (23.00,45.55)	-1.343	0.179
AHI (enents/h)	35.75 (20.80,55.60)	2.60 (1.40,3.90)	35.001	<0.001
LSaO2 (%)	73 (61,80)	87 (84,91)	-28.633	<0.001

### 3.2. Comparison between two independent segmented samples after sampling

Because the sample size of the OSA group was significantly higher than control group, and in order to avoid classification models having a bias towards the majority class and ignoring the minority class, which could reduce the classification accuracy, the study data were undersampled to improve the predictive accuracy of the model. The sample function of R (Version 4.1.3) was used to randomly select an appropriate 30% of the samples from the OSA groups to generate case group, so that the numbers of cases in case group matched the number of cases in control group by about 1:1. Meanwhile, the remaining 70% samples from the OSA group after sampling were used as the post-sampling residual group. Two independent segmented samples (case group and post-sampling residual group) after sampling were compared between groups. The results showed that differences were statistically insignificant between the variables of the two independently segmented samples ( $P$

> 0.05). So, the authors considered that the differences in the data generated by the sampling error in the process of under-sampling were statistically insignificant, and we could select the case group for which the sample size was close to the control group from them for the subsequent data analysis (**Table 2**).

**Table 2.** Comparison of research data between two independent segmented samples after sampling

Variable	Case group (n=517)	Post-sampling residual group (n=1205)	Z/ $\chi^2$ -value	P-value
Gender	370 (Male) 147 (Female)	872 (Male) 333 (Female)	0.115	0.735
Age (years)	47 (42,53)	46 (41,53)	-1.621	0.105
Smoking history	277	656	0.108	0.742
Drinking history	240	571	0.135	0.713
BMI (kg/m <sup>2</sup> )	28.02 (25.55,29.18)	28.07 (25.81,28.99)	0.207	0.836
BP (mmHg)				
Systolic	123 (114,135)	124 (114,135)	0.474	0.636
Diastolic	78.00 (71.00,86.00)	79.00 (71.00, 85.50)	0.281	0.779
UA (μmol/L)	370.0 (297.6,434.0)	370 (307,434)	0.52	0.603
BUN (mmol/L)	4.93 (4.16,5.64)	4.83 (4.15,5.56)	-1.709	0.28
Cr (μmol/L)	77.90 (67.65,86.90)	77.30 (67.80,86.70)	-0.332	0.74
AST (U/L)	19.40 (16.75,22.00)	19.00 (16.70,22.30)	-0.266	0.79
ALT (U/L)	19.70 (14.60,26.85)	20.00 (15.00,26.95)	0.96	0.337
TG (mmol/L)	1.45 (1.02,2.16)	1.51 (1.10,2.18)	1.544	0.123
CHOL (mmol/L)	4.79 (4.30,5.25)	4.74 (4.22,5.25)	-1.408	0.295
LDLc (mmol/L)	3.17 (2.68,3.63)	3.17 (2.66,3.63)	-0.204	0.838
HDLc (mmol/L)	1.23 (1.06,1.46)	1.23 (1.06,1.43)	-0.786	0.432
FPG (mmol/L)	5.9 (5.6,6.3)	5.9 (5.5,6.2)	-0.569	0.569
γ-GT (U/L)	29.90 (20.40,49.80)	30.50 (21.35,47.65)	0.497	0.619
HCY (μmol/L)	11.70 (10.60,12.70)	11.60 (10.50,12.55)	-1.298	0.194
AHI (events/h)	37.40 (18.65,57.55)	35.40 (21.20,54.70)	0.318	0.750
LSaO2 (%)	73 (61,79)	73 (61,80)	0.774	0.439

### 3.3. Comparison between two groups after sampling

After approving that the differences in the data generated by the sampling error in the process of under-sampling were not statistically significant, the authors further accomplished the comparison between the two groups after sampling. The result of comparison between two groups after sampling showed that compared with control group, the levels of age, male prevalence rate, smoking rate and drinking rate of case group were increased, the levels of indexes such as UA, TG, CHOL, LDLc and FPG were increased, and the levels of HDLc were decreased, with statistical significance ( $P < 0.05$ ). The comparison of BUN, Cr, AST, ALT, and γ-GT between the two groups was statistically insignificant ( $P > 0.05$ ), as shown in **Table 3**.

**Table 3.** Comparison of study data between the case group and the control group

Variable	case group (n=517)	Control group (n=536)	Z/ $\chi^2$ -value	P-value
Gender	370 (Male) 147 (Female)	291 (Male) 245 (Female)	33.61	<0.001
Age (years)	47.00 (42.00,53.00)	43.00 (35.25,51.00)	6.611	<0.001
BMI (kg/m <sup>2</sup> )	28.01 (25.55,29.18)	23.70 (21.80,25.66)	18.352	<0.001
Smoking history	277	67	201.885	<0.001
Drinking history	240	47	188.18	<0.001
BP (mmHg)				
Systolic	123 (114,135)	117 (107,129)	6.567	<0.001
Diastolic	78 (71,86)	75 (67,82)	4.932	<0.001
UA ( $\mu$ mol/L)	370.0 (297.6,434.0)	335.30 (266.10,390.73)	6.242	<0.001
BUN (mmol/L)	4.93 (4.16,5.64)	4.71 (3.96,5.65)	1.806	0.071
Cr ( $\mu$ mol/L)	77.90 (67.65,86.90)	74.75 (65.13,88.78)	1.083	0.279
AST (U/L)	19.40 (16.75,22.00)	19.10 (16.00,23.28)	0.531	0.595
ALT (U/L)	19.70 (14.60,26.85)	19.30 (13.60,26.90)	0.828	0.408
TG (mmol/L)	1.45 (1.02,2.16)	1.31 (0.88,1.85)	3.93	<0.001
CHOL (mmol/L)	4.79 (4.30,5.25)	4.26 (3.77,4.75)	10.561	<0.001
LDLc (mmol/L)	3.17 (2.68,3.63)	2.90 (2.51,3.38)	4.802	<0.001
HDLc (mmol/L)	1.23 (1.06,1.46)	1.37 (1.16,1.62)	-6.994	<0.001
FPG (mmol/L)	5.9 (5.6,6.3)	5.3 (5.1,5.8)	13.065	<0.001
$\gamma$ -GT (U/L)	29.90 (20.40,49.80)	31.00 (23.00,45.55)	-1.34	0.18

### 3.4. Variable handling

In order to construct a classification tree model conveniently, and to make the output result of the model more explicit and intuitive, the above statistically significant single factors, excluding age, were assigned to the variables with strict reference to the diagnostic criteria of the previous study indicators (**Table 4**).

**Table 4.** Variable assignment table

Variable	Assignment situation
Obesity	Non obesity =0, Obesity =1
Gender	Female=0, Male =1
Drinking history	No history of drinking=0, Drinking history=1
Smoking history	No history of smoking=0, Smoking history =1
Hypertension	No hypertension=0, Hypertension =1
Dyslipidemia	No dyslipidemia =0, Dyslipidemia =1
Hyperuricemia	No hyperuricemia =0, Hyperuricemia =1
Abnormal glucose metabolism	No abnormal glucose metabolism =0, Abnormal glucose metabolism =1



### 3.5. Comparison of categorical variables before and after sampling

After accomplishing the assignment of each categorical variable, a chi-square test was performed by using the assignment results of categorical variables between the pre- and post-sampling groups. The study showed that: compared with the control group, obesity rate, male prevalence rate, drinking rate, hypertension rate, dyslipidemia rate, hyperuricemia rate, and abnormal glucose metabolism rate were all increased, with statistical significance ( $P < 0.05$ ), as shown in **Tables 5** and **6**.

**Table 5.** Comparison of categorical variables between the OSA group and the control group

Variable	OSA group (n=1722)	Control group (n=536)	$\chi^2$ -value	P-value
Obesity, n (%)	896 (52.0%)	46 (8.5%)	317.397	<0.001
Sex, n (%)	Male 1242 (72.1%)	Male 291 (54.2%)	59.643	<0.001
Drinking history, n (%)	811 (47.0%)	47 (8.7%)	254.878	<0.001
Smoking history, n (%)	933 (54.1%)	67 (12.5%)	287.820	<0.001
Hypertension, n (%)	920 (53.4%)	149 (27.7%)	107.69	<0.001
Dyslipidemia, n (%)	634 (36.8%)	125 (23.3%)	33.369	<0.001
Hyperuricemia, n (%)	529 (30.7%)	79 (14.7%)	53.059	<0.001
Abnormal glucose metabolism, n (%)	613 (35.5%)	81 (15.1%)	80.584	<0.001

**Table 6.** Comparison of categorical variables between the case group and the control group

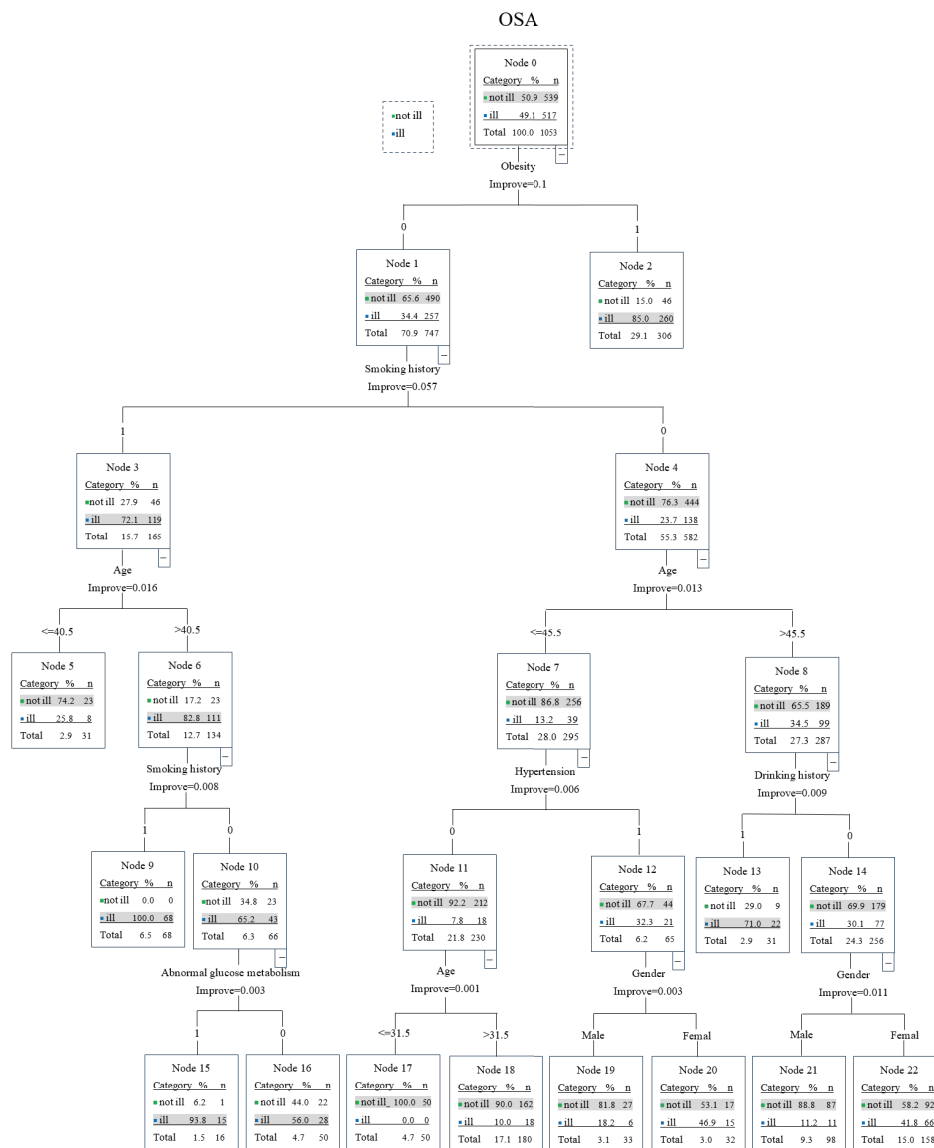
Variable	Case group (n=517)	Control group (n=536)	$\chi^2$ -value	P-value
Obesity, n (%)	260 (50.2%)	46 (8.5%)	222.066	<0.001
Sex, n (%)	Male 370 (71.5%)	Male 291 (54.2%)	33.61	<0.001
Drinking history, n (%)	240 (46.4%)	47 (8.7%)	188.18	<0.001
Smoking history, n (%)	277 (53.5%)	67 (12.5%)	201.885	<0.001
Hypertension, n (%)	279 (53.9%)	149 (27.7%)	74.689	<0.001
Dyslipidemia, n (%)	193 (37.3%)	125 (23.3%)	24.504	<0.001
Hyperuricemia, n (%)	163 (31.5%)	79 (14.7%)	41.909	<0.001
Abnormal glucose metabolism, n (%)	178 (34.4%)	81 (15.1%)	52.950	<0.001

Compared the results of pre- and post-sampling between groups, which demonstrated that the results of pre- and post-sampling were consistent with the OSA group when the case group was on behalf of the OSA group in the data analysis. And it proved that after the undersampling treatment, the sampling result of the case group still responded well to the total sample size. Hence, the case group could be selected instead of the OSA group for subsequent data analysis.

### 3.6. Construction of the classification tree model

The case group and control group were used to be study subjects, including 517 in the case group and 536 in the control group. OSA was used as the dependent variable; those who suffered from OSA were assigned a value of 1, and not suffer from OSA were assigned a value of 0. Obesity (obesity = 1, no obesity = 0),

gender (male = 1, female = 0), age, drinking history (drinking history = 1, no history of drinking = 0), smoking history (smoking history = 1, no history of smoking = 0), hypertension (hypertension = 1, no hypertension = 0), dyslipidemia (dyslipidemia = 1, no dyslipidemia = 0), hyperuricemia (hyperuricemia = 1, no hyperuricemia = 0), abnormal glucose metabolism (abnormal glucose metabolism = 1, no abnormal glucose metabolism = 0) were used as independent variables, and obesity, gender, drinking history, smoking history, hypertension, dyslipidemia, hyperuricemia and abnormal glucose metabolism were defined as classified variables, and age was defined as continuous variable. By pre-setting the growth depth and pruning rules of the tree, the results of the classification tree model of risk factors related to obstructive sleep apnea comprised 5 layers and 23 nodes, including 12 terminal nodes. Finally, 7 explanatory variables which affected OSA were selected, including obesity, smoking history, age, drinking history, hypertension, abnormal glucose metabolism, and gender (**Figure 1**).



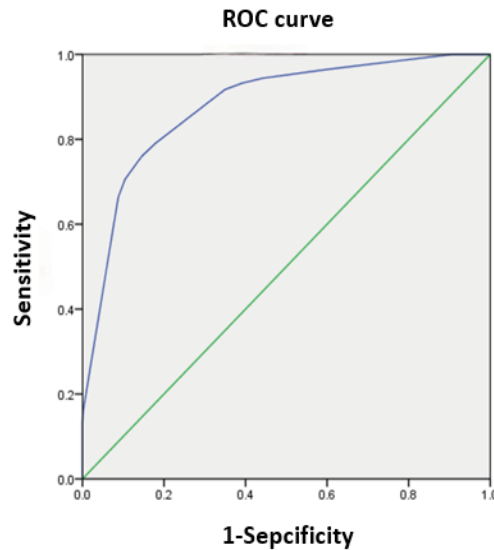
**Figure 1.** Classification tree model of factors influencing obstructive sleep apnea

### 3.7. The result of the classification tree model

The first level of the classification tree was divided into intervals according to obesity and no obesity; thus, obesity was the primary risk factor for OSA. And the prevalence rate of OSA in obese people (85%, 260/306) was significantly higher than no obese people (34.4%, 257/747). The second level of the model was split by smoking history and no history of smoking, and in no obese people, the prevalence rate of OSA in those who had a history of smoking (72.1%, 119/165) was significantly higher than those who had no history of smoking (23.7%, 138/582). OSA-related risk factor screened for the third level of the model was age. In non-obese obesity with a history of smoking, the prevalence rate of OSA in those aged >40.5 years (82.8%, 111/134) was significantly higher than those aged ≤40.5 years (25.8%, 8/31). But in those with no obesity and no history of smoking, the prevalence rate of OSA in those aged >45.5 years (34.5%, 99/287) was significantly higher than aged ≤45.5 years (13.2%, 39/295). OSA-related risk factors screened for the fourth level of the model were drinking history and hypertension. Among those without obesity, had smoking history, and those aged >40.5 years, the prevalence rate of OSA in had drinking history (100%, 68/68) was significantly higher than those without drinking history (65.2%, 43/66). Among those without obesity, no smoking history, and aged ≤45.5 years, the prevalence rate of OSA in those with hypertension (32.3%, 21/65) was significantly higher than those without hypertension (7.8%, 18/230), whereas among those without obesity, without history of smoking, and age >45.5 years, the prevalence rate of OSA in those with a history of alcohol consumption (71%, 22/31) were significantly higher than those without a history of drinking (30.1%, 77/256). OSA-related risk factors screened for the fifth level of the model were abnormal glucose metabolism, age, and gender. In those without smoking history, aged >40.5 years, and without drinking history, the prevalence rate of OSA in abnormal glucose metabolism (93.8%, 15/16) was significantly higher than those who did not have abnormal glucose metabolism (56%, 28/50). In those no obesity, without smoking history, aged ≤45.5 years, and without hypertension, the prevalence rate of OSA in those aged >31.5 years (10%, 18/180) was significantly higher than those aged ≤31.5 years (0%, 0/50). In people without obesity, without smoking history, aged ≤45.5 years, and with hypertension, the prevalence rate of OSA in females (46.9%, 15/32) was significantly higher than in males (18.2%, 6/33). But in people without obesity, without smoking history, aged >45.5 years, and without drinking history, the prevalence rate of OSA in females (41.8%, 66/158) was significantly higher than in males (11.2%, 11/98).

### 3.8. Evaluation of the classification tree model

By conducting 10-fold cross-validation for the classification tree model, the authors obtained that the re-substitution estimators and cross-validation estimators of the model were 0.192 and 0.200, respectively, and the standard errors were both 0.012. The results indicated that the correct rate was 80.8% by using a classification tree model to predict OSA influencing factors and proved that the model fitting results were well. The ROC curve was plotted by using the multi-factor combined predictive probabilities from the model: the Youden index of the ROC curve of classification tree model was 0.614, sensitivity was 76.0%, specificity was 85.4%, the area under the curve (AUC) value was 0.880 (95% CI: 0.860~0.901), and standard error was 0.010, ( $P < 0.001$ ); it indicated that model had high accuracy and could effectively select OSA-related risk factors (**Figure 2**).



**Figure 2.** ROC curve of OSA predicted by the classification tree model

## 4. Discussions

OSA is a globally prevalent and not adequately diagnosed public health disease, which faces a huge and increasing demand for diagnosis in clinical practice. People need a reliable primary screening method to identify people at high risk of OSA. Meanwhile, the complexity and diversity of clinical symptoms and metabolic features of OSA patients are creating an urgent need for us to explore the intrinsic links between various types of clinical symptoms and metabolic profiles. At present, logistic regression or multifactorial linear regression models are usually used to screen the risk factors of OSA in China. Although the two types of models above are sufficient to analyze the main effects of the independent variables, they are difficult to use to analyze the hierarchical relationships among the independent variables, which reduces the analytical efficacy. The classification tree model, as a non-parametric model, can be used to divide the total research population into several relatively homogeneous subintervals according to the features by automatically generating the importance of features, and to display them in a tree diagram, which makes the output results clearer and more direct. Currently, the classification tree model is mainly used in market research studies, and some studies have also applied it to screen the risk factors of diseases. But no study has reported applying the model to screen for the risk factors of OSA. Therefore, the aim of this study is to screen the specific population affected by each variable through the classification tree model, thereby adopting individualized preventive and treatment measures for this kind of high-risk group of OSA, in order to prevent and treat OSA and the development of complications by early intervention and treatment of the disease.

The relationship between OSA and demographic characteristics: the result of this study demonstrated that obesity was detected as the primary explanatory variable for OSA in the classification tree model, which was consistent with the results of previous studies, confirmed by epidemiological data that obesity was the most important independent risk factor of OSA <sup>[8-9]</sup>. Meanwhile, the result of the classification tree model indicated that it was not possible to re-divide the obese population by using an influencing factor as a split point to generate new sub-nodes in the obese population, which suggested that under the influence of obesity as the primary risk factor, the strong correlation of pathogenic factors had already been shown. And the correlation of pathogenic of other

influencing factors of OSA was hidden, which further reminded the importance of obesity in the development of OSA. This study indicated that, compared with the control group, the age and prevalence rate of males in the OSA group and case group were increased, with statistical significance, which was consistent with the result confirmed by traditional epidemiological data. The classification tree model could also screen out age and gender as explanatory variables, but gender as an explanatory variable showed inconsistent results with the univariate analysis. The prevalence rate of OSA was significantly higher in women than in men for a given condition when screened by layer-by-layer subdividing in the population without obesity, which suggested that although the overall prevalence rate of OSA in males was higher than in females, males were more likely to develop the disease under the condition of obesity. The independence correlation of pathogenic obesity, as a primary risk factor of OSA, decreased the interaction between itself and other variables, including male, which could be verified in the first level of the model. In the meantime, the result of the third level of the model showed that, in those without obesity and with a history of smoking, the prevalence rate of OSA in those aged  $>40.5$  was increased significantly, but in those without obesity and a history of smoking, the prevalence rate of OSA in those aged  $>45.5$  was increased significantly. The result showed that as age increased, the risk of the prevalence rate of OSA also increased, whether or not there was a history of smoking. The result of the fifth level of model showed that, in those without obesity, without history of smoking, aged  $\leq 45.5$  and without hypertension, the prevalence rate of OSA in aged  $>31.5$  was significantly higher than aged  $\leq 31.5$ , which displayed that patients were likely onset by not shown in model, slightly lower degree explanation of hyperuricemia, dyslipidemia and other relative risk factors of OSA, and the age of onset was showing a younger-age trend. But in without obesity, without smoking history, aged  $>45.5$  years old and without drinking history people, the prevalence rate of OSA in female was significantly higher than male, which suggested that female above menopause age were more likely to suffer from OSA than male after excluding influencing factors such as obesity and unhealthy lifestyle behaviors, and it indicated that OSA should not be limited to the traditionally recognized disease in male, we should pay more attention to middle-aged and elder women above the age of perimenopausal with OSA related symptoms.

The relationship between OSA and lifestyle behaviors: the result of this study demonstrated that, compared with the control group, the rate of smoking and drinking was increased in the OSA group and the drinking group, with statistical significance. The second level of the classification tree model was split by smoking history, and without smoking history, in the non-obesity population, the prevalence rate of OSA in those with a smoking history was significantly higher than those without smoking history. The third level of classification tree model was split by age, the result showed that the age as split point in without obesity and with smoking history people was 40.5 years, and in without obesity and without smoking history people was 45.5 years, which suggested that smoking, an unhealthy lifestyle behavior, not only contributed to increase significantly for the prevalence rate of OSA, but also led to a younger-age trend of disease. The result of the model in the fourth level showed that, without obesity, with smoking history, and aged  $>40.5$  years, the prevalence rate of OSA in those with a drinking history was significantly higher than those without a drinking history. And in people without obesity, without smoking history, and aged  $>45.5$  years, the prevalence rate of OSA in those with a drinking history was also significantly higher than those without a drinking history. The above two results indicated that a history of drinking contributed significantly to the increase in the prevalence rate of OSA, and even under the condition of without smoking history, the elderly OSA patients who had a drinking history still appeared to have a higher morbidity, which suggested that with the prolongation of drinking history, the risk of OSA was increased.

Relationship between OSA and hypertension: this study indicated that, compared with the control group, the



rate of hypertension in the OSA group and case group was elevated, with statistical significance, which is close to the result of epidemiological data <sup>[10]</sup>. The result of the model in the fourth level showed that, without obesity, without smoking history, and aged  $\leq 45.5$  years, the prevalence rate of OSA in hypertension was significantly higher than those without hypertension. And the next level sub-nodes of this node were split by gender, and under this background, the female population was more likely to develop OSA than the male population, which suggested that hypertension, a cardiovascular disease, might mediate the pathogenetic process of OSA in a large number of pre-menopausal females who hadn't unhealthy life style and behaviors such as obesity and smoking previous.

Relationship between OSA and metabolic syndrome: this study indicated that, compared with the control group, the rate of dyslipidemia, hyperuricemia, and abnormal glucose metabolism in the OSA group and case group was elevated, with statistical significance. However, the classification tree model only screens out the abnormal glucose metabolism as an influencing factor of OSA. Although neither type of model were not screened out dyslipidemia and hyperuricemia as risk factors of OSA, the result of non-parametric tests showed that the control group had a better level of control of TG, CHOL, LDLc, HDLc, and UA, when contrasted respectively with the OSA group and case group patients, with statistical significance. The appearance of this phenomenon might be related to the confounding effect of obesity and OSA, and obesity has been confirmed to be strongly associated with the metabolic syndrome by a vast amount of epidemiological data <sup>[11]</sup>. Metabolic syndrome is a group of clinical syndromes including hyperglycemia, dyslipidemia, hyperuricemia, etc., and with the obesity rate increasing in the world population, the incidence of metabolic syndrome also increases yearly <sup>[12]</sup>. Meanwhile, obesity was the primary risk factor of OSA; thus, the correlation of dyslipidemia and hyperuricemia for the occurrence of OSA might be masked by obesity. This statement was confirmed in the second-level classification model tree, which used obesity as a split point and failed to delineate the lower child nodes. Abnormal glucose metabolism was detected as a risk factor in two types of models, which suggested that the effect of abnormal glucose metabolism on OSA was likely the most important among the metabolic traits. Meanwhile, the results of the classification tree model were classified in the context of the population without obesity, which reflected that the pathogenic relevance of abnormal glucose metabolism for OSA was independent of the confounding effect of obesity and metabolic syndrome.

## 5. Conclusion

In conclusion, the main influencing factors of OSA were obesity, smoking history, age, drinking history, hypertension, abnormal glucose metabolism, and gender. Even though men were an independent risk factor of OSA, in the context of without obesity and without smoking history, we should pay more attention to pre-menopausal women with hypertension with OSA-related symptoms and middle-aged and elderly women above the age of perimenopause without a history of alcohol consumption. Abnormal glucose metabolism may be the most important among metabolic diseases associated with OSA, and this association is independent of the confounding effects of obesity and metabolic syndrome.

There are certain limitations and flaws to this study: this retrospective research was conducted in a single medical centre, which introduced unavoidable time bias and selection bias. The gender composition and age composition of the study subjects were more focused, which resulted in a certain bias for consequences. The study can be improved by using a more accurate sampling method, which would further reduce the impact of sampling

error on results and improve the accuracy of the model. At the same time, by enlarging the sample size to conduct the propensity score matching design, more accurate research results can be obtained.

## Funding

This work was supported by grants from the Guangxi Natural Science Foundation (Grant No. 2022JJA140014).

## Disclosure statement

The authors declare no conflict of interest.

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# Research Progress on the Treatment of Hypertension Combined with Coronary Heart Disease with Amlodipine and Atorvastatin Calcium Tablets

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**Abstract:** Hypertension combined with coronary heart disease, as a common chronic disease, often coexists, which has a significant impact on patients' health and quality of life. As a compound preparation, amlodipine and atorvastatin calcium tablets have shown significant efficacy in the treatment of hypertension combined with coronary heart disease in recent years. This study systematically analyzes the pharmacological characteristics, clinical treatment effect, and safety of amlodipine and atorvastatin calcium tablets. The research points out that this compound preparation can significantly regulate blood pressure, optimize myocardial blood supply, and thus effectively reduce the occurrence of adverse cardiovascular events.

**Keywords:** Amlodipine; Atorvastatin calcium tablets; Hypertension; Coronary heart disease

**Online publication:** September 8, 2025

## 1. Introduction

Hypertension and coronary heart disease are important cardiovascular diseases that affect people's lives and health globally, and their incidence and prevalence are increasing year by year. According to a WHO report, about 1.1 billion people worldwide suffer from hypertension, and a large number of new cases emerge every year. In China, the prevalence of hypertension remains high, with an estimated prevalence of about 27.9% among adults, affecting hundreds of millions of people<sup>[1]</sup>. Meanwhile, coronary heart disease cannot be ignored, as its mortality rate ranks among the highest among many diseases, making it a significant "killer" of the health of Chinese residents. Hypertension and coronary heart disease are closely related. As an independent risk factor for coronary heart disease, long-term elevated blood pressure can cause coronary endothelial injury, accelerate

the formation of atherosclerosis, and thus induce coronary heart disease. For people who have already developed coronary sclerosis, hypertension can further increase the heart's load, increasing the likelihood of severe cardiovascular events such as myocardial infarction and heart failure, affecting patients' quality of life and threatening their safety <sup>[2]</sup>. Amlodipine Atorvastatin Calcium Tablets are a combination of amlodipine, a dihydropyridine calcium channel blocker, and atorvastatin, a hydroxymethylglutaryl-CoA reductase inhibitor. Amlodipine can dilate blood vessels and lower blood pressure, while atorvastatin can lower blood lipids and stabilize plaques. The combination of the two complements each other and provides multiple functions such as lowering blood pressure, regulating blood lipids, and protecting blood vessels. Currently, through continuous clinical exploration, the medical community has confirmed the outstanding value of amlodipine atorvastatin calcium tablets in the comprehensive treatment of hypertension combined with coronary heart disease. With its significant therapeutic effect and high safety, this drug has gained high clinical recognition, opening up a new path for the treatment of hypertension combined with coronary heart disease and providing an effective reference.

## **2. Pharmacological effects of Amlodipine Atorvastatin Calcium Tablets**

### **2.1. Amlodipine**

Amlodipine is a third-generation dihydropyridine calcium channel blocker (CCB). Its positively charged side chain can specifically bind to the negatively charged regions of vascular smooth muscle cell membranes, continuously inhibiting the opening of L-type calcium channels and significantly reducing the influx of calcium ions. This mechanism promotes full relaxation of vascular smooth muscles and pronounced vasodilation, resulting in significant and sustained blood pressure-lowering effects, providing a reliable treatment option for hypertensive patients. Its mechanism of action lies in blocking vasoconstriction signal transmission, maintaining vasodilation, and achieving blood pressure control by improving hemodynamic parameters. Additionally, amlodipine can exert a certain blocking effect on N-type calcium channels. This action helps reduce the reflex sympathetic activation caused by vasodilation, prevents adverse reactions such as excessive heart rate, and also inhibits the increase in glomerular capsule pressure, protecting renal function <sup>[3]</sup>.

As a complex drug molecule with both water and fat solubility, amlodipine consists of two enantiomers: racemic levorotatory and dextrorotatory forms. The racemic levorotatory form is the key active component that blocks calcium ion selective channels, exhibiting significant pharmacological efficacy. Although the dextrorotatory form has weaker pharmacological activity, it has significant advantages in scavenging oxidative stress damage and stimulating endogenous nitric oxide (NO) production, which helps improve the structural and functional integrity of vascular endothelial cells. The absorption process of this drug after oral administration is slow and complete, typically reaching peak blood concentration 6–12 hours after administration, with a stable blood concentration maintained at 8–12ng/ml. Its high bioavailability ranges from 64%–90%, and it is not affected by dietary factors, making it clinically convenient to administer <sup>[4]</sup>.

### **2.2. Atorvastatin**

Atorvastatin, as a 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase inhibitor, plays a crucial role in lipid regulation in clinical practice. Through a highly competitive inhibitory mechanism, it directly targets HMG-CoA reductase, effectively blocking the biosynthetic pathway of cholesterol. This mechanism not only

significantly reduces the synthesis and storage of cholesterol in hepatocytes but also accelerates the metabolic clearance of low-density lipoprotein cholesterol (LDL-C). As a result, it causes a notable decrease in serum total cholesterol and LDL-C concentrations, with a reduction range of up to 30%–50% <sup>[5]</sup>. Additionally, atorvastatin exhibits multifaceted effects in regulating blood lipids, promoting the production of high-density lipoprotein cholesterol (HDL-C), and improving the lipid profile. Atorvastatin also effectively enhances the synthesis and release of nitric oxide (NO) by endothelial cells, thereby strengthening vasodilation and providing dynamic support to the vascular system. Furthermore, by inhibiting the proliferation and migration of vascular smooth muscle cells, it prevents the thickening of blood vessel walls and narrowing of lumens, ensuring the continuous patency of vascular channels. In the treatment of atherosclerosis (AS), atorvastatin stabilizes plaques, significantly reducing the risk of plaque rupture and providing robust protection to the vascular structure. Simultaneously, it suppresses local inflammatory responses, notably decreasing levels of inflammatory markers such as C-reactive protein and mitigating the destructive effects of inflammation on blood vessel walls. The absorption process of atorvastatin is rapid, reaching peak concentrations in the plasma within 1–2 hours after oral administration, allowing it to exert its therapeutic effects. Although the first-pass effect through the liver and intestine is significant, resulting in an absolute bioavailability of only 14% after a 10 mg oral dose, this efficiency is sufficient to ensure clinically significant results.

### **2.3. Combination therapy with amlodipine and atorvastatin**

When amlodipine and atorvastatin are combined into a compound preparation, there is no significant difference in the absorption rate and extent (bioavailability) of the two component drugs compared to when they are administered separately. Although food does not significantly affect the absorption process of amlodipine, it can inhibit the absorption efficiency and extent of atorvastatin, resulting in a decrease in absorption rate by approximately 32% and a reduction in absorption degree by 11%. However, eating does not weaken the clinical efficacy of atorvastatin in reducing LDL-C. A study has shown that even when 10 mg of amlodipine and 80 mg of atorvastatin are administered together, the pharmacokinetic characteristics of amlodipine remain stable, while the peak concentration of atorvastatin is not affected. However, its area under the curve (AUC) increases by 18%, suggesting that the compound preparation may further enhance the efficacy of atorvastatin through synergistic effects <sup>[6]</sup>. The synergistic action of the two drugs allows for complementary advantages, enabling precise blood pressure control and optimized lipid metabolism. This significantly improves the state of vascular endothelium, effectively inhibits plaque development, and greatly reduces the incidence of cardiovascular adverse events, providing a more effective treatment strategy for patients with hypertension and coronary heart disease.

## **3. Clinical efficacy and safety of Amlodipine and Atorvastatin Calcium Tablets**

### **3.1. Synergistic hypotension**

Multiple clinical studies have clearly pointed out that amlodipine and atorvastatin calcium tablets have significant advantages in lowering blood pressure in combination therapy for hypertension with coronary heart disease <sup>[7]</sup>. Yu Peng et al. conducted a randomized controlled study that randomly divided 120 patients diagnosed with hypertension and coronary heart disease into two groups <sup>[8]</sup>. The experimental group was treated with oral amlodipine and atorvastatin calcium tablets (atorvastatin 20 mg, amlodipine 5 mg), once a



day, while the reference group only received oral amlodipine 5 mg treatment, once a day, with an intervention period of 12 weeks. The research data showed that the reductions in systolic and diastolic blood pressure in the experimental group were 22.5 mmHg and 12.3 mmHg, respectively, while the systolic and diastolic blood pressure in the reference group only decreased by 16.8 mmHg and 9.2 mmHg, respectively. The statistical difference between the two groups was significant ( $P < 0.05$ ). In addition, the blood pressure compliance rate (systolic blood pressure  $<140$  mmHg and diastolic blood pressure  $<90$  mmHg) in the treatment group was as high as 88.3%, which was significantly higher than the 71.7% in the control group ( $P < 0.05$ ). A large multicenter study by Hideaki involving 1000 patients confirmed that amlodipine and atorvastatin calcium tablets have a synergistic effect in lowering blood pressure<sup>[9]</sup>. In this study, patients were divided into single-drug amlodipine and atorvastatin groups and a combination treatment group. After 2 months of treatment, the blood pressure reduction in the combination group was increased by 6.2 mmHg (systolic blood pressure) and 3.5 mmHg (diastolic blood pressure) compared to the single-drug groups, respectively, and the blood pressure control rate reached 92%, which was also higher than the 78% and 80% in the single-drug groups. The mechanism may be related to the following synergistic blood pressure-lowering effects: (1) Improving endothelial function: Amlodipine lowers blood pressure by vasodilation, and atorvastatin reduces oxidative stress and protects endothelial cells. The combination of amlodipine and atorvastatin increases NO secretion, thereby lowering blood pressure; (2) Improving arterial compliance: Decreased arterial compliance is one of the important pathophysiological mechanisms of hypertension. The combination of amlodipine and atorvastatin can not only effectively improve arterial elasticity and delay the progression of atherosclerosis, but also significantly reduce blood pressure levels; (3) Regulation of neuroendocrine function: Hypertensive patients often exhibit hyperactivity of the sympathetic nervous system and increased activity of the renin-angiotensin-aldosterone system (RAAS). Amlodipine effectively inhibits sympathetic excitability by regulating calcium ion levels in vascular smooth muscle cells, while atorvastatin indirectly regulates the activity balance of the RAAS system by improving lipid metabolism. The combined use of these two drugs can intervene in neuroendocrine mechanisms synergistically, thereby promoting stable blood pressure control<sup>[10]</sup>.

### 3.2. Synergistic lipid regulation

A study by MZG on patients with hyperlipidemia and hypertension showed that after 12 weeks of treatment, the level of low-density lipoprotein cholesterol (LDL-C) in the combination therapy group decreased by 42% compared to baseline, significantly higher than the 35% decrease in the atorvastatin monotherapy group ( $P < 0.01$ )<sup>[11]</sup>. Simultaneously, the high-density lipoprotein cholesterol (HDL-C) level in the combination therapy group increased by 12%, and the total cholesterol (TC)/HDL-C ratio decreased significantly. This indicates that the combination therapy not only effectively reduces “bad cholesterol” but also increases “good cholesterol” levels, optimizing the lipid profile. The mechanism of synergistic lipid regulation is analyzed as follows: (1) Inhibition of P-glycoprotein: Atorvastatin is a substrate of P-glycoprotein, while amlodipine, a calcium ion antagonist, can inhibit P-glycoprotein activity. This reduces the excretion of atorvastatin in the intestine and liver, increases the bioavailability of atorvastatin, and enhances its lipid-regulating efficacy. (2) Influence on cytochrome P450 enzymes: Atorvastatin is primarily metabolized by CYP3A4 enzymes, and amlodipine, as a CYP3A4 enzyme inhibitor, can reduce the metabolism rate of atorvastatin, prolong its duration of action, and enhance its lipid-regulating effect<sup>[12]</sup>. (3) Influence on gene expression: Amlodipine can induce the expression of LDL receptor genes, increase the number of LDL receptors on hepatocyte membranes, enhance the clearance

ability of LDL-C, and simultaneously inhibit the expression of HMG-CoA reductase genes, reducing cholesterol synthesis, thereby affecting lipid metabolism from multiple perspectives.

### 3.3. Safety evaluation

Amlodipine and atorvastatin calcium tablets are relatively safe in clinical applications. Numerous clinical trials have demonstrated that the combined use of these drugs has a similar incidence of adverse reactions compared to their use as single agents, with most reactions being mild to moderate and capable of resolving spontaneously or with symptomatic treatment.

Common adverse reactions primarily include headache, facial flushing, lower extremity edema, and gastrointestinal discomfort. The incidence of these reactions increases slightly with higher dosages, but remains relatively low overall. In a long-term follow-up study by Lu Xiangyang involving 2000 patients, the incidence of lower extremity edema in the combination therapy group was 8.5%, which was not significantly different from the 9.2% incidence in the amlodipine monotherapy group ( $P > 0.05$ )<sup>[13]</sup>. Atorvastatin monotherapy may cause a slight increase in transaminase levels, but combination therapy does not significantly increase this risk. The aforementioned long-term follow-up study showed that the incidence of elevated alanine aminotransferase (ALT) in the combination therapy group was only 1.2%, which was similar to the monotherapy group. When statin drugs are used alone or in combination with other drugs, a very small number of patients may experience myalgia, myositis, or even rhabdomyolysis.

However, the combination of amlodipine and atorvastatin does not significantly increase the risk of myopathy. A meta-analysis showed no significant difference in the incidence of myopathy between the combination therapy group and the monotherapy group (OR=1.05, 95% CI: 0.87–1.26)<sup>[14]</sup>. Long-term use of statin drugs may slightly increase the probability of developing diabetes, but this risk is far outweighed by the significant benefits of cardiovascular protection. The addition of amlodipine does not alter this risk profile, and the incidence of new-onset diabetes in the combination therapy group is similar to that in the monotherapy group.

### 3.4. Application in special populations

Amlodipine and atorvastatin calcium tablets have demonstrated good efficacy and safety in special populations such as the elderly, diabetics, and patients with renal insufficiency. In elderly patients with hypertension and coronary heart disease, combination therapy can significantly reduce the risk of cardiovascular events, and the incidence of adverse reactions is not significantly different from that of younger patients. For diabetic patients, combination therapy not only effectively controls blood pressure and blood lipids but also improves insulin resistance, with no adverse effects on blood glucose metabolism. In patients with renal insufficiency, amlodipine is primarily metabolized through the liver, and atorvastatin dose adjustment is relatively simple, making combination therapy a safe and effective treatment option.

## 4. The impact of amlodipine and atorvastatin calcium tablets on endpoint events

Liu Bing studied and analyzed the application of amlodipine and atorvastatin calcium tablets in patients with hypertension and coronary heart disease<sup>[15]</sup>. The study included 560 patients aged between 50–85 years old, diagnosed with hypertension and stable coronary heart disease. They were randomly assigned to the amlodipine

and atorvastatin calcium tablet group (amlodipine 5–10 mg/d combined with atorvastatin 20–40 mg/d) or the conventional treatment group (receiving only antihypertensive drugs and basic treatment for coronary heart disease). After a 3-year follow-up observation, the results showed that the amlodipine and atorvastatin calcium tablet group had a significantly lower incidence of major cardiovascular endpoint events (including myocardial infarction, rehospitalization for unstable angina, cardiac death, and stroke) compared to the conventional treatment group, with a relative risk reduction of 23% ( $P=0.018$ ). In terms of myocardial infarction, the incidence in the amlodipine and atorvastatin calcium tablet group was reduced by 28% compared to the control group ( $P=0.032$ ), demonstrating the significant advantage of this combination therapy in preventing acute coronary events.

Additionally, according to the research conducted by Leng Defeng et al., in a 5-year follow-up study of hypertensive patients taking amlodipine and atorvastatin calcium tablets, there was a significant optimization in the estimated 10-year cardiovascular risk based on the Framingham Risk Scoring System<sup>[16]</sup>. The risk decreased significantly from a baseline level of 18.5% to 10.2% ( $P < 0.001$ ). This clinical benefit was not a short-term effect but gradually emerged 24 months after the initiation of treatment and showed a continuously increasing dose-dependent characteristic with prolonged medication use. This evidence not only clearly demonstrates that amlodipine and atorvastatin calcium tablets can serve as an effective primary prevention strategy for cardiovascular disease but also suggests that immediate initiation of continuous treatment has an irreplaceable clinical value for improving the long-term prognosis of patients with coronary heart disease.

## 5. Conclusion

In summary, amlodipine and atorvastatin calcium tablets exhibit significant synergistic effects in lowering blood pressure and regulating lipids in the treatment of hypertension with coronary heart disease through their unique pharmacological mechanisms of action, while also demonstrating good safety and tolerability. This compound preparation not only effectively controls blood pressure and lipid levels but also improves endothelial function, stabilizes atherosclerotic plaques, and reduces the risk of cardiovascular events, providing patients with a more comprehensive and effective treatment plan.

## Disclosure statement

The authors declare no conflict of interest.

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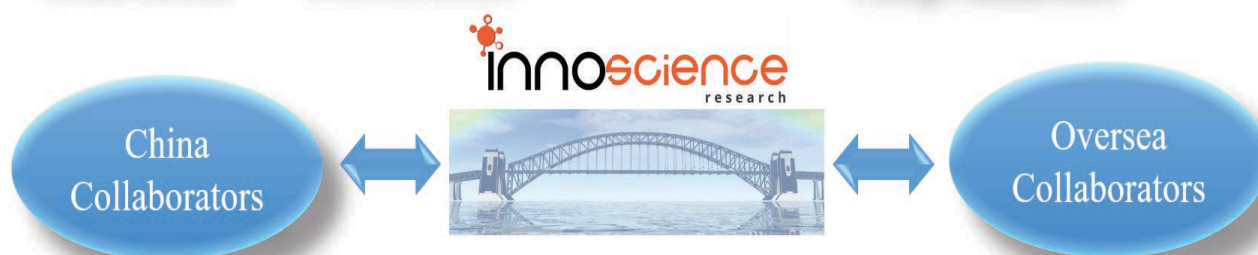
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