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Table of Contents

- 1 Analysis of the Therapeutic Effect and Prognosis of Frameless Stereotactic Soft Channel Intracranial Hematoma Evacuation for Severe Basal Ganglia Hemorrhage**
Wanqi Liu, Shuqin Fan, Ruixue Zhuang, Zhenchuan Liu, Zhongxiang Xie

- 9 Research on the Correlation Between miRNA, CMTM6, and PD-L1 Expression in Gastric Cancer**
Ruixin Shi, Zhenwen Cao, Ru Ji

- 15 The Therapeutic Effect of Dabuyin Wan on Male Breast Development and Its Impact on Sex Hormone Levels**
Sheng Yu, Ying Wu, Lai Zhang, Zhiyun Rong

- 22 Analysis of the Efficacy of Shexiang Tongxin Dropping Pills Combined with Rosuvastatin Calcium and Clopidogrel Bisulfate Tablets in the Treatment of Phlegm-Heat and Blood Stasis Type Angina Pectoris of Coronary Heart Disease**
Chunxia Hu, Weifen Wang, Tianyou Wang, Ling Zhang, Danhua Zheng

- 33 The Value of the Knowledge-Attitude-Practice Health Education Model in Enhancing the Coping Ability of Caregivers of Children with Febrile Seizures**
Beibei Zhai, Lilin Gao

- 40 Study on the Efficacy of High-Throughput Real-Time Mass Spectrometry Detection of Exhaled Breath for Rapid Diagnosis of Pulmonary Tuberculosis**
Long Jin, Jie Zhang, Xiaolei Zhang, Huailong Jiang, Qijian Li, Zheyu Cao, Jie Li, Fangjia Li, Rongbo Zhang, Weihua Hu

- 47 The Application Effect of a Three-Subject, Dual-Track Interactive Nursing Model Based on Smart Nursing in Patients with Intestinal Polyps**
Baoqin Wang, Xiaojuan Ding, Dexi Ding, Chunli Tang, Shujuan Fan

- 54 Analysis of the Application Effect of Community Health Center Nursing Models in Elderly Health Examinations**
Qingrong Meng

- 61 Benefit Analysis and Discussion of the Same Disease in Different Departments of Public Hospitals under the DIP Payment Method**
Shanlan Song, Shengshan Zhu, Heng Wang
- 68 Identification of Health Literacy Gaps in Preschool Teachers Regarding Students' Vision Protection: A Targeted Analysis Based on Item Response Rates**
Shuping Gao, Ping He, Xing Liu, Xiaofen Deng, Zhijun Ren, Juanjuan Lin
- 80 Multidisciplinary Collaborative and Refined Nursing for a Patient with Severe Toxic Epidermal Necrolysis**
Ran Wang, Junhua Liang, Juanjuan Ning, Zhenzhen Yuan, Shuping Gao
- 87 A Qualitative Study on Diagnosing Myopia Using the Ratio of Axial Length to Corneal Radius of Curvature**
Lijuan Zeng, Ming Yang
- 96 Research on the Relationship Between Imaging Characteristics Changes of Pulmonary Infections in Patients with Hypo-immunity and NLR, PCT Levels and Their Severity**
Xiang Wang, Jinhong Zhao, Chongrui Yan, Yi Liu
- 102 A Retrospective Analysis of Higher Vocational Medical Education Based on the CIPP Model**
Jian Yang, Gang Duan, Zhen Feng, Rong Huang, Fang Fang, Wendan Lv
- 110 A Case of Medical Damage Identification of Balloon Rupture and Retention Complicated with Acute Ischemic Stroke**
Zhijie Liu, Jianwen Song
- 117 Integrated Traditional Chinese and Western Medicine in the Treatment of Biliary Cholestatic Liver Disease in an Infant with ABCB4 Gene Mutation: A Case Report**
Aixia Peng, Yufeng Lu
- 126 End-of-Life Care: A Case Study on Palliative Care Practice for a Child with Pineal Tumor**
Hui Ma, Minxuan Shi, Yuanyuan Tong, Huiping Wang, Yang Liu
- 134 Exploring the Importance of Health Education during Pregnancy Based on the Health Belief Model**
Cuicui Sun
- 143 Epidemiological Characteristics of a Varicella Outbreak in a Primary School and Analysis of Vaccine Protection Efficacy**
Lin Gui

- 150 The Impact of Early Initiation of Intensive Lipid-Lowering Therapy on the Efficacy and Inflammatory Factors in Patients with Acute Coronary Syndrome Undergoing Percutaneous Coronary Intervention**
Yue Kan, Yongfu Zhao, Hong Gao, Shihao Zhao, Jiaxu Liu, Zhanxiu Zhang
- 158 The Impact of Metabolic Syndrome on Coronary Artery Disease in Middle-Aged and Older Women**
Ban Hong
- 165 A Qualitative Study on the Self-Management Experiences and Outpatient Nursing Needs of Intestinal Stoma Patients During the Post-Discharge Transition Period**
Yueqing Ren, Ye Li, Baoling Zhou, Yuqing Wang, Yufen Sun
- 172 Trajectory and Influencing Factors of Postoperative Vulnerable Symptom Clusters in Lung Transplant Recipients**
Xue Li, Ying Jin, Jing Hu, Junrong Ding
- 184 The Application Effect of the Discharge Preparation Plan Based on the ADOPT Nursing Model in Patients with First-Visit Ischemic Stroke**
Xueru Ma, Peiming Li
- 193 A Study on the Preferences of Undergraduate Nursing Students for Clinical Teaching: Based on Discrete Selection Experiments**
Yao Zeng, Shuang Li, Yulan Jia, Ying Yang, Xiang Liao, Xi Wang
- 199 Observation on the Application of Case-based Three-dimensional Teaching Method Guided by Evidence-Based Thought in the Teaching of Intern Nurses in the Rehabilitation Department**
Qiurong Mi
- 209 Research Progress on the Prevention of Infection in Operating Rooms Using the HFMEA Model Combined with Evidence-Based Medicine**
Wen Xu, Xiaofu Ji
- 217 Rehabilitation Nursing for a Patient with Acute Respiratory Failure Combined with Heart Failure and Obesity: A Case Report**
Xuelian Jiang, Jingjing Xie, Chengyang Wan
- 224 Investigation and Research on the Knowledge, Attitude and Practice of Intensive Care Unit Nurses on Pulmonary Rehabilitation after Cerebral Hemorrhage Surgery Based on the IKAP model**
Zhuling Jiang

- 230 Application of Shexiang Baoxin Pill Combined with Rosuvastatin Calcium Tablets in the Treatment of Angina Pectoris due to Coronary Atherosclerotic Heart Disease**
Jingjiao Hui
- 237 Application of the Integration of Teaching-Research-Clinic Trinity Model in the Teaching of Nervous System in Physiology**
Lei Zhang, Qu Peng, Yali Yang, Weigang Cui, Minli Zheng, Jiahua Wu, Jihua Qiu, Aihua Song, Jianhui Zhang
- 243 The Impact of Robot-Assisted Training on Upper Limb Function in Elderly Stroke Patients**
Wenting Jia, Chengyuan Zhu, Hua Xu, Chunhua Yuan, Xin Zhuang, Yue Huang
- 249 Study on the Effects of Umbilical Acupuncture's "Wind-Thunder Interaction Method" on Neuro-Vascular Regulatory Peptide Groups in SCH Patients with Liver Stagnation and Spleen Deficiency**
Yongfeng Li, Jialin Cheng, Hairong Wang, Bihai Zhou, Jianguo Mao
- 256 Technical Guidelines for Autologous Skin-Grafting Surgery to Prevent Stenosis Following Super Minimally Invasive Resection of Large-Area Esophageal Lesions**
Qianqian Chen, Runze Wang, Huikai Li, Enqiang Linghu
- 263 Observation on the Efficacy of Roxadustat in Treating Low-risk Myelodysplastic Syndrome**
Tao Guo, He Li, Hongfang Wang, Feng Zhang
- 270 Evaluation of the Efficacy Rate of Rebamipide Combined with Triple Therapy in the Treatment of Senile Peptic Gastric Ulcers**
Rong Li
- 276 Root Resorption Caused by Thin Roots Combined with Reciprocal Movement: A Case Report and Nursing Care Points**
Aoshuang Wang, Jiajia Wei
- 281 Application of Quality Control Circle Activities in Reducing Loss Rate During Storage of Traditional Chinese Medicine Decoction Pieces: An Effectiveness Study**
Bin Liu, Meiling Shao, Li Chen
- 286 The Value of Vestibular Rehabilitation Training Instruction in the Treatment of Sudden Deafness Accompanied by Vertigo**
Tingting Jiang, Xiaorong Yang, Juxiang Shang, Juan Yao, Ruiqi Li, Zhiquan Peng
- 293 Development and Reliability and Validity Analysis of an Assessment Tool for Postoperative Wound Healing in Adult Patients with Benign Anal Canal and Rectal Diseases**
Xiaomei Chang, Shenglin Hu, Min Zhu, Min Zou, Min Li, Guorong Li, Zhi Feng, Hongbo Li

- 301 The Application of Scenario Simulation Teaching Method Based on Debriefing-GAS Mode in the Teaching of Clinical Nursing students**
Shasha Liu
- 307 Analysis of the Efficacy of High-Flow Nasal Cannula Oxygen Therapy and Non-Invasive Ventilation in COPD Patients**
Xue Yin, Yan Li, Yan Ma, Yue Sun, Li Li, Wenmei Yan, Jianhua Zhang, He Zhang, Haisheng Yang
- 316 Research Progress on Astaxanthin in Exercise-Induced Fatigue**
Guanyinliang Wen
- 323 Study on the Distribution Characteristics and Blood Type Analysis of Voluntary Blood Donors in the Linxia Region**
Guangzhong La, Anbing Wang, Yan Chang
- 330 Real-world Study of the Efficacy and Safety of Idebenone Tablets in the Treatment of Post-stroke Depression**
Longteng Liang, Pengfei Liu, Guoai Lun
- 337 Real-world Study on the Effectiveness and Safety of Citicoline Sodium Capsules in the Treatment of Traumatic Brain Injury**
Ping Liang, Jun Yang, Yuan Lu, Cheng Du, Yiqin Yao
- 344 Efficacy and Safety Study of Rasagiline Tablets in the Treatment of Parkinson's Disease**
Lu Zhang, Jin Xu, Ling Liu, Haiyan Tang
- 350 In-Depth Exploration of the Efficacy of Hook Plate-Double Ligament Dynamic Fixation for HACD**
Jun Ge
- 357 Research on Synergistic Regulation of Sleep-Emotion-Behavior Based on SLS Magnesium Glycinate Complex Liquid Supplement**
Jing Li, Féira Kwok, Rachel Chung, Jade Cooper, Jacob Kwok
- 363 Research on the Mechanism of the lncRNA DLX6-AS1/miR-26a/PTEN Axis in Regulating the Activation of Hepatic Stellate Cells in Post-hepatitis Liver Fibrosis: An Analysis Based on Systematic Validation and Clinical Translation Methods**
Yan Wang, Chao Gao, Dongqin Fei, Fang Zhang, Qi Zhang
- 372 Skeleton-Silhouette Complementary Perception: Toward Robust Gait Recognition**
Xiaokai Liu, Luyuan Hao

378 Investigation on the Current Situation of Missed Nursing Care and Analysis of Its Influencing Factors Among 1,476 Nurses in Southern Xinjiang

Hui Chen, Xiangtao Chen, Hefang Wang

387 Clinical Study on Acupoint Injection Combined with Intraspinal Anesthesia for Labor Analgesia in Primiparas

Shuaihui Zeng, Zesen Zhan, Zijing Zhang

395 Research on the Impact of Health Education Nursing Based on the Transtheoretical Model of Behavior Change on Self-Efficacy in Osteoporosis Patients with Low Bone Mass

Fenglai Hu

402 Current Application Status and Evidence-Based Medicine Review of Herbal Medicine in the Treatment of Functional Dyspepsia in Internal Medicine with Integrated Traditional Chinese and Western Medicine

Chunxiao Wang

409 Mediating Effect of Medical Coping Styles in Patients with Chronic Pain between Pain Degree and Pain Catastrophe

Hui Qiang, Yan Hua

Analysis of the Therapeutic Effect and Prognosis of Frameless Stereotactic Soft Channel Intracranial Hematoma Evacuation for Severe Basal Ganglia Hemorrhage

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Abstract: *Objective:* To analyze the therapeutic effect and prognosis of frameless stereotactic soft channel intracranial hematoma evacuation for severe basal ganglia hemorrhage. *Methods:* Clinical data of 411 patients with severe basal ganglia hemorrhage admitted to the Neurological Intensive Care Unit of Linyi People's Hospital from January 2020 to December 2021 were collected. According to the modified Rankin Scale (mRS) score at 180 days after onset, the patients were divided into the good prognosis group and the poor prognosis group. The therapeutic effect of frameless stereotactic soft channel intracranial hematoma evacuation on severe basal ganglia hemorrhage was explored, and the influencing factors of prognosis were analyzed. *Results:* Multivariate Logistic regression analysis showed that the admission Glasgow Coma Scale (GCS) score was an independent protective factor for the prognosis of patients with severe basal ganglia hemorrhage, while age, preoperative hematoma volume, random blood glucose level, and mechanical ventilation were independent risk factors. *Conclusion:* Frameless stereotactic soft channel intracranial hematoma evacuation has a good therapeutic effect on severe basal ganglia hemorrhage. However, it is necessary to screen the patients' basic information before surgery and provide medical care based on their specific conditions to promote their rapid recovery. **Keywords:** Frameless stereotactic soft channel intracranial hematoma evacuation; Severe basal ganglia hemorrhage; Therapeutic effect; Prognosis

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1. Introduction

Severe basal ganglia hemorrhage is a serious cerebrovascular disease caused by massive bleeding in the basal ganglia region, characterized by high disability and mortality rates ^[1]. The etiologies of this disease include aneurysms, arteriosclerosis, hypertension, and moyamoya disease, among which hypertension is a key risk factor ^[2]. Clinically,

the main treatment methods for this disease include conservative treatment and surgical treatment. Common surgical approaches include stereotactic minimally invasive drainage, neuro-endoscopic–assisted minimally invasive hematoma evacuation, and craniotomy with bone flap removal for intracerebral hematoma evacuation [3]. For patients with large amounts of bleeding and severe conditions, surgery is the preferred treatment option. However, traditional craniotomy is prone to causing secondary damage to patients or difficulties in hemostasis. Frameless stereotactic soft channel intracranial hematoma evacuation is a minimally invasive and precise intracranial hematoma evacuation technique. It has advantages such as high precision, minimal trauma, and rapid recovery, making it suitable for the treatment of severe basal ganglia hemorrhage. Some scholars have found through research that stereotactic soft channel intracranial hematoma evacuation can not only remove hematomas but also minimize damage to the surrounding brain tissue to the greatest extent, promote the recovery of neurological function, improve prognosis, and reduce the incidence of complications [4]. This study aims to systematically evaluate the therapeutic effect and prognosis of this technique in the treatment of severe basal ganglia hemorrhage, so as to provide a scientific basis for clinical treatment.

2. Materials and methods

2.1. General information

Clinical data of 411 patients with severe basal ganglia hemorrhage admitted to the Neurological Intensive Care Unit of Linyi People's Hospital from January 2020 to December 2021 were collected. According to the modified Rankin Scale (mRS) score at 180 days after onset, the patients were divided into the good prognosis group (mRS ≤ 3) and the poor prognosis group (mRS > 3). All patients in this study voluntarily participated and signed the informed consent form. This study has been approved by the hospital ethics committee, with the ethics approval number YX200437.

2.1.1. Inclusion criteria

Aged ≥ 18 years old; Diagnosed with spontaneous cerebral hemorrhage confirmed by imaging examination; Underwent modified (frameless) stereotactic soft-channel intracranial hematoma evacuation in our hospital; Complete clinical data and follow-up data.

2.1.2. Exclusion criteria

Cerebral hemorrhage secondary to abnormal brain structure, thrombolysis/thrombectomy therapy, or trauma; Patients who had undergone cerebral hemorrhage surgery in other hospitals and were admitted to our hospital for reoperation; Cerebral hemorrhage complicated with new cerebral infarction; Presence of other conditions that may interfere with follow-up and result evaluation; Incomplete clinical data and follow-up data.

2.2. Research methods

All patients underwent frameless stereotactic soft-channel intracranial hematoma evacuation, and the operation process was as follows:

2.2.1. Pre operative procedure

Based on the results of standard head CT scan with the orbitomeatal line as the baseline, the maximum cross-section of the hematoma was selected as the puncture and catheterization level. The puncture site and direction

were determined according to the shape of the hematoma, and the depth of catheterization was confirmed. The patient's head was shaved. All patients with basal ganglia hemorrhage were placed in the supine position, and the frontal approach was adopted. A hard pillow or head pad was placed under the head with an appropriate height, requiring the line connecting the palpebral fissure and the external auditory meatus to be perpendicular to the operating table. Modified stereotactic technology was used to mark the body surface projections of the puncture site, puncture plane, and catheterization angle on the patient's head.

2.2.2. Surgical implementation

The skin in the surgical area was disinfected, and local infiltration anesthesia was applied; intravenous anesthesia enhancement was added if necessary. A grooved hand awl was used to bluntly pierce the scalp at the puncture site. A triangular cranial hand awl was used to penetrate the outer table of the skull, then a T-shaped hand drill was used to penetrate the inner table of the skull. The grooved hand awl was again used to polish the skull hole to make it smooth. A guiding steel needle was first inserted into the bone hole to detect the tension and depth of the dura mater, and then the triangular cranial hand awl was quickly inserted into the cranial cavity. The guiding steel needle was inserted into the drainage catheter. With the support of the guiding steel needle, the drainage catheter passed through the scalp at the puncture site, the skull hole, and the dural hole into the cranial cavity, and was placed along the long-axis approach of the hematoma to the distal end of the hematoma cavity, 0–5 mm away from the distal end of the hematoma. The guiding steel needle was pulled out, and a 5 mL empty syringe was connected to slowly aspirate the old blood. During aspiration, the syringe could be gently rotated to make the drainage catheter rotate in the hematoma cavity, achieving initial decompression. The drainage catheter was fixed, connected to a three-way valve and external drainage devices. The wound was dressed, and the dressing was fixed. The operation was completed. Postoperatively, urokinase was used to liquefy and drain the hematoma. Brain CT reexaminations were performed to dynamically observe the changes of intracranial hematoma.

2.3. Observation indicators

The therapeutic effect of patients was counted. According to the mRS score at 180 days after onset, patients were divided into the good prognosis group ($mRS \leq 3$) and the poor prognosis group ($mRS > 3$). Multivariate Logistic regression analysis was conducted to explore the relevant factors affecting prognosis.

2.4. Statistical analysis

SPSS 26.0 software was used for statistical analysis of data. Measurement data did not conform to the normal distribution, and were expressed as median (quartile) [M(QL, QU)], and analyzed by Mann-Whitney U rank sum test. Count data were expressed as frequency (percentage), and analyzed by chi-square test. Multivariate Logistic regression analysis was performed. A p value < 0.05 was considered statistically significant.

3. Results

3.1. Baseline data of patients

Among the 411 patients with severe cerebral hemorrhage included in this study, 278 were male, accounting for 67.64%, and 133 were female, accounting for 32.36%. There were 286 patients with a history of hypertension, accounting for 69.59%, and 40 patients with a history of cerebral hemorrhage, accounting for 9.73%. Other specific baseline data are shown in **Table 1**.

Table 1. Descriptive analysis of count data in patients with severe basal ganglia hemorrhage

Factor	Category	Cases (%)
Gender	Male	278 (67.64)
	Female	133 (32.36)
History of hypertension	Yes	286 (69.59)
	No	125 (30.41)
History of cerebral hemorrhage	Yes	40 (9.73)
	No	371 (90.27)
History of cerebral infarction	Yes	54 (13.14)
	No	357 (86.86)
History of diabetes mellitus	Yes	36 (8.76)
	No	375 (91.24)
History of coronary heart disease	Yes	16 (3.89)
	No	395 (96.17)
History of antiplatelet drug use	Yes	65 (15.82)
	No	346 (84.18)
Smoking history	Yes	124 (30.17)
	No	287 (69.83)
Drinking history	Yes	166 (40.39)
	No	245 (59.61)
Secondary ventricular hemorrhage	Yes	192 (46.71)
	No	219 (53.28)
Endotracheal intubation	Yes	193 (46.96)
	No	218 (53.04)
Tracheotomy	Yes	58 (14.11)
	No	353 (85.89)
Mechanical ventilation	Yes	96 (23.36)
	No	315 (76.64)

3.2. Univariate analysis of prognosis in the two groups

As shown in **Table 2**, there were statistically significant differences between the two groups in the following factors (all $p < 0.05$): age, history of cerebral infarction, history of diabetes mellitus, history of coronary heart disease, antiplatelet drug use, drinking history, admission GCS score, time from onset to surgery, preoperative hematoma volume, duration of intracranial drainage tube placement, length of ICU stay, admission random blood glucose level, secondary ventricular hemorrhage, and performance of endotracheal intubation, tracheotomy, or mechanical ventilation during hospitalization. These factors were identified as univariate factors influencing patient prognosis.

Table 2. Comparison of general clinical data between the two groups

Variable		Good prognosis group (n = 187)	Poor prognosis group (n = 224)	t/ χ^2	p
Age (years)		51.30 (42.54, 57.65)	61.00 (51.00, 70.00)	12.154	< 0.001
Gender	Male	119	159	3.241	0.072
	Female	68	65		
History of hypertension	No	52	73	0.864	0.353
	Yes	135	151		
History of cerebral hemorrhage	No	19	21	0.053	0.818
	Yes	168	203		
History of cerebral infarction	No	149	208	14.414	< 0.001
	Yes	38	16		
History of diabetes mellitus	No	161	214	12.303	< 0.001
	Yes	26	10		
History of coronary heart disease	No	175	220	4.193	0.041
	Yes	12	4		
Antiplatelet drug use	No	145	201	7.963	0.005
	Yes	42	23		
Smoking history	No	128	159	0.193	0.660
	Yes	59	65		
Drinking history	No	123	122	6.044	0.014
	Yes	64	102		
Admission GCS score (points)		9 (8,10)	6 (5,7)	-10.657	< 0.001
Time from onset to surgery (h)		26.00 (17.85,40.54)	17 (5.33,28.60)	-7.451	< 0.001
Preoperative hematoma volume (mL)		31.62 (23.50,41.33)	48.65 (32.60,74.58)	-8.848	< 0.001
Hematoma evacuation rate (%)		85.62 (74.30,94.10)	89.74 (75.33,94.28)	-0.801a	0.419
Duration of drainage tube placement (d)		2 (1,3)	3 (2,4)	-6.488	< 0.001
Length of ICU stay (d)		33 (3,5)	5 (4,9)	-4.736	< 0.001
Random blood glucose (mmol/L)		9 (8,10)	6 (5,7)	-10.540	< 0.001
Secondary ventricular hemorrhage	No	68	151	34.785	< 0.001
Endotracheal intubation	Yes	119	73	19.055	< 0.001
	No	63	155		
Tracheotomy	Yes	124	69	6.767	0.009
	No	142	211		
Mechanical ventilation	Yes	45	13	15.024	< 0.001
	No	115	200		

3.3. Multivariate logistic regression analysis

Variables including age, gender, history of cerebral infarction, history of diabetes mellitus, antiplatelet drug use, drinking history, admission GCS score, time from onset to surgery, preoperative hematoma volume, duration of intracranial drainage tube placement, length of ICU stay, admission random blood glucose level, secondary ventricular hemorrhage, and performance of endotracheal intubation, tracheotomy, or mechanical ventilation during hospitalization were assigned values and subjected to multivariate Logistic regression analysis. The results showed that age, admission GCS score, preoperative hematoma volume, random blood glucose level, and mechanical ventilation were independent influencing factors for the prognosis of patients with severe basal ganglia hemorrhage (all $p < 0.05$). Among them, admission GCS score was an independent protective factor, while age, preoperative hematoma volume, random blood glucose level, and mechanical ventilation during hospitalization were independent risk factors. Details are shown in **Table 3**.

Table 3. Multivariate logistic regression analysis of prognostic factors in patients with severe cerebral hemorrhage

Variable	B value	SE value	value	<i>p</i> value	OR value	95%CI
Age	0.088	0.010	80.016	< 0.001*	1.092	1.071–1.113
Admission GCS score	-0.174	0.043	16.156	< 0.001*	0.840	0.772–0.915
Preoperative hematoma volume	0.016	0.005	11.211	0.001*	1.016	1.007–1.025
Random blood glucose	0.080	0.038	4.442	0.035*	1.083	1.006–1.167
Mechanical ventilation	0.969	0.305	10.078	0.002*	2.635	1.449–4.793

Note: * indicates $p < 0.05$.

4. Discussion

Severe basal ganglia hemorrhage is a cerebrovascular disease characterized by massive bleeding in the basal ganglia region, with high disability and mortality rates^[5]. The etiology of severe basal ganglia hemorrhage is complex, and hypertension is the most important risk factor^[6]. This disease has an acute onset and rapid progression, leading to neurological deficits in patients and endangering their lives. Traditional treatment methods include conservative treatment and craniotomy. However, conservative treatment is difficult to effectively remove hematomas and reduce intracranial pressure, while craniotomy may cause secondary damage due to large trauma and difficult hemostasis, affecting patient prognosis. Therefore, finding a minimally invasive, precise, and effective treatment method has become the focus of clinical research^[7].

Frameless stereotactic soft-channel intracranial hematoma evacuation is a minimally invasive surgical method based on modern imaging technology and stereotactic principles^[8]. Through preoperative CT scanning, this technology accurately locates the hematoma. Combined with the “four lines and three points” positioning method, the puncture site and path are determined. During the operation, a soft-channel drainage catheter is inserted along the long axis of the hematoma to gradually aspirate the hematoma, and urokinase is used for liquefaction and drainage to achieve precise hematoma removal^[9]. Compared with traditional craniotomy, this technology has good minimally invasive characteristics: it only requires local anesthesia and a small scalp incision, avoids extensive skull opening and brain tissue exposure, and significantly reduces surgical trauma and bleeding risk. It has high precision: stereotactic technology enables precise positioning and puncture of the hematoma, minimizing damage to surrounding brain tissue and protecting neurological function^[10]. It also promotes rapid recovery: patients have

a short recovery time after surgery and a low incidence of complications, making it suitable for elderly patients or those with multiple underlying diseases ^[11].

In this study, multivariate Logistic regression analysis showed that admission GCS score was an independent protective factor for the prognosis of patients with severe basal ganglia hemorrhage, while age, preoperative hematoma volume, random blood glucose level, and mechanical ventilation were independent risk factors ^[12]. This result is consistent with previous studies, suggesting that the early neurological status (GCS score) has a key impact on prognosis. Advanced age, massive bleeding, hyperglycemia, and mechanical ventilation may worsen prognosis by aggravating cerebral edema and secondary infection ^[13].

Combined with the results of univariate analysis, there were significant differences ($p < 0.05$) between the good prognosis group and the poor prognosis group in indicators such as age, history of cerebral infarction, history of diabetes mellitus, admission GCS score, and preoperative hematoma volume. This further emphasizes the importance of early intervention and hematoma control. In addition, as an independent risk factor, mechanical ventilation may be associated with complications such as ventilator-associated pneumonia and atelectasis, indicating that clinical practice needs to strictly grasp the indications for mechanical ventilation and strengthen respiratory tract management ^[14].

This study also found that there was no significant difference in hematoma evacuation rate between the two groups, but the good prognosis group had a shorter duration of drainage tube placement and ICU stay ($p < 0.001$). Therefore, in clinical practice, it is necessary to comprehensively evaluate patients' conditions and formulate individualized treatment plans: for elderly patients, those with massive bleeding, or those with hyperglycemia, perioperative monitoring should be strengthened, blood glucose management optimized, and the necessity of mechanical ventilation carefully evaluated; at the same time, through precise surgical operations and early postoperative rehabilitation intervention, the prognosis of patients should be improved to the greatest extent ^[15].

5. Conclusion

In conclusion, frameless stereotactic soft-channel intracranial hematoma evacuation has a significant therapeutic effect on severe basal ganglia hemorrhage, but the prognosis is affected by multiple factors. In the future, it is necessary to further explore multimodal monitoring technologies, such as intracranial pressure monitoring and cerebral oxygen saturation detection; and comprehensive intervention strategies to improve the treatment level of severe cerebral hemorrhage.

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Disclosure statement

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Research on the Correlation Between miRNA, CMTM6, and PD-L1 Expression in Gastric Cancer

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Abstract: *Objective:* To investigate the correlation between miRNA, CMTM6, and PD-L1 expression in gastric cancer, providing new therapeutic targets for immunotherapy in gastric cancer. *Methods:* This study selected gastric cancer patients who were diagnosed and treated at our hospital from October 2022 to October 2024 as the research subjects. Based on the patients' PD-L1 examination results, they were divided into a positive group and a negative group. General patient data were collected, and qPCR and WB experiments were used to detect the levels of CMTM6 and miRNA in the patients. Univariate analysis was conducted to identify factors influencing PD-L1 expression, and variables with $p < 0.05$ were included in multivariate logistic regression analysis to clarify the correlation between miRNA, CMTM6, and PD-L1 expression in gastric cancer. *Results:* A total of 118 patients were included in this study, with 75 patients in the positive group and 43 patients in the negative group. Univariate analysis revealed that TNM stage, miRNA, and CMTM6 showed statistical significance in data comparison ($p < 0.05$). These variables were then included in multivariate logistic regression analysis, which found that TNM stage (OR = 2.849, 95% CI: 2.227–3.425), miRNA (OR = 3.038, 95% CI: 2.968–3.509), and CMTM6 (OR = 3.185, 95% CI: 2.995–3.810) all exhibited a positive correlation with PD-L1 expression in gastric cancer. *Conclusion:* There is a certain correlation between miRNA, CMTM6, and PD-L1 expression in gastric cancer. As miRNA and CMTM6 levels increase, the positive rate of PD-L1 examination in patients also rises, warranting clinical attention.

Keywords: miRNA; CMTM6; Gastric cancer; PD-L1; Correlation

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1. Introduction

Gastric cancer (GC) is a clinically common type of cancer with a relatively high mortality rate and a trend of affecting younger individuals. The pathogenesis of gastric cancer is mostly attributed to *Helicobacter pylori*

infection ^[1]. In addition, high-salt diets, gastritis, and Epstein-Barr virus (EB virus) infection are also major influencing factors for gastric cancer. Although traditional chemotherapy and targeted therapy have, to a certain extent, extended the survival period of patients, the five-year survival rate for patients with advanced gastric cancer remains below 30%, and treatment efficacy is often limited due to tumor heterogeneity, drug resistance, and immune microenvironment suppression ^[2]. In recent years, immune checkpoint inhibitors targeting programmed death receptor-1 (PD-1) and its ligand (PD-L1) have achieved breakthrough progress in the treatment of gastric cancer ^[3]. However, their efficacy is highly dependent on the expression level of PD-L1 and the infiltration status of immune cells in the tumor microenvironment. As a core molecule of immunosuppression, PD-L1 expression is regulated at multiple levels, including chromatin remodeling, transcription factor activation, epigenetic modifications, and post-transcriptional regulation ^[4]. CKLF-like MARVEL transmembrane domain-containing 6 (CMTM6), a factor with a MARVEL domain, has been identified in recent years as a core positive regulator of PD-L1 expression. Studies have found that CMTM6 maintains the stability of PD-L1 on the cell membrane surface by directly binding to PD-L1 and preventing its ubiquitination-mediated degradation and lysosomal pathway degradation ^[5]. MicroRNAs (miRNAs), non-coding RNAs approximately 22 nucleotides in length, play a crucial role in tumor development and immune evasion by binding to the 3'-untranslated region (3'-UTR) of target gene mRNAs to inhibit their translation or promote their degradation ^[6]. However, the correlation between miRNAs, CMTM6, and PD-L1 expression in gastric cancer remains unclear. Based on this, this study selected gastric cancer patients who received diagnosis and treatment at our hospital from October 2022 to October 2024 as the research subjects to explore the correlation between miRNAs, CMTM6, and PD-L1 expression in gastric cancer. The specific report is as follows.

2. Materials and methods

2.1. General information

In this study, gastric cancer patients who sought diagnosis and treatment at our hospital from October 2022 to October 2024 were selected as the research subjects and divided into a positive group and a negative group based on the PD-L1 test results.

2.1.1. Inclusion criteria

- (1) Complete clinical data
- (2) Completion of the immunohistochemical examination for PD-L1 expression
- (3) Patients and their family members signed informed consent forms, indicating their voluntary participation in this study

2.1.2. Exclusion criteria

- (1) Non-primary gastric cancer
- (2) Recent receipt of other adjuvant therapies, including chemotherapy and radiotherapy
- (3) Incomplete data

2.2. Methods

In this study, immunohistochemistry was used to detect PD-L1, and based on the test results, patients were

divided into a positive group and a negative group. The specific detection steps are as follows ^[7].

(1) Dewaxing and hydration

Place the sections on a 60°C baking machine for 30 minutes to prevent detachment. Then, immerse them sequentially in xylene → absolute ethanol → 95% ethanol → 70% ethanol → distilled water

(2) Antigen retrieval

Immerse the sections in EDTA retrieval solution, heat in a pressure cooker to 121°C and maintain for 2 minutes, and then allow them to cool naturally to room temperature. After retrieval, rinse with PBS three times, each for 5 minutes

(3) Blocking

Add 3% hydrogen peroxide solution and incubate at room temperature for 10 minutes to block endogenous peroxidase activity. Rinse with PBS three times, each for 5 minutes. Add 5% goat serum or BSA and block at room temperature for 30 minutes to reduce non-specific binding

(4) Incubation

Add PD-L1 antibody and incubate overnight at 4°C or for 1 hour at 37°C. Rinse with PBS three times, each for 5 minutes

(5) Color development

Add DAB working solution and observe under a microscope until the positive signal turns brown, then stop the color development

(6) Result determination

Calculate the percentage of positive tumor cells among all tumor cells. A tumor-specific staining percentage (TSP) $\geq 1\%$ is considered positive, and $< 1\%$ is considered negative ^[7].

The independent variables selected include the patients' general information, as well as miRNA and CMTM6. The general information includes the patient's gender, age, pathological type, tumor size, and TNM stage.

2.3. Statistical methods

In this study, statistical software SPSS21.00 was utilized for data processing and calculation during data comparison. Measurement data were subjected to chi-square tests and expressed as (n, %), while count data were analyzed using *t*-tests and presented as (mean \pm standard deviation). Variables with statistical significance in univariate analysis were included in multivariate logistic analysis. A calculated result of $p < 0.05$ indicated statistical significance in differences.

3. Results

3.1. Clinical data analysis

A total of 118 patients with gastric cancer were included in this study, consisting of 61 male patients and 57 female patients, with an average age of (57.49 ± 6.58) years. Among the pathological types, there were 81 cases of adenocarcinoma and 36 cases of other types. The average tumor size was (4.85 ± 1.16) cm. In terms of TNM staging, there were 27 cases in stage I, 40 cases in stage II, and 51 cases in stage III. There were 54 cases with high expression of CMTM6 and 74 cases with low expression. Regarding miRNA expression, there were 60 cases with high expression and 58 cases with low expression, as detailed in **Table 1**.

Table 1. Results of clinical data analysis

Variable	Category	Results
Gender [n (%)]	Male	61 (51.69)
	Female	57 (48.31)
Age (years)	Mean \pm SD	57.49 \pm 6.58
Pathological type [n (%)]	Adenocarcinoma	81 (68.64)
	Other	36 (31.36)
Tumor size (cm)	Mean \pm SD	4.85 \pm 1.16
TNM stage [n (%)]	Stage I	27 (22.88)
	Stage II	40 (33.90)
	Stage III	51 (43.22)
CMTM6 expression [n (%)]	High	54 (45.76)
	Low	74 (54.24)
miRNA expression [n (%)]	High	60 (50.85)
	Low	58 (49.15)

3.2. Univariate analysis results

After immunogenomic examination, 75 cases were included in the positive group and 43 cases in the negative group. Univariate analysis revealed that TNM staging, miRNA, and CMTM6 exhibited statistical significance in data comparison ($p < 0.05$), while other variables did not show statistical significance, as shown in **Table 2**.

Table 2. Results of univariate analysis

Variable	Category	Positive group (n = 75)	Negative group (n = 43)	χ^2/t	p-value
Gender [n (%)]	Male (n = 61)	39 (52.00)	22 (51.16)	0.008	0.930
	Female (n = 57)	36 (48.00)	21 (48.84)		
Age (years)	Mean \pm SD	57.60 \pm 6.61	57.47 \pm 6.28		
Pathological type [n (%)]	Adenocarcinoma (n = 81)	50 (66.67)	31 (72.09)	0.374	0.541
	Other (n = 36)	25 (33.33)	12 (27.91)		
Tumor size (cm)	Mean \pm SD	4.87 \pm 1.16	4.85 \pm 1.15		
TNM stage [n (%)]	Stage I (n = 27)	13 (17.33)	14 (32.56)	7.434	0.006
	Stage II (n = 40)	22 (29.33)	18 (41.86)		
	Stage III (n = 51)	40 (53.33)	11 (25.58)		
CMTM6 expression [n (%)]	High (n = 54)	42 (56.00)	12 (27.91)	8.690	0.003
	Low (n = 64)	33 (44.00)	31 (72.09)		
miRNA expression [n (%)]	High (n = 60)	48 (64.00)	12 (27.91)	14.246	< 0.001
	Low (n = 58)	27 (36.00)	31 (72.09)		

3.3. Multivariate logistic analysis results

Based on the findings from univariate analysis, three variables, including TNM staging, CMTM6, and miRNA were included. Multivariate logistic analysis indicated that TNM staging (OR = 2.849, 95% CI: 2.227–3.425), miRNA (OR = 3.038, 95% CI: 2.968–3.509), and CMTM6 (OR = 3.185, 95% CI: 2.995–3.810) all demonstrated positive correlations with PD-L1 expression in gastric cancer, as detailed in **Table 3**.

Table 3. Multivariate logistics regression results analysis

Variable	β	S.E.	<i>p</i> -value	OR	95% CI
TNM stage	0.87	0.83	< 0.05	2.849	2.227–3.425
CMTM6	0.92	0.90	< 0.05	3.038	2.968–3.509
miRNA	0.96	0.94	< 0.05	3.185	2.995–3.810

4. Discussion

As an immune checkpoint molecule, PD-L1 plays a pivotal role in immune evasion in gastric cancer. Its expression levels are regulated by various factors, among which microRNAs (miRNAs) and CMTM6 have emerged as research hotspots in recent years ^[8]. Both factors influence PD-L1 expression through distinct mechanisms, thereby modulating the immune microenvironment and therapeutic response in gastric cancer. miRNAs are a class of non-coding RNAs that regulate gene expression by binding to the 3' untranslated region (3'UTR) of target gene mRNAs, inhibiting their translation or promoting their degradation. In gastric cancer, miRNA regulation of PD-L1 exhibits bidirectionality, with certain miRNAs suppressing tumor immune evasion by negatively regulating PD-L1 expression. Studies have indicated that miR-375 is significantly downregulated in gastric cancer patients with high PD-L1 expression, showing a negative correlation between the two. Mechanistically, miR-375 inhibits PD-L1 expression by targeting the JAK2/STAT3 pathway ^[9]. CMTM6, on the other hand, reduces PD-L1 ubiquitination levels, thereby decreasing its degradation via the proteasome or lysosomal pathways and prolonging its half-life. Studies have shown that CMTM6 colocalizes with PD-L1 in the cell membrane and recycling endosomes, directly interacting to form a complex that protects PD-L1 from degradation, which is generally consistent with the findings of this study ^[10].

Based on this, this paper explores the correlation between miRNAs, CMTM6, and PD-L1 expression in gastric cancer. A total of 118 gastric cancer patients were included and categorized into positive and negative groups based on PD-L1 test results. Univariate analysis revealed that TNM stage, miRNAs, and CMTM6 were statistically significant ($p < 0.05$). Variables with statistical significance in the univariate analysis were then included in a multivariate logistic regression analysis, which found positive correlations between TNM stage, miRNAs, CMTM6, and PD-L1 expression in gastric cancer.

5. Conclusion

In summary, miRNAs and CMTM6 play crucial roles in regulating PD-L1 expression in gastric cancer. Through distinct mechanisms, they synergistically influence tumor immune evasion and therapeutic response, providing novel theoretical foundations and potential targets for gastric cancer immunotherapy. Future research should

further explore the interactions between miRNAs and CMTM6 in gastric cancer and elucidate the specific molecular mechanisms underlying their regulation of PD-L1.

Disclosure statement

The authors declare no conflict of interest.

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The Therapeutic Effect of Dabuyin Wan on Male Breast Development and Its Impact on Sex Hormone Levels

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Abstract: *Objective:* To investigate the efficacy of Dabuyin Wan (Concentrated Pills) in the treatment of prepubertal gynecomastia in boys and to analyze its impact on sex hormone levels. *Methods:* A total of 100 boys with gynecomastia diagnosed and treated in our hospital from July 2022 to February 2025 were selected and randomly divided into two groups using a random number table, with 50 cases in each group. The control group received non-pharmacological treatment, while the observation group was treated with Dabuyin Wan (Concentrated Pills). Both groups continued treatment for 6 months. Clinical efficacy, TCM syndrome scores, sex hormone levels [estradiol (E2), luteinizing hormone (LH), testosterone (T), prolactin (PRL)], and adverse reactions were compared between the two groups. *Results:* The total clinical effective rate in the observation group was higher than that in the control group ($\chi^2 = 5.316$, $P < 0.05$). After treatment, the TCM syndrome score in the observation group was lower than that in the control group ($t = 15.513$, $P < 0.05$). After treatment, E2, LH, and PRL levels in the observation group were lower than those in the control group, while the T level in the observation group was higher than that in the control group ($t = 5.819, 11.000, 7.275, 9.524$, respectively; $P < 0.05$ for all). There was no significant difference in the incidence of adverse reactions between the two groups. *Conclusion:* The use of Dabuyin Wan (Concentrated Pills) for prepubertal gynecomastia in boys can improve clinical outcomes, alleviate clinical symptoms, modulate sex hormone levels, and demonstrate a favorable safety profile.

Keywords: Prepubertal gynecomastia in boys; Dabuyin Wan (Concentrated Pills); Efficacy; Sex hormones

Online publication: Dec 3, 2025

1. Introduction

Gynecomastia in boys is mainly manifested by unilateral or simultaneous bilateral breast enlargement, accompanied by enlargement of the nipple and areola, with painless or dull-aching masses palpable locally ^[1]. Currently, the clinical treatment of gynecomastia in boys primarily relies on anti-estrogen drugs, which can inhibit the secretion of estrogen in the body, reduce estrogen levels, and thereby improve the clinical symptoms of

affected children^[2]. However, long-term use of Western medications can easily lead to adverse reactions, affecting the physical health of the children. In traditional Chinese medicine, gynecomastia in boys is classified under the category of “Ruli” (a traditional Chinese medical term). It is believed that insufficient kidney Yin affects liver Yin, leading to an imbalance of Yin and Yang in the kidneys and an excess of ministerial fire. Treatment primarily focuses on nourishing Yin and reducing fire^[3]. Dabuyin Wan (Concentrated Pill) has the effects of clearing heat, reducing fire, nourishing Yin, and cooling blood. In view of this, this study aims to explore the efficacy of Dabuyin Wan (Concentrated Pill) in treating gynecomastia in boys and its impact on sex hormone levels. The report is as follows.

2. Materials and methods

2.1. General information

A total of 100 boys with gynecomastia treated at the hospital from July 2022 to February 2025 were included in the study, and the families of the children all signed informed consent forms. The children were randomly divided into two groups using a random number table method, with 50 cases in each group. The control group ranged in age from 9 to 16 years, with an average age of (11.98 ± 1.82) years; the body mass index ranged from 19.52 to 25.87 kg/m², with an average of (22.67 ± 1.46) kg/m²; the diameter of the masses ranged from 1 to 10 cm, with an average of (5.70 ± 2.13) cm; the disease duration ranged from 3 to 6 months, with an average of (4.32 ± 0.84) months; the affected side: 11 cases on the left, 10 cases on the right, and 29 cases bilaterally; breast Tanner staging^[4]: 19 cases in stage II and 31 cases in stage III. The observation group ranged in age from 9 to 16 years old, with an average age of (12.20 ± 1.55) years old; the body mass index ranged from 17.79 to 25.38 kg/m², with an average of (22.09 ± 1.50) kg/m²; the diameter of the masses ranged from 1 to 10 cm, with an average of (5.52 ± 2.07) cm; the disease duration ranged from 2 to 6 months, with an average of (4.26 ± 0.80) months; the affected side: 13 cases on the left, 12 cases on the right, and 25 cases bilaterally; breast Tanner staging: 23 cases in stage II and 27 cases in stage III. Comparison of general information between the two groups ($P > 0.05$) indicated comparability.

2.2. Inclusion criteria

Inclusion criteria: (1) Western medicine diagnostic criteria: Presence of unilateral or bilateral breast enlargement symptoms, with breast ultrasound indicating the existence of breast tissue with a diameter ≥ 0.5 cm; (2) Traditional Chinese medicine (TCM) diagnostic criteria: Conforming to kidney Yin deficiency syndrome in Modern TCM Breast Disease^[5], with primary symptoms including unilateral or bilateral breast enlargement and non-tender lumps; secondary symptoms including obesity, hot flashes, five-center heat (sensation of heat in the palms, soles, and chest), irritability, dry throat and mouth; tongue and pulse manifestations: red tongue with scanty coating, and thin and rapid pulse; (3) No prior relevant medication treatment; (4) The child is mentally clear, has good compliance, and can cooperate with this study.

Exclusion criteria: (1) Endocrine disorders such as incomplete development of secondary sexual characteristics, Hashimoto's thyroiditis, Klinefelter syndrome, and nephrotic syndrome; (2) Concomitant benign or malignant breast tumors; (3) Abnormal breast development caused by long-term oral administration of drugs such as estrogen, isoniazid, and digitalis; (4) Intolerance or allergy to the study drugs; (5) Concomitant cardiac, hepatic, or renal dysfunction.

2.3. Treatment methods

The control group received non-pharmacological treatment, including dietary and exercise management. The observation group was treated with Dabuyin Wan (concentrated pills, 3 g per bag), with each bag containing 0.65 g of prepared rehmannia root, 0.45 g of salt-fried anemarrhena rhizome, 0.45 g of salt-fried phellodendron bark, 0.65 g of processed tortoise shell, and 0.8 g of pig spinal cord. The dosage was 3 g each time, taken twice daily. Both groups received continuous treatment for 6 months.

2.4. Observation indicators

(1) Clinical efficacy

Clinical efficacy was evaluated based on Modern TCM Breast Disease. Cure: disappearance of breast lumps; Improvement: reduction of breast lumps by more than 1/2; Ineffective: no disappearance or reduction of lumps. The effective rate = cure rate + improvement rate.

(2) TCM syndrome score: Before treatment and at 6 months of treatment, the severity of symptoms such as unilateral or bilateral breast enlargement, non-tender lumps, obesity, hot flashes, five-center heat, irritability, and dry throat and mouth were quantified and assigned values as follows: no symptoms: 0 points, mild: 1 point, moderate: 2 points, severe: 3 points. Tongue and pulse manifestations were scored as 1 point for presence and 0 points for absence, with a total score ranging from 0 to 24 points.

(3) Sex hormone levels: Before treatment, at 6 months of treatment, and at other time points, 5 mL of fasting venous blood samples were collected, respectively. After centrifuging the samples for 5 minutes, the serum was obtained and tested using the chemiluminescence method, including serum estradiol (E2), luteinizing hormone (LH), testosterone (T), prolactin (PRL), etc.

(4) Adverse reactions: Record the occurrences of vomiting and diarrhea.

2.5. Statistical analysis

Data were processed using SPSS 25.0 software, with mean \pm standard deviation (SD) representing measurement data and t-tests; percentages representing count data and χ^2 tests, and rank sum tests for ordinal data. Statistical significance was set at $P < 0.05$.

3. Results

3.1. Efficacy

The efficacy in the observation group was higher than that in the control group ($P < 0.05$). See **Table 1**.

Table 1. Efficacy analysis table [$n(\%)$]

Group	Number of cases	Cured, n (%)	Improved, n (%)	Ineffective, n (%)	Effective rate, n (%)
Control group	50	13 (26.00%)	26 (52.00%)	11 (22.00%)	39 (78.00%)
Observation group	50	22 (44.00%)	25 (50.00%)	3 (6.00%)	47 (94.00%)
Statistic (Z/χ^2)	—	$Z = 2.460$			$\chi^2 = 5.316$
P -value	—	0.014			0.021

3.2. TCM syndrome scores

The syndrome scores in the observation group after treatment with Dabuyin Wan were lower than those in the control group ($P < 0.05$). See **Table 2**.

Table 2. TCM syndrome score analysis table (mean \pm SD, points)

Group	n	Before treatment (Mean \pm SD)	After treatment (Mean \pm SD)	t-value (Within-group)	P-value (Within-group)
Control group	50	13.78 \pm 1.82	9.28 \pm 1.44	13.854	< 0.001
Observation group	50	13.12 \pm 1.79	5.16 \pm 1.20	25.872	< 0.001
t-value		1.827	15.513		
P-value		0.071	<0.001		

3.3. Sex hormone level

After treatment with Dabuyin Wan, the levels of sex hormones such as E₂, LH, and PRL in the observation group were lower than those in the control group, while T was higher than that in the control group ($P < 0.05$). See **Table 3**.

Table 3. Sex hormone analysis table (mean \pm SD)

Time	Group	n	E ₂ (pmol/L)	LH (IU/L)	T (nmol/L)	PRL (ng/mL)
Before treatment	Control group	50	53.47 \pm 12.21	13.61 \pm 2.62	6.81 \pm 1.12	21.40 \pm 4.52
	Observation group	50	53.69 \pm 12.89	13.54 \pm 2.75	6.79 \pm 1.10	21.14 \pm 4.19
	t-value		0.088	0.130	0.046	0.310
	P-value		0.930	0.897	0.963	0.758
After treatment	Control group	50	43.85 \pm 10.29 ^a	7.95 \pm 0.83 ^a	8.05 \pm 1.11 ^a	17.57 \pm 3.61 ^a
	Observation group	50	31.75 \pm 10.51 ^a	6.27 \pm 0.69 ^a	10.93 \pm 1.82 ^a	12.65 \pm 3.14 ^a
	t-value		5.819	11.000	9.524	7.275
	P-value		< 0.001	< 0.001	< 0.001	< 0.001

Note: Compared with the same group before treatment, ^a $P < 0.05$

3.4. Adverse reactions

No obvious adverse reactions occurred in the control group. In the observation group, there was one case of vomiting and one case of diarrhea, resulting in a total of 2 cases (4.0%). No significant difference in the incidence of adverse reactions was observed between the two groups.

4. Discussion

The development of male breast tissue in boys is primarily associated with hormonal imbalances in the blood circulation, particularly involving sex hormones. During puberty, boys experience rapid development of male characteristics, but if their testes secrete insufficient androgens while there is relatively higher estrogen secretion in the body, estrogen can stimulate breast tissue, ultimately leading to breast development ^[6]. Tamoxifen is a commonly used medication in clinical treatment for male breast development. It belongs to the triphenylethylene

derivatives and can bind to estrogen receptors in target tissues, blocking the effects of estrogen, reducing estrogen levels, and thereby regulating the balance between estrogen and androgens, ultimately alleviating clinical symptoms in affected children ^[7]. However, the drug instructions for tamoxifen clearly state that no experiments have been conducted on its use in children, and there are no reliable references available. Additionally, long-term use can easily lead to adverse reactions, affecting the physical health of children. Therefore, it is necessary to seek safer and more effective treatment options. Traditional Chinese medicine holds that the nipple is associated with the liver, and the male breast is associated with the kidneys, indicating a close relationship between breast diseases and the liver and kidneys. Children are considered to have delicate and immature organs and qi circulation, making them prone to imbalances in Yin and Yang. The kidneys are considered the foundation of the body's innate constitution. If kidney Yin is insufficient and unable to restrain Yang, the ministerial fire will become overly vigorous, disrupting the harmony between water and fire, and leading to breast development. Therefore, treatment should primarily focus on nourishing Yin and reducing fire ^[8,9].

The results of this study show that the observation group had a higher overall clinical effectiveness rate and lower scores for traditional Chinese medicine syndromes, indicating that Dabuyin Wan (concentrated pills) has a good therapeutic effect in treating male breast development and can alleviate clinical symptoms. The reason for this may be that in Dabuyin Wan (concentrated pills), prepared rehmannia root nourishes Yin, replenishes the kidneys, and enriches essence and marrow, serving as the principal herb; anemarrhena rhizome (salt-fried) clears heat, reduces fire, nourishes Yin, and moistens dryness, while phellodendron bark (salt-fried) clears heat, dries dampness, reduces fire, and eliminates steaming heat. Together, these three herbs work synergistically to clear heat and reduce fire, serving as adjuvant herbs. Vinegar-processed tortoise shell nourishes liver Yin and kidney Yin, serving as an assistant herb; while pig spinal cord nourishes Yin, strengthens Yang, fortifies tendons and bones, serving as both an assistant and messenger herb ^[10]. When combined, these herbs work together to nourish Yin, generate fluids, clear heat, and reduce fire, thereby inhibiting breast development in children and alleviating their clinical symptoms.

T, E₂, LH, and PRL are commonly used indicators for clinical sex hormone tests. Among them, T is the primary male sex hormone, which promotes male pubertal development and inhibits breast growth. E₂, with high biological activity among estrogens, acts on breast ducts, accelerating breast hyperplasia, while stimulating the development of ducts and adjacent lobular tissues, ultimately leading to ductal elongation and even branching, thereby stimulating breast development. LH, secreted by the adenohypophysis, promotes breast growth and development. PRL, a protein hormone, facilitates the growth and development of breast tissue ^[11,12]. In male children with breast development, hyperfunction of the hypothalamic-pituitary-gonadal axis leads to decreased T levels and increased E₂, LH, and PRL levels, resulting in hormonal imbalances and premature breast development. The results of this study show that the observation group had lower E₂, LH, and PRL levels and higher T levels compared to the control group, indicating that Dabuyin Wan (concentrated pill) can improve sex hormone levels in male children with breast development. This can be attributed to the fact that the vinegar-processed tortoise shell in Dabuyin Wan (concentrated pill), composed of organic substances such as keratin and bone, has kidney-tonifying and antipyretic effects. *Rehmannia glutinosa* can enhance renal function, improve kidney Yin deficiency, and nourish the liver and kidneys. The combined use of these herbs can strengthen kidney-tonifying effects and alleviate kidney Yin deficiency in children. The total saponins of *Anemarrhena asphodeloides* in salt-processed Anemarrhena can inhibit the increase in LH levels, thereby reducing E₂ secretion and improving sex hormone levels. *Phellodendron amurense* can stimulate androgen secretion, inhibit the function of the hypothalamic-

pituitary-gonadal axis, and effectively regulate the body's hormonal and endocrine levels^[11]. Therefore, the combined use of these herbs can tonify kidney Yin deficiency, reduce hypothalamic neuronal functional activity, regulate dysfunction of the hypothalamic-pituitary-gonadal axis, and thereby improve sex hormone levels. Additionally, this study observed low incidences of adverse reactions in both groups during treatment, indicating that Dabuyin Wan (concentrated pill) has a low incidence of adverse reactions and good safety in the treatment of male children with breast development.

5. Conclusion

In summary, Dabuyin Wan (concentrated pill) can enhance the therapeutic effect on male children with breast development, alleviate clinical symptoms, improve sex hormone levels, and demonstrate high safety.

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Disclosure statement

The authors declare no conflict of interest.

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Analysis of the Efficacy of Shexiang Tongxin Dropping Pills Combined with Rosuvastatin Calcium and Clopidogrel Bisulfate Tablets in the Treatment of Phlegm-Heat and Blood Stasis Type Angina Pectoris of Coronary Heart Disease

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Abstract: *Objective:* To investigate the clinical efficacy of Shexiang Tongxin Dropping Pills combined with rosuvastatin calcium and clopidogrel bisulfate tablets in treating phlegm-heat and blood stasis type angina pectoris of coronary heart disease. *Methods:* Sixty-four patients with phlegm-heat and blood stasis type angina pectoris of coronary heart disease, hospitalized at Lin'an District Hospital of Traditional Chinese Medicine from January 2024 to April 2025, were selected and randomly divided into a control group (administered 10mg of rosuvastatin calcium and 75mg of clopidogrel bisulfate once daily) and an observation group (administered 2 Shexiang Tongxin Dropping Pills three times daily in addition to the control group's treatment regimen), with 32 patients in each group. The therapeutic effects of the two groups were compared. *Results:* After 56 days of treatment, the angina pectoris score in the observation group was significantly lower than that in the control group (4.49 ± 0.39 vs 4.88 ± 0.47 , $p < 0.05$); the Seattle Angina Questionnaire (SAQ) score indicated improvement in the frequency of angina pectoris attacks. (SAQ-AF: 71.35 ± 5.29 vs. 64.25 ± 7.55 , $p < 0.05$) and treatment satisfaction (SAQ-TS: 58.79 ± 6.22 vs. 54.16 ± 5.02 , $p < 0.05$) were more significantly improved in the observation group. The total effective rate (96.87% vs. 90.62%, $p < 0.05$) and marked effective rate (62.50% vs. 31.25%) were higher in the observation group than in the control group. The Traditional Chinese Medicine (TCM) syndrome score (4.49 ± 0.39 vs. 4.88 ± 0.47 , $p < 0.05$) and lipid index (LDL-C: 1.79 ± 0.31 vs. 1.99 ± 0.33 mmol/L, $p < 0.05$) decreased more significantly in the observation group. *Conclusion:* Shexiang Tongxin Dropping Pills combined with rosuvastatin calcium and clopidogrel bisulfate tablets demonstrated good efficacy and high safety in the treatment of phlegm-heat and blood stasis type angina pectoris associated with coronary heart disease.

Keywords: Shexiang Tongxin dropping pills; Rosuvastatin calcium; Phlegm-heat and blood stasis Type coronary heart disease; Angina pectoris

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1. Introduction

Cardiovascular disease (CVD) is currently the leading cause of health threats to residents in China. According to the “China Cardiovascular Health and Disease Report 2023”, there are approximately 330 million CVD patients in China, including 11.39 million patients with coronary heart disease (CHD), and the incidence and mortality rates continue to rise ^[1]. Recent investigations into Traditional Chinese Medicine (TCM) syndromes in coronary heart disease (CHD) have revealed an overall upward trend in the prevalence of phlegm turbidity and blood stasis, which have gradually become the primary syndrome elements in modern times. Meanwhile, heat (toxin)/heat accumulation has also emerged as a significant and noteworthy new syndrome factor ^[2,3]. Consequently, among the syndrome types of coronary heart disease angina pectoris (CHD-AP), the phlegm-heat stasis obstruction type of CHD-AP has gradually garnered clinical attention in diagnosis and treatment. The current Western medical treatment protocols for CHD-AP predominantly involve medications such as aspirin, beta-blockers, calcium antagonists, and nitrates. Although these treatments demonstrate remarkable efficacy, they are associated with numerous adverse drug reactions that impact patients’ quality of life ^[4]. Therefore, integrating traditional Chinese medicine (TCM) formulations with fewer adverse reactions and excellent efficacy represents an effective strategy for preventing and treating the phlegm-heat stasis obstruction type of CHD-AP ^[5]. Musk Heart-Activating Dripping Pills, derived from the modified Zhibao Dan formula, possess functions such as promoting blood circulation to remove blood stasis, clearing heat and detoxifying, and replenishing qi to unblock the meridians. They are widely used in the treatment of cardiac diseases and exhibit rapid efficacy ^[6]. Hence, this study aims to investigate the efficacy and long-term medication safety of Musk Heart-Activating Dripping Pills combined with rosuvastatin calcium and clopidogrel bisulfate tablets in treating the phlegm-heat stasis obstruction type of CHD-AP.

2. Materials and methods

2.1. General information

Sixty-four patients with phlegm-heat stasis obstruction type of coronary heart disease angina pectoris, hospitalized at Lin’an District Traditional Chinese Medicine Hospital from January 2024 to April 2025, were selected. These patients were randomly divided into a control group and an observation group using a random number method, with 32 patients in each group. The control group comprised 12 females and 20 males, aged between 50–76 years (63.37 ± 11.53 years); the observation group included 14 females and 18 males, aged between 47–82 years (66.03 ± 10 years).

2.1.1. Inclusion criteria

- (1) Patients meeting the diagnostic criteria for coronary heart disease angina pectoris
- (2) Patients classified as having the phlegm-heat stasis obstruction type according to TCM syndrome differentiation
- (3) Patients and their families provided informed consent for participation in this study. (The syndrome differentiation criteria refer to the “International Diagnostic Guidelines for Blood Stasis Syndrome”^[7]).

2.1.2. Exclusion criteria

- (1) Patients with diabetes and unstable blood glucose control
- (2) Patients with severe liver or kidney dysfunction

- (3) Patients with malignant tumors
- (4) Patients with mental disorders or unconsciousness
- (5) Patients with allergic reactions to medications or excipients in the treatment protocol or those with a history of allergies
- (6) Women planning pregnancy or those in the pregnancy period.

2.2. Research methods

2.2.1. General information

Sixty-four patients with CHD-AP of the Phlegm-Heat and Blood Stasis Obstruction type were randomly divided into a control group and an observation group, with 32 patients in each group, using a random number table method. Patients in the control group were administered 10 mg of rosuvastatin calcium (Zhejiang Jingxin Pharmaceutical Co., Ltd., E2310072, 10 mg) and 75 mg of clopidogrel hydrogen sulfate tablets (Shiyao Group Ouyi Pharmaceutical Co., Ltd., R10230821, 75 mg) once daily. The observation group received, in addition to the control group's treatment, 2 pills of Shexiang Tongxin Dropping Pills (Inner Mongolia Conba Pharmaceutical Co., Ltd., 230812, 35 mg per pill) three times daily. Both groups underwent a 56-day treatment course.

2.2.2. Randomization method

Random sequences were generated by an independent statistician using SAS 9.4 software (block length = 4), and the allocation scheme was sealed in opaque envelopes. After enrollment, research nurses opened the envelopes to execute the intervention allocation. Both the enrolling physicians and the participants were unaware of the grouping sequence.

2.2.3. Sample size calculation

Based on preliminary trial data (angina score difference = 0.8 ± 0.5), with $\alpha = 0.05$ and $\beta = 0.2$, 30 patients were required per group. Considering a 10% dropout rate, 32 patients were ultimately included in each group.

2.3. Observation indicators

2.3.1. Angina symptom score

Scoring was based on the frequency of angina attacks, the severity of angina, duration, the dosage of nitroglycerin used, and the rate of discontinuation or reduction; scoring was also conducted according to the Seattle Angina Questionnaire (SAQ). Observations and records were conducted once before medication, on the 28th day after medication, and on the 56th day after medication (see attached materials for relevant scoring tables).

2.3.2. Clinical efficacy

- (1) Markedly effective
Disappearance of angina pectoris and normalization of electrocardiogram (ECG)
- (2) Effective
Significant reduction and alleviation of angina pectoris attacks, with an increase in the S-T segment depression on ECG by more than 0.05 mV
- (3) Ineffective
No reduction in the frequency of angina pectoris attacks or alleviation of symptoms, with no significant

changes in ECG.

2.3.3. TCM syndrome scores

Scoring was based on the severity of primary symptoms (chest tightness, chest pain, palpitations, shortness of breath) and secondary symptoms (obesity, excessive phlegm, red face, red eyes, dark urine, tongue appearance, etc.), with observations and records conducted once before medication, on the 28th day after medication, and on the 56th day after medication (see attached materials for relevant scoring tables).

2.3.4. Blood lipid indicators

Fasting venous blood samples were collected from patients before medication, on the 28th day after medication, and on the 56th day after medication to measure the levels of total cholesterol (TC), triglycerides (TG), and low-density lipoprotein (LDL-C).

2.4. Quality control

Drug administration was carried out by cardiovascular specialist nurses, who also recorded medication compliance (control group: $98.4 \pm 1.2\%$; observation group: $97.6 \pm 1.8\%$). Non-adherence to the treatment plan was defined as missing medication for three consecutive days. In the control group, one patient reduced the dosage due to gastrointestinal reactions, while there were no cases of dosage reduction or discontinuation in the observation group.

2.5. Statistical methods

All data in this article are presented as mean \pm standard deviation ($\bar{x} \pm s$) (using SPSS 26.0 software). For continuous data conforming to a normal distribution, an independent samples *t*-test was used to determine statistical differences between groups. For non-normally distributed continuous data, the Mann-Whitney test was employed to assess statistical differences. For categorical data, the chi-square test was used, with results expressed as rates (%). A *p*-value < 0.05 indicates a statistically significant difference.

3. Experimental results

3.1. Comparison of baseline data between the two groups

Before treatment, there were no statistically significant differences in the scores for angina pectoris symptoms, standard scores on the Seattle Angina Questionnaire, Traditional Chinese Medicine (TCM) syndrome scores, or blood lipid indicators between the control group and the observation group. The results are shown in **Table 1**.

Table 1. Comparison of baseline data between the two groups before treatment ($\bar{x} \pm s$)

	Angina Symptoms	Seattle Angina questionnaire					TCM syndrome score	Lipid profile (mmol/L)		
		PL	AS	AF	TS	DP		TC	TG	LDL-C
Control group	7.09 ± 0.72	49.0 ± 4.02	47.9 ± 4.72	53.2 ± 6.88	47.6 ± 6.23	48.3 ± 10.94	7.09 ± 0.72	4.55 ± 0.58	1.63 ± 0.58	2.59 ± 0.66
Observation group	6.84 ± 1.21	49.94 ± 6.22	47.29 ± 4.51	54.39 ± 4.28	44.69 ± 7.36	48.78 ± 8.40	6.84 ± 1.21	4.45 ± 0.82	1.52 ± 0.68	2.63 ± 0.92
<i>p</i> -value	0.530	0.493	0.557	0.276	0.186	0.888	0.530	0.274	0.060	0.405

3.2. Comparison of Angina Pectoris scores

Scores were assigned and evaluated based on the angina pectoris conditions of patients with coronary heart disease-Angina Pectoris (CHD-AP). Given that the data were not normally distributed, the Mann-Whitney test was used to analyze statistical differences in the data. Upon comparing the scores between the control group and the observation group, we found no statistically significant differences among the groups before treatment, indicating a good baseline. On day 28 of treatment, the score in the observation group (5.21 ± 0.57) was slightly lower than that in the control group (5.42 ± 0.56), but the difference did not reach statistical significance ($p = 0.392$). After 56 days of treatment, the angina pectoris score in the observation group (4.49 ± 0.39) was significantly lower than that in the control group (4.88 ± 0.47), with an inter-group difference of -0.39 points (95% CI: -0.68, -0.10, $p = 0.015$). These results indicate that the combined use of Shexiang Tongxin Dripping Pills can more effectively alleviate angina pectoris symptoms, providing strong evidence for the core efficacy indicator. The results are shown in **Table 2** and **3**.

Table 2. Scores for Angina Pectoris symptoms in patients ($\bar{x} \pm s$)

Group	Before treatment	28 days	56 days
Control group	7.09 ± 0.72	5.42 ± 0.56	4.88 ± 0.47
Observation group	6.84 ± 1.21	5.21 ± 0.57	4.49 ± 0.39
<i>p</i> -value	0.530	0.392	0.015*

Table 3. Angina Pectoris scores ($\bar{x} \pm s$, Inter-group difference [95% CI])

Time point	Control group	Observation group	Between-group difference (95% CI)	<i>p</i> -value
28 Days	5.42 ± 0.56	5.21 ± 0.57	-0.21 (-0.58, 0.16)	0.392
56 Days	4.88 ± 0.47	4.49 ± 0.39	-0.39 (-0.68, -0.10)	0.015*

3.3. Comparison of the Seattle Angina questionnaire

Following the classification of the Seattle Angina Questionnaire, data were divided into five sections for separate scoring: Physical Limitation (SAQ-PL), Angina Stability (SAQ-AS), Angina Frequency (SAQ-AF), Treatment Satisfaction (SAQ-TS), and Disease Perception (SAQ-DP). The results showed that there were no statistically significant differences among the groups before treatment, indicating a good baseline. Meanwhile, we found that both the control group and the observation group demonstrated favorable therapeutic effects during the treatment period, as shown in **Table 4** and **5**. Notably, the observation group, which received additional Shexiang Tongxin Dripping Pills, exhibited more significant additional benefits across multiple dimensions

Table 4. Standard scores of the Seattle Angina questionnaire for patients ($\bar{x} \pm s$)

	Before treatment			28 days			56 days		
	Control	Observation	<i>p</i>	Control	Observation	<i>p</i>	Control	Observation	<i>p</i>
PL	49.04 ± 4.02	49.94 ± 6.22	0.493	54.42 ± 3.34	55.39 ± 7.21	0.493	57.2 ± 3.69	62.32 ± 5.77	0.000
AS	47.975 ± 4.72	47.29 ± 4.51	0.557	49.84 ± 5.37	51.42 ± 4.66	0.215	53.4 ± 2.69	58.47 ± 5.41	0.000
AF	53.21 ± 6.88	54.39 ± 4.28	0.276	59.5 ± 5.56	64.92 ± 4.03	0.001	64.25 ± 7.55	71.35 ± 5.29	0.003
TS	47.65 ± 6.23	44.69 ± 7.36	0.186	49.78 ± 5.15	53.03 ± 6.56	0.017	54.16 ± 5.02	58.79 ± 6.22	0.002
DP	48.34 ± 10.94	48.78 ± 8.40	0.888	52.21 ± 7.65	54.16 ± 7.00	0.200	56.26 ± 8.41	61.51 ± 6.81	0.009

Table 5. Standard scores of the Seattle Angina questionnaire ($\bar{x} \pm s$ Inter-group differences [95% CI])

Domain	Time point	Control group	Observation group	Between-group difference (95% CI)	<i>p</i> -value
SAQ-PL	28 Days	54.42 ± 3.34	55.39 ± 7.21	0.97 (-1.98, 3.92)	0.493
	56 Days	57.20 ± 3.69	62.32 ± 5.77	5.12 (3.21, 7.03)	< 0.001
SAQ-AS	28 Days	49.84 ± 5.37	51.42 ± 4.66	1.58 (-1.05, 4.21)	0.215
	56 Days	53.40 ± 2.69	58.47 ± 5.41	5.07 (3.15, 6.99)	< 0.001
SAQ-AF	28 Days	59.50 ± 5.56	64.92 ± 4.03	5.42 (3.15, 7.69)	0.001
	56 Days	64.25 ± 7.55	71.35 ± 5.29	7.10 (4.02, 10.18)	0.003
SAQ-TS	28 Days	49.78 ± 5.15	53.03 ± 6.56	3.25 (0.58, 5.92)	0.017
	56 Days	54.16 ± 5.02	58.79 ± 6.22	4.63 (1.89, 7.37)	0.002
SAQ-DP	28 Days	52.21 ± 7.65	54.16 ± 7.00	1.95 (-1.20, 5.10)	0.200
	56 Days	56.26 ± 8.41	61.51 ± 6.81	5.25 (1.89, 8.61)	0.009

3.3.1. Angina frequency (SAQ-AF)

At 28 days of treatment, the observation group's score (64.92 ± 4.03) was significantly higher than that of the control group (59.50 ± 5.56), with a between-group difference of +5.42 points (95% CI: 3.15, 7.69, $p = 0.001$). This advantage further widened at 56 days of treatment, with the observation group's score (71.35 ± 5.29) exceeding that of the control group (64.25 ± 7.55) by +7.10 points (95% CI: 4.02, 10.18, $p = 0.003$), indicating that Shexiang Tongxin Dropping Pills more effectively reduced the frequency of angina attacks.

3.3.2. Treatment satisfaction (SAQ-TS)

At 28 days of treatment, the observation group's satisfaction score (53.03 ± 6.56) was already significantly higher than that of the control group (49.78 ± 5.15), with a between-group difference of +3.25 points (95% CI: 0.58, 5.92, $p = 0.017$). By 56 days of treatment, the observation group's score (58.79 ± 6.22) continued to significantly outperform that of the control group (54.16 ± 5.02), with a difference of +4.63 points (95% CI: 1.89, 7.37, $p = 0.002$), suggesting that the combination of Shexiang Tongxin Dropping Pills significantly enhanced patients' satisfaction with the treatment.

3.3.3. Other dimensions

At 56 days of treatment, the observation group also scored significantly better than the control group in three dimensions: Physical Limitation (SAQ-PL), Angina Stability (SAQ-AS), and Disease Perception (SAQ-DP) (all $p < 0.01$, see **Table 5**). In summary, the combined use of Shexiang Tongxin Dropping Pills provided comprehensive benefits beyond those of conventional Western medicine treatments in improving patients' quality of life related to angina, particularly in reducing the frequency of angina attacks and enhancing treatment satisfaction.

3.4. Comparison of clinical efficacy

Electrocardiogram (ECG) tests were conducted on patients on the 28th and 56th days after medication administration. The results were treated as ordinal data and analyzed using an appropriate test. The results showed that on the 28th day of treatment, the total effective rate in the observation group (84.37%) was higher than that in the control group (78.13%), but the difference did not reach statistical significance ($p = 0.641$).

After 56 days of treatment, the observation group, which received additional Shexiang Tongxin Dropping Pills, exhibited significantly superior clinical efficacy. This indicates that as the treatment duration extended, the clinical advantages of the combined Shexiang Tongxin Dropping Pills regimen became fully apparent, significantly improving both the marked effective rate and the overall treatment effective rate in patients (**Table 6**).

Table 6. Comparison of clinical efficacy in patients (n, %)

	28 days				56 days			
	Markedly effective	Effective	Ineffective	Total effective rate	Markedly effective	Effective	Ineffective	Total effective rate
Control	7	18	7	25 (78.13%)	10	19	3	29 (90.62%)
Observation	10	17	5	27 (84.37%)	20	11	1	31 (96.87%)
χ^2				0.891				6.467
p				0.641				0.039

3.5. Comparison of Traditional Chinese medicine (TCM) syndrome scores

Prior to patient enrollment, we conducted TCM syndrome assessments and scored them. The results showed no statistically significant difference in TCM syndrome scores between the two groups ($p = 0.53$), indicating that the data were comparable. On the 28th day of treatment, the TCM syndrome score in the observation group (5.21 ± 0.57) was lower than that in the control group (5.42 ± 0.56), but the difference did not reach statistical significance ($p = 0.392$). On the 56th day of treatment, the TCM syndrome score in the observation group (4.49 ± 0.39) was significantly lower than that in the control group (4.88 ± 0.47), with a statistically significant difference ($p = 0.015$). This suggests that the addition of Shexiang Tongxin Dropping Pills had an additive effect compared to conventional treatment for CHD-AP with phlegm-heat stasis obstruction, more effectively improving the primary symptoms (such as chest tightness and chest pain) and secondary symptoms (such as obesity, heavy limbs, and excessive phlegm) in patients with this condition. This demonstrates the therapeutic advantages of Shexiang Tongxin Dropping Pills in addressing the relevant TCM pathogenic mechanisms (phlegm, heat, and stasis) (**Table 7** and **8**).

Table 7. TCM syndrome scores in patients

	Control	Observation	p
Before treatment	7.09 ± 0.72	6.84 ± 1.21	0.530
28 days	5.42 ± 0.56	5.21 ± 0.57	0.392
56 days	4.88 ± 0.47	4.49 ± 0.39	0.015

Table 8. TCM syndrome scores ($\bar{x} \pm s$, Inter-group differences [95% CI])

Time point	Control	Observation	Between-group difference (95%CI)	p-value
Before treatment	7.09 ± 0.72	6.84 ± 1.21	-0.25(-0.82,0.32)	0.530
28 days	5.42 ± 0.56	5.21 ± 0.57	-0.21(-0.58,0.16)	0.392
56 days	4.88 ± 0.47	4.49 ± 0.39	-0.39(-0.68,-0.10)	0.015

3.6. Comparison of blood lipid indicators

Before receiving treatment, there were no statistically significant differences in the levels of blood TC, TG, and LDL-C between the two groups of patients, indicating comparability. At 28 days of treatment, the TC and TG levels in the observation group were superior to those in the control group ($p < 0.05$), but the LDL-C level did not reach statistical significance ($p = 0.217$). At 56 days of treatment, the levels of TC, TG, and LDL-C in the observation group were significantly lower than those in the control group, with statistical significance ($p < 0.05$). This indicates that Shexiang Tongxin Dropping Pills have a good ability to reduce blood lipids and demonstrate better efficacy when added to conventional treatment (Table 9 and 10).

Table 9. Comparison of blood lipid indicators in patients (mmol/L) ($\bar{x} \pm s$)

	Before treatment			28 days			56 days		
	Control	Observation	p	Control	Observation	p	Control	Observation	p
TC	4.55 \pm 0.58	4.45 \pm 0.82	0.274	4.05 \pm 0.25	3.82 \pm 0.22	0.004	3.87 \pm 0.44	3.53 \pm 0.26	0.000
TG	1.63 \pm 0.58	1.52 \pm 0.68	0.06	1.34 \pm 0.26	1.13 \pm 0.31	0.000	1.06 \pm 0.25	0.83 \pm 0.33	0.000
LDL-C	2.59 \pm 0.66	2.63 \pm 0.92	0.405	2.15 \pm 0.37	2.07 \pm 0.31	0.217	1.99 \pm 0.33	1.79 \pm 0.31	0.011

Table 10. Changes in blood lipid indicators ($\bar{x} \pm s$, 95%CI)

Indicator	Time point	Control group	Observation group	Between-group difference (95% CI)	p-value
LDL-C	28 days	2.15 \pm 0.37	2.07 \pm 0.31	-0.08 (-0.25, 0.09)	0.217
	56 days	1.99 \pm 0.33	1.79 \pm 0.31	-0.20 (-0.35, -0.05)	0.011
TC	28 days	4.05 \pm 0.25	3.82 \pm 0.22	-0.23 (-0.35, -0.11)	0.004
	56 days	3.87 \pm 0.44	3.53 \pm 0.26	-0.34 (-0.52, -0.16)	< 0.001
TG	28 days	1.34 \pm 0.26	1.13 \pm 0.31	-0.21 (-0.35, -0.07)	< 0.001
	56 days	1.06 \pm 0.25	0.83 \pm 0.33	-0.23 (-0.38, -0.08)	< 0.001

3.7. Evaluation of safety indicators and adverse reactions

The longitudinal changes in serum safety indicators (ALT, AST, and SCR) for both the control and observation groups are detailed in Table 11. At all measured time points (28 days and 56 days), no statistically significant differences were observed between the two groups, as indicated by all p -values being greater than 0.05. The point estimates for the inter-group differences and their 95% confidence intervals consistently crossed zero for all indicators, further supporting the lack of a significant treatment effect. Overall, these results suggest that the intervention had no notable impact on liver function (ALT, AST) or renal function (SCR) compared to the control.

Table 11. Changes in serum safety indicators ($\bar{x} \pm s$, 95%CI)

Indicator	Time point	Control group	Observation group	Between-group difference (95% CI)	p-value
ALT	28 days	27.87 \pm 8.62	26.40 \pm 8.01	-1.47 (-5.63, 2.69)	0.483
	56 days	23.44 \pm 6.04	22.43 \pm 6.53	-1.01 (-4.15, 2.15)	0.527
AST	28 days	29.43 \pm 8.30	26.69 \pm 5.92	-2.74 (-6.35, 0.85)	0.132
	56 days	26.06 \pm 5.50	23.84 \pm 5.13	-2.22 (-4.88, 0.44)	0.100
SCR	28 days	75.50 \pm 12.64	71.75 \pm 14.09	-3.75 (-10.44, 2.94)	0.267
	56 days	77.80 \pm 13.44	67.28 \pm 13.33	-3.66 (-9.68, 2.37)	0.230

4. Discussion

Traditional Chinese medicine theory considers coronary heart disease (CHD) as “chest obstruction” and “heart pain,” characterized by a deficiency in essence and an excess in manifestation. The deficiency in essence refers to the deficiency of qi and blood, while the external manifestation is obstruction of the meridians. The excess in manifestation is mainly characterized by blood stasis, cold coagulation, and phlegm turbidity, with heat accumulation being more prevalent than cold coagulation^[8]. Modern research has found that heat toxicity is an important pathogenetic mechanism of CHD and is interconnected with the progression of inflammation in the body^[9]. Studies have shown that inflammatory reactions can promote thrombus formation, leading to incomplete or complete vascular occlusion and subsequently triggering coronary heart disease^[10,11]. This study, through a randomized controlled trial, confirms that the addition of Shexiang Tongxin Dropping Pills to the standard treatment regimen of rosuvastatin calcium combined with clopidogrel bisulfate can improve the clinical symptoms and blood lipid levels of patients with phlegm-heat stasis-type coronary heart disease angina pectoris (CHD-AP) at both 28 days and 56 days, with more significant effects observed at 56 days.

Rosuvastatin calcium and clopidogrel bisulfate are first-line drugs for the clinical treatment of CHD-AP. Their combined use can not only reduce blood lipids but also decrease thrombus formation and the rupture of atherosclerotic plaques^[12,13]. However, while reducing blood lipids, rosuvastatin calcium can also cause adverse reactions such as gastrointestinal reactions and musculoskeletal system abnormalities. Meanwhile, clopidogrel hydrogen sulfate increases the risk of bleeding. Shexiang Tongxin Dropping Pills are composed of artificial musk, total ginsenosides from ginseng stems and leaves, venom of toad, salvia miltiorrhiza, artificial cow-bezoar, bear bile powder, and borneol. They are rich in various active ingredients such as esters of bufogenin, salvianolic acid B, and ginsenoside Rg1, which can significantly improve the symptoms of CHD^[14,15].

In this study, after treatment with Shexiang Tongxin Dropping Pills, the TCM syndrome scores in the observation group significantly decreased, and the main symptoms such as chest pain and chest tightness were alleviated, further demonstrating the effects of Shexiang Tongxin Dropping Pills in promoting blood circulation to remove blood stasis and clearing heat and detoxifying. Additionally, SAQ data showed that the observation group exhibited significantly better improvements in dimensions such as SAQ-AF and SAQ-TS compared to the control group ($p < 0.01$), suggesting that the inclusion of Shexiang Tongxin Dropping Pills may be related to inhibiting platelet activation and regulating vascular endothelial function. At 56 days of treatment, the reductions in TC, TG, and LDL-C were significantly better in the observation group than in the control group ($p < 0.05$), indicating that Shexiang Tongxin Dropping Pills may enhance the lipid-lowering effects of rosuvastatin calcium through pathways such as regulating lipid metabolism enzyme activity or bile acid excretion^[16,17]. In summary, Shexiang Tongxin Dropping Pills can enhance the therapeutic effects of rosuvastatin calcium and clopidogrel hydrogen sulfate in treating CHD-AP.

As a single-center exploratory trial, this study has certain limitations, such as a limited sample size, no assessment of long-term effects (including the incidence of major adverse cardiovascular events), and no multi-center validation. Therefore, further multi-center, large-sample, and long-term follow-up studies are needed to confirm these results.

5. Conclusion

Based on the results of this study, the treatment regimen combining Shexiang Tongxin Dropping Pills with

rosuvastatin calcium and clopidogrel hydrogen sulfate is a viable option for treating CHD-AP of the phlegm-heat and blood stasis obstruction type. However, it is essential to strictly monitor the initial indicators and liver and kidney safety indicators of patients and to refine medication guidelines through high-quality evidence-based research to promote precise treatment for preventing and treating coronary heart disease angina through the integration of traditional Chinese and Western medicine.

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Disclosure statement

The authors declare no conflict of interest.

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The Value of the Knowledge-Attitude-Practice Health Education Model in Enhancing the Coping Ability of Caregivers of Children with Febrile Seizures

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Abstract: *Objective:* To analyze the impact of the Knowledge-Attitude-Practice (KAP) health education model on the coping ability of caregivers of children with febrile seizures. *Methods:* A total of 60 caregivers of children with febrile seizures admitted to our hospital from May 2024 to April 2025 were selected and randomly divided into a control group (receiving conventional health education) and a research group (receiving the KAP health education model). The health knowledge mastery, coping ability, anxiety levels, recurrence rates of the children, and caregiver satisfaction were compared between the two groups. *Results:* The research group demonstrated higher scores in health knowledge mastery and coping ability, lower scores in anxiety and depression, a lower recurrence rate of febrile seizures in children, and higher caregiver satisfaction compared to the control group ($p < 0.05$). *Conclusion:* The KAP health education model can effectively enhance the coping ability of caregivers of children with febrile seizures, alleviate their anxiety, reduce the recurrence rate of febrile seizures in children, and improve caregiver satisfaction. It is worthy of clinical promotion and application.

Keywords: Knowledge-attitude-practice health education model; Children with febrile seizures; Caregivers; Coping ability

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1. Introduction

Febrile seizures are one of the common pediatric emergencies, mostly occurring in children aged 6 months to 5 years, with an incidence rate of approximately 2–5%. During a febrile seizure, the child may suddenly experience symptoms such as generalized or localized muscle convulsions and loss of consciousness, which seriously affect the child's physical health and growth and development, while also imposing significant psychological stress and burden on caregivers^[1]. As the primary caregivers responsible for the daily lives of pediatric patients,

the coping abilities of caregivers directly influence the disease control and rehabilitation outcomes of these children. However, due to a lack of relevant medical knowledge and coping experience, most caregivers tend to panic and fail to take correct measures when faced with febrile seizures in children, thereby delaying treatment^[2]. Traditional health education models predominantly rely on one-way knowledge dissemination, lacking specificity and interactivity. Caregivers often passively receive information and find it difficult to truly translate learned knowledge into practical actions. In contrast, the Knowledge-Attitude-Practice (KAP) health education model is a cognitive, attitudinal, and behavioral change-based approach that emphasizes imparting knowledge, fostering beliefs, and guiding behaviors to help caregivers establish correct health concepts and behavioral habits, thereby enhancing their coping abilities. The KAP health education model has demonstrated significant effects in improving the coping abilities of caregivers for children with febrile seizures. This model enables caregivers to acquire systematic knowledge about febrile seizures, understand their causes, symptoms, and potential risks, and correct previous misconceptions^[3]. On this basis, it helps caregivers establish correct health beliefs, prompting them to prioritize daily prevention and correct handling during seizure episodes. With the support of knowledge and beliefs, caregivers can put correct coping methods into action, such as accurately measuring body temperature, adopting reasonable cooling measures, remaining calm during seizures, and performing proper first aid, thereby effectively enhancing their ability to manage children with febrile seizures^[4]. This study aims to explore the application effectiveness of the KAP health education model in improving the coping abilities of caregivers for children with febrile seizures, with the following content:

2. Materials and methods

2.1. General information

The trial period was set from May 2024 to April 2025. The selected subjects were caregivers of 60 pediatric patients with febrile seizures, randomly divided into two groups of 30 each. In the control group, there were 8 male caregivers and 22 female caregivers; the youngest was 22 years old, and the oldest was 45 years old, with an average age of (32.14 ± 3.05) years; Relationship with the child: 25 parents, 5 grandparents; in the research group, there were 9 males and 21 females; aged between 23 and 47 years old, with an average age of (32.06 ± 3.07) years; relationship with the child: 26 parents, 4 grandparents.

2.1.1. Inclusion criteria

All caregivers of children with febrile seizures; understanding the purpose of this study and signing the consent form.

2.1.2. Exclusion criteria

Individuals without medical records; caregivers with concurrent organic, mental, infectious, chronic, or other severe illnesses. There were no significant differences in the above data between the two groups ($p > 0.05$).

2.2. Methods

The control group received the conventional health education model. After the child was admitted to the hospital, the responsible nurse provided the caregivers with brochures on febrile seizures and conducted a centralized health education lecture for them. The content included the definition, causes, symptoms, and emergency treatment

methods of febrile seizures. During the child's hospitalization, the responsible nurse regularly provided oral health education to the caregivers and answered their questions. The research group adopted the Knowledge-Attitude-Practice (KAP) health education model, with the following specific content.

2.2.1. Knowledge dissemination phase

(1) Develop personalized education plans

After the child's admission, the responsible nurse communicated with the caregivers to understand their educational background, knowledge level, psychological state, etc., and formulated personalized health education plans.

(2) Diversified education methods

Various educational methods were used to impart knowledge about febrile seizures to the caregivers, such as distributing brochures, holding special lectures, playing video materials, and providing one-on-one explanations. The brochure content included the causes, symptoms, emergency treatment methods, and preventive measures of febrile seizures; special lectures invited pediatric experts to teach and explain in detail the pathogenesis and treatment principles of febrile seizures; video materials demonstrated the correct handling methods during febrile seizure episodes and key points of daily care; one-on-one explanations answered the caregivers' questions based on their individual needs.

2.2.2. Belief-building phase

(1) Case sharing

Organize caregivers to participate in case-sharing sessions, inviting caregivers who had previously cared for children with febrile seizures and handled them well to share their experiences, so that caregivers could understand that correct responses and care can effectively reduce the recurrence rate in children and enhance their confidence.

(2) Psychological support

The responsible nurse closely monitors the psychological state of caregivers, promptly identifies negative emotions such as anxiety and fear, and provides psychological support and counseling. Through communication and interaction with caregivers, the nurse helps alleviate their psychological stress and establish correct health beliefs.

2.2.3. Behavioral guidance phase

(1) Simulation exercises

Organize caregivers to participate in simulated exercises of febrile convulsions, allowing them to personally experience and operate in simulated scenarios, thereby mastering correct first-aid methods and nursing skills. After the exercises, the responsible nurse evaluates and guides the caregivers' operations, promptly correcting any errors.

(2) Regular follow-ups

After the child is discharged from the hospital, the responsible nurse conducts regular follow-ups with the caregivers to understand their nursing situation and the child's condition, providing targeted guidance and suggestions. At the same time, the nurse encourages caregivers to develop good nursing habits in their daily lives, such as regularly measuring body temperature, maintaining a reasonable diet, and engaging in

appropriate exercise.

2.3. Observation indicators

(1) Mastery of health knowledge

A self-designed questionnaire is used to survey caregivers in both groups before the child's discharge. The questionnaire covers aspects such as etiology, symptoms, first-aid methods, and preventive measures, with a total score of 100 points. Higher scores are preferable.

(2) Coping ability

A self-compiled questionnaire is used to assess coping knowledge, coping skills, and coping attitudes, with a total score of 100 points. Higher scores indicate stronger coping abilities among caregivers.

(3) Anxiety

The Self-Rating Anxiety Scale (SAS) and the Self-Rating Depression Scale (SDS) are used to survey caregivers upon the child's admission and before discharge. The scales consist of 20 items, each rated on a 4-point scale, with a total score range of 20–80 points. Higher scores indicate more severe anxiety among caregivers.

(4) Caregiver satisfaction

A self-designed questionnaire is used to evaluate satisfaction with aspects such as the content and methods of health education, as well as the service attitude of medical staff. The total score is 100 points, divided into three levels: very satisfied (80–100 points), satisfied (60–79 points), and dissatisfied (< 60 points).

2.4. Statistical analysis

Data were processed using SPSS 26.0 software. Measurements and counts were expressed as $\bar{x} \pm s$ and (n, %), respectively. Differences were assessed using t , χ^2 ; A p -value of less than 0.05 was considered statistically significant.

3. Results

3.1. Analysis of health knowledge mastery and coping ability of caregivers in the study group and control group

After nursing intervention, the scores for health knowledge mastery and coping ability among caregivers in the study group were higher than those in the control group, with a statistically significant difference ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of knowledge mastery and coping ability between the two groups ($\bar{x} \pm s$, points)

Group	n	Knowledge mastery	Coping ability
Study group	30	85.17 \pm 3.02	88.11 \pm 3.52
Control group	30	67.41 \pm 2.96	71.04 \pm 3.09
t -value	/	23.003	19.961
p -value	/	0.000	0.000

3.2. Assessment of anxiety levels among caregivers in the study group and control group

The SAS scores of caregivers in the study group were lower than those in the control group after nursing intervention, with a statistically significant difference ($p < 0.05$), as shown in **Table 2**.

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

Group	n	SAS		SDS	
		Before care	After care	Before care	After care
Study group	30	52.14 \pm 4.60	35.14 \pm 3.06	68.54 \pm 7.51	32.31 \pm 4.33
Control group	30	51.51 \pm 4.75	48.22 \pm 3.92	68.26 \pm 7.38	43.26 \pm 5.54
<i>t</i> -value	/	0.521	14.406	0.193	11.388
<i>p</i> -value	/	0.603	0.000	0.846	0.000

3.3. Evaluation of recurrence rates in pediatric patients in the study group and control group

The recurrence rate in the study group was lower than that in the control group, with a statistically significant difference ($p < 0.05$), as shown in **Table 3**.

Table 3. Comparison of recurrence rates between the two groups (n, %)

Group	n	Recurrence cases	Rate (%)
Study group	30	2	6.67
Control group	30	8	26.67
χ^2	/		4.320
<i>p</i> -value	/		0.038

3.4. Assessment of caregiver satisfaction in the study group and control group

After nursing intervention, the satisfaction scores in the study group were higher than those in the control group, with a statistically significant difference ($p < 0.05$), as shown in **Table 4**.

Table 4. Comparison of satisfaction levels between the two groups (n, %)

Group	n	Very satisfied	Satisfied	Dissatisfied	Total satisfaction rate
Study group	30	18 (60.00)	10 (33.33)	2 (6.67)	28 (93.33)
Control group	30	10 (33.33)	12 (40.00)	8 (26.67)	22 (73.33)
χ^2	/	/	/	/	4.320
<i>p</i> -value	/	/	/	/	0.038

4. Discussion

Febrile seizures are one of the common neurological disorders in pediatrics, characterized by acute onset and rapid progression. The pathogenesis of febrile seizures is not yet fully understood, but it is generally believed to be related to factors such as incomplete development of the nervous system in children, genetic predisposition,

and infections. The onset of febrile seizures not only causes certain damage to the child's brain but may also lead to sequelae such as epilepsy, seriously affecting the child's physical and mental health and quality of life ^[5]. According to statistics, approximately 30–40% of children with febrile seizures experience recurrence, imposing significant psychological stress and economic burdens on caregivers. As the primary caregivers in the child's daily life, caregivers play a crucial role in observing the child's condition, providing nursing care, and facilitating rehabilitation. The caregiver's ability to respond directly relates to whether the child receives timely and effective treatment during febrile seizures and whether seizures can be prevented from recurring ^[6]. However, because most caregivers lack relevant medical knowledge and coping experience, they often panic when faced with a child's febrile seizure and fail to implement timely response measures, thereby delaying treatment. Therefore, improving caregivers' ability to respond is of great significance for improving the prognosis of children.

Traditional health education models primarily rely on one-way dissemination of knowledge, lacking specificity and interactivity. Under this model, healthcare professionals often simply impart basic knowledge and nursing methods about febrile seizures to caregivers, who tend to passively receive information and find it difficult to truly translate the learned knowledge into practical behavior ^[7]. Moreover, traditional health education models often overlook caregivers' psychological needs and belief changes, making it difficult to stimulate caregivers' enthusiasm and initiative for learning, thereby affecting the effectiveness of health education. The Knowledge-Attitude-Practice (KAP) health education model is a health education approach based on cognitive, attitudinal, and behavioral changes. It primarily focuses on imparting knowledge, fostering beliefs, and guiding behaviors to help caregivers establish correct health concepts and behavioral habits. In the KAP health education model, knowledge serves as the foundation, beliefs as the driving force, and behaviors as the goal. By imparting knowledge about febrile seizures to caregivers, the model helps them establish correct health beliefs, thereby guiding them to adopt correct behavioral approaches and improve their ability to respond. Compared with traditional health education models, the KAP health education model places greater emphasis on caregivers' subjectivity and participation, better meeting their individualized needs and enhancing the effectiveness of health education ^[8].

The results of this study show that the caregivers in the research group scored higher in terms of their mastery of health knowledge compared to the control group. This is because the Knowledge-Attitude-Practice (KAP) health education model, through the formulation of personalized education plans and diverse educational methods, can impart relevant knowledge about febrile seizures to caregivers in a targeted manner according to their different needs and characteristics, enabling caregivers to better understand and master the content learned. Meanwhile, methods such as case sharing and psychological support can stimulate caregivers' learning interest and enthusiasm, thereby improving their learning outcomes. The coping ability scores of caregivers in the research group were higher than those in the control group. On the basis of knowledge transmission, the KAP health education model emphasizes the establishment of beliefs and the guidance of behaviors. Through case sharing and psychological support, caregivers are helped to establish correct health beliefs and enhance their confidence in coping with febrile seizures. Furthermore, through simulated drills and regular follow-ups, caregivers continuously improve their coping skills in practice and develop good nursing habits, thereby effectively enhancing their coping abilities ^[9].

5. Conclusion

In summary, the KAP health education model can effectively enhance the coping abilities of caregivers of children with febrile seizures, improve their anxiety levels, reduce the recurrence rate in children, and increase caregiver

satisfaction, making it worthy of clinical promotion and application. In future clinical work can further refine the KAP health education model, improve the quality and effectiveness of health education, and provide better guarantees for the healthy growth of children.

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Disclosure statement

The authors declare no conflict of interest.

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Study on the Efficacy of High-Throughput Real-Time Mass Spectrometry Detection of Exhaled Breath for Rapid Diagnosis of Pulmonary Tuberculosis

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Abstract: *Objective:* To evaluate the clinical efficacy of high-throughput real-time mass spectrometry detection technology for exhaled breath in the rapid diagnosis of pulmonary tuberculosis (PTB), providing a novel technological support for early screening and diagnosis of PTB. *Methods:* A total of 120 PTB patients admitted to a hospital from January 2023 to June 2024 were selected as the case group, and 150 healthy individuals and patients with non-tuberculous pulmonary diseases during the same period were selected as the control group. Exhaled breath samples were collected from all study subjects, and the types and concentrations of volatile organic compounds (VOCs) in the samples were detected using a high-throughput real-time mass spectrometer. A diagnostic model was constructed using machine learning algorithms, and core indicators such as diagnostic sensitivity, specificity, and area under the curve (AUC) of this technology were analyzed and compared with the efficacy of traditional sputum smear examination, sputum culture, and GeneXpert MTB/RIF detection. *Results:* The diagnostic sensitivity of the high-throughput real-time mass spectrometry diagnostic model for exhaled breath in diagnosing PTB was 92.5%, the specificity was 94.0%, and the AUC was 0.978, which were significantly higher than those of sputum smear examination (sensitivity 58.3%, specificity 90.0%, AUC 0.741). Compared with GeneXpert technology, its specificity was comparable (94.0% vs 93.3%), and the detection time was shortened to less than 15 minutes. The model achieved an accuracy of 91.3% in distinguishing PTB from other pulmonary diseases and was not affected by demographic factors such as age and gender. *Conclusion:* High-throughput real-time mass spectrometry detection technology for exhaled breath has the advantages of being non-invasive, rapid, highly sensitive, and highly specific, and holds significant clinical application value in the rapid diagnosis and large-scale screening of PTB, warranting further promotion.

Keywords: Tuberculosis; Exhaled breath detection; High-throughput real-time mass spectrometry; Volatile organic compounds; Rapid diagnosis

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1. Introduction

Tuberculosis, a chronic respiratory infectious disease caused by *Mycobacterium tuberculosis* infection, has become the leading infectious cause of death globally. According to the World Health Organization (WHO) Global Tuberculosis Report 2024, there were 10.8 million new tuberculosis cases and 1.25 million deaths worldwide in 2023, with China accounting for 6.8% of the global case count, indicating a severe epidemic prevention and control situation^[1]. Early and accurate diagnosis is crucial for controlling the spread of tuberculosis and improving patient prognosis. However, traditional diagnostic methods have significant limitations: sputum smear microscopy has a sensitivity of only 30–50%, leading to a high risk of missed diagnoses; sputum culture, considered the “gold standard”, requires a detection period of 2–8 weeks, failing to meet the demand for rapid diagnosis; although the GeneXpert MTB/RIF technology can shorten detection time, it relies on specialized equipment and sputum samples, making it difficult to popularize in resource-limited areas and subject to a certain false-negative rate^[2].

In recent years, exhaled breath detection technology has become a research hotspot in the field of infectious disease diagnosis due to its non-invasive and convenient characteristics. Volatile organic compounds (VOCs) in exhaled breath, serving as “biological fingerprints” of metabolic status, undergo characteristic changes in tuberculosis patients due to the metabolic activities of *Mycobacterium tuberculosis* and host immune responses. Existing studies have shown that exhaled breath detection technology based on gas chromatography-mass spectrometry (GC-MS) can achieve a diagnostic sensitivity for tuberculosis of 82.6–91.7%.

However, the complexity of the operation and long detection period of this technology limit its clinical application and promotion^[3]. High-throughput real-time mass spectrometry technology, with its advantages of rapid detection and high resolution, exhibits tremendous potential in the diagnosis of respiratory diseases. This study aims to systematically evaluate the efficacy of exhaled breath high-throughput real-time mass spectrometry detection for the rapid diagnosis of tuberculosis and provide a novel diagnostic technology solution for clinical practice. The research results are now reported as follows.

2. Materials and methods

2.1. Study subjects

A total of 120 tuberculosis patients who sought treatment in the Respiratory Medicine and Infectious Diseases Departments of a tertiary grade-A hospital from January 2023 to June 2024 were selected as the case group. All patients met the criteria of the “WS 288-2017 Diagnosis of Pulmonary Tuberculosis”. Among them, there were 85 newly-treated patients and 35 retreated patients; 68 males and 52 females; aged between 18 and 75 years old, with an average age of (42.3 ± 12.5) years^[4].

During the same period, 150 cases were selected as the control group, including 80 healthy individuals undergoing physical examinations (with no history of pulmonary diseases and negative tuberculin skin tests) and 70 patients with non-tuberculous pulmonary diseases (including 25 cases of pneumonia, 20 cases of chronic obstructive pulmonary disease, 15 cases of bronchiectasis, and 10 cases of lung cancer); 82 males and 68 females; aged between 20 and 72 years old, with an average age of (40.8 ± 11.6) years.

Exclusion criteria include the patients with severe liver and kidney dysfunction, malignant tumors, or immune system diseases; those who had used anti-tuberculosis drugs or antibiotics within the past month; and those who were unable to cooperate with exhaled breath sample collection. This study was approved by the hospital’s Ethics Committee (Ethics Approval Number: 2022-123), and all study subjects signed informed consent forms (refer **Table 1**).

Table 1. Comparison of baseline data of study subjects

Characteristic	Case group (n = 120)	Control group (n = 150)	Statistic	p-value
Gender (Male/Female, n)	68/52	82/68	$\chi^2 = 0.124$	0.724
Age (years, Mean \pm SD)	42.3 \pm 12.5	40.8 \pm 11.6	$t = 0.987$	0.324
Smoking history (Yes/No, n)	45/75	50/100	$\chi^2 = 0.356$	0.550
Disease duration (months, Median [IQR])	3.5 (1.0—8.0)	-	-	-
Disease type (n)	-	Healthy: 80		
	-	Pneumonia: 25		
	-	COPD: 20		
	-	Bronchiectasis: 15		
	-	Lung Cancer: 10		

2.2. Main instruments and reagents

High-throughput real-time mass spectrometer for exhaled breath (Model: HRMS-2023, produced by a certain biotechnology company); GeneXpert MTB/RIF detector (produced by Cepheid, USA); *Mycobacterium tuberculosis* culture kit (produced by a biotechnology company in Hangzhou); disposable exhaled breath collection bags (made of inert materials, with a volume of 500 mL).

2.3. Sample collection and detection

2.3.1. Exhaled breath sample collection

After fasting for 12 hours, the study subjects rested for 15 minutes in a quiet environment. They were instructed to seal their mouths and noses with a disposable mask, take a deep breath, and then exhale slowly into the collection bag until approximately 300 mL of exhaled breath was collected. The bag was then sealed and immediately sent for testing. The detection was completed within 2 hours after sample collection.

2.3.2. Mass spectrometry detection process

Connect the collection bag to the sample inlet of the high-throughput real-time mass spectrometer, and set the sample injection temperature to 40°C, the ion source temperature to 200°C, the scanning range to m/z 20–350, and the scanning interval to 0.2.

The instrument automatically collects VOCs ion signals, performs data preprocessing through built-in software to remove background noise and interference signals, and extracts characteristic ion peaks.

2.3.3. Traditional detection methods

All patients in the case group and the suspected case control group simultaneously underwent sputum smear acid-fast staining, sputum *Mycobacterium tuberculosis* culture, and GeneXpert MTB/RIF testing. The operations were strictly conducted according to the reagent kit instructions and clinical laboratory standard procedures ^[5].

2.4. Data analysis

Data analysis was performed using SPSS 26.0 statistical software and Python 3.9. Measurement data conforming to a normal distribution were expressed as ($\bar{x} \pm s$), and comparisons between groups were made using the t -test.

Measurement data not conforming to a normal distribution were expressed as median (quartile), and comparisons between groups were made using the rank-sum test. Count data were expressed as cases (%), and comparisons between groups were made using the χ^2 test.

A diagnostic model for exhaled breath VOCs was constructed using the random forest algorithm, and the receiver operating characteristic (ROC) curve was plotted to calculate sensitivity, specificity, AUC, and the 95% confidence interval (95% CI). A p -value of < 0.05 was considered statistically significant.

3. Results

3.1. Analysis of exhaled breath VOCs characteristics

Through high-throughput real-time mass spectrometry detection, a total of 32 differentially expressed VOCs were identified. Among them, the concentrations of 18 VOCs, including ortho-cymene, naphthalene, and 1-methylcyclohexane, were significantly higher in the case group than in the control group.

While the concentrations of 14 VOCs, including cyclohexanone and nonanal, were significantly lower in the case group than in the control group ($p < 0.05$). Ten core characteristic VOCs (**Table 2**) were selected based on the random forest algorithm to construct a tuberculosis diagnostic model.

Table 2. Core characteristic VOCs for tuberculosis diagnosis

No.	VOC name	Molecular weight	Case group concentration (ng/L, $\bar{x} \pm s$)	Control group concentration (ng/L, $\bar{x} \pm s$)	Fold change	p -value
1	o-Cymene	134	45.6 \pm 12.3	12.8 \pm 5.6	3.57	< 0.001
2	Naphthalene	128	38.9 \pm 10.5	10.2 \pm 4.8	3.81	< 0.001
3	1-Methylcyclohexane	98	32.4 \pm 9.6	8.5 \pm 3.2	3.81	< 0.001
4	2-Butyl-1-octanol	172	28.7 \pm 8.9	7.3 \pm 2.9	3.93	< 0.001
5	Decane	142	25.3 \pm 7.8	6.9 \pm 2.5	3.67	< 0.001
6	Cyclohexanone	98	8.2 \pm 3.1	25.6 \pm 9.2	0.32	< 0.001
7	Nonanal	142	6.5 \pm 2.8	22.4 \pm 8.5	0.29	< 0.001
8	Toluene	92	18.7 \pm 6.5	10.3 \pm 4.2	1.82	0.002
9	p-Xylene	106	15.4 \pm 5.8	8.6 \pm 3.5	1.79	0.003
10	Butane*	72	12.8 \pm 4.9	5.7 \pm 2.1	2.25	0.001

3.2. Evaluation of diagnostic model efficacy

The diagnostic model based on high-throughput real-time mass spectrometry of exhaled breath demonstrated a sensitivity of 92.5% (95% CI: 87.2–96.1%) and a specificity of 94.0% (95% CI: 89.3–97.1%) for tuberculosis diagnosis, with an AUC of 0.978 (95% CI: 0.965–0.991).

In subgroup analysis, the model showed a sensitivity of 94.1% for newly diagnosed tuberculosis patients and 88.6% for retreated patients. The diagnostic accuracy was 95.2% for individuals under 30 years old and 91.8% for those aged 30 or older.

The sensitivity for female patients (93.8%) was slightly higher than that for male patients (91.5%), but the difference was not statistically significant ($p > 0.05$).

Table 3. Comparison of diagnostic efficacy of different diagnostic methods

Diagnostic method	Sensitivity (% 95% CI)	Specificity (% 95% CI)	Accuracy (%)	AUC (95% CI)	Turnaround time
Exhaled breath High-throughput Real-time mass spectrometry	92.5 (87.2–97.8)	94.0 (89.3–98.7)	93.3	0.978 (0.965–0.991)	< 15 min
Sputum smear microscopy	58.3 (50.1–66.5)	90.0 (84.5–94.1)	76.2	0.741 (0.698–0.784)	2–4 h
Sputum culture	80.0 (72.5–86.3)	100.0 (Reference)	91.5	0.900 (0.872–0.928)	2–8 h
GeneXpert MTB/RIF	89.2 (82.8–94.0)	93.3 (88.5–96.7)	91.6	0.945 (0.925–0.965)	2 h

4. Differential diagnostic efficacy for other pulmonary diseases

When distinguishing tuberculosis from non-tuberculous pulmonary diseases, the model achieved a diagnostic accuracy of 91.3%. Specifically, it showed a sensitivity of 90.5% and a specificity of 88.0% for pneumonia, a sensitivity of 92.0% and a specificity of 90.0% for chronic obstructive pulmonary disease, and a sensitivity of 89.0% and a specificity of 92.0% for lung cancer, with an AUC of 0.962 (95% CI: 0.948–0.976).

5. Discussion

Rapid and early diagnosis of tuberculosis is a critical component of global tuberculosis control efforts. The limitations of traditional diagnostic methods have significantly hindered the progress of these efforts. Exhaled breath analysis, as a non-invasive and convenient diagnostic technique, reflects disease status by analyzing characteristic changes in volatile organic compounds (VOCs) and has been applied in the diagnosis of various respiratory diseases ^[6]. The tuberculosis diagnostic model developed in this study, based on high-throughput real-time mass spectrometry technology, exhibited excellent diagnostic efficacy, providing a new technological pathway for rapid tuberculosis diagnosis.

This study identified 10 core characteristic volatile organic compounds (VOCs), among which ortho-cymene, reported for the first time as a specific biomarker for tuberculosis, exhibited significantly elevated concentrations in the case group. This finding is consistent with the latest research results published in the Nature sub-journal Scientific Reports. Ortho-cymene not only effectively distinguishes active tuberculosis from healthy individuals but also holds potential value in differentiating drug-resistant tuberculosis ^[7]. The differential expression of VOCs such as naphthalene and 1-methylcyclohexane has also been validated by previous studies. The Phillips team discovered high expression levels of these substances in *Mycobacterium tuberculosis* cultures using gas chromatography-mass spectrometry (GC-MS) technology, with a clinical sample detection sensitivity of 82.6% ^[8]. This study further confirmed the reliability of these VOCs as biomarkers for tuberculosis diagnosis, providing targets for the development of subsequent diagnostic kits.

In terms of diagnostic performance, the model constructed in this study outperformed traditional sputum smear examinations in terms of sensitivity, specificity, and area under the curve (AUC) values. Compared to the GeneXpert technology, the detection time was reduced from 2 hours to less than 15 minutes, and it did not rely on sputum samples, offering advantages for patients unable to produce sputum. Compared to the BreaTB breathomics model reported in Health World (with a sensitivity of 91.7% and specificity of 93.0%), the performance of our model was slightly improved, possibly due to the higher detection resolution and more precise feature ion

extraction capabilities of high-throughput real-time mass spectrometry technology ^[9]. Additionally, the model maintained stable diagnostic performance across patients of different ages, genders, and treatment stages, indicating its broad clinical applicability.

In terms of differential diagnosis, the model achieved a 91.3% accuracy rate in distinguishing tuberculosis from common pulmonary diseases such as pneumonia and chronic obstructive pulmonary disease, addressing the challenge of differentiating early lesions in traditional imaging diagnosis. This advantage stems from the ability of high-throughput real-time mass spectrometry technology to capture subtle differences in VOC profiles across different disease states. Compared to single biomarker detection, the multi-feature VOCs combination model exhibits stronger discriminatory power. Meanwhile, the non-invasive nature of this technology makes it more suitable for large-scale population screening, particularly in resource-limited areas, where it can effectively improve tuberculosis detection rates and reduce disease transmission risks ^[10].

This study has certain limitations. Firstly, it employed a single-center design with a relatively limited sample size, which may introduce selection bias. Subsequent multi-center, large-sample studies are needed to validate the external validity of the model. Secondly, no specific analysis was conducted on patients with drug-resistant tuberculosis, and the differences in core volatile organic compounds (VOCs) between infections caused by drug-resistant and sensitive strains warrant further exploration. Finally, the high cost of detection instruments restricts their immediate adoption in primary healthcare facilities. In the future, it is necessary to optimize technical solutions and develop portable detection devices.

6. Conclusion

The high-throughput real-time mass spectrometry detection technology for exhaled breath enables rapid and accurate diagnosis of tuberculosis by analyzing characteristic VOCs spectra. It offers significant advantages, including high sensitivity, high specificity, and non-invasiveness, and holds substantial clinical value in early diagnosis, large-scale screening, and differential diagnosis of tuberculosis ^[11]. The widespread adoption of this technology is expected to overcome the limitations of traditional diagnostic methods and provide new technical support for global tuberculosis prevention and control ^[12]. Subsequent research should focus on multi-center validation, differentiation of drug-resistant tuberculosis, and miniaturization of detection devices to further expand its clinical applications.

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The authors declare no conflict of interest.

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The Application Effect of a Three-Subject, Dual-Track Interactive Nursing Model Based on Smart Nursing in Patients with Intestinal Polyps

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Abstract: *Objective:* To explore the clinical value of a three-subject, dual-track interactive nursing model based on smart nursing in patients with intestinal polyps. *Methods:* From July 2024 to February 2025, 200 patients with intestinal polyps admitted to our hospital were selected and divided into a control group and an observation group, with 100 patients in each group, based on different nursing methods. The control group received routine nursing, while the observation group received a three-subject, dual-track interactive nursing model based on smart nursing. The nursing effects of the two groups were compared and analyzed. *Results:* The first defecation time in the observation group was shorter than that in the control group ($p < 0.05$). After nursing, the ESCA score, CSES score, scores for the right colon, transverse colon, left colon, total BBPS score, intestinal preparation qualification rate, and nursing satisfaction in the observation group were all higher than those in the control group ($p < 0.05$). *Conclusion:* The application of a three-subject, dual-track interactive nursing model based on smart nursing in patients with intestinal polyps can effectively alleviate gastrointestinal function, improve self-care ability, and enhance nursing satisfaction.

Keywords: Smart nursing; Three-subject, Dual-track interactive nursing; Intestinal polyps

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1. Introduction

Intestinal polyps, as a common disease of the digestive system, although mostly benign, carry a certain risk of malignant transformation, seriously affecting patients' quality of life and long-term health^[1]. Its treatment not only relies on precise surgical operations; postoperative care is equally crucial, directly affecting the patient's rehabilitation process and disease recurrence rate. However, for the treatment of intestinal polyps, apart from surgical methods, postoperative care also has a certain impact on patients' prognosis and recurrence. However, conventional care is limited to in-hospital aspects, and upon discharge, patients are entirely responsible for self-

management at home without professional nursing staff providing long-term care. Consequently, rehabilitation outcomes are not ideal. For those with poor knowledge of nursing care, complications are more likely to occur after surgery, affecting the patient's prognosis. Against this backdrop, smart nursing represents a relatively novel nursing model characterized by informatization and intelligence, enabling effective monitoring and real-time management of patients' conditions, thereby enhancing the quality of nursing work ^[2]. The three-subject, dual-track interactive nursing model integrates hospitals, communities, and patients as three subjects, forming an in-hospital and out-of-hospital dual-track nursing model that provides seamless nursing services throughout the patient's journey. This approach is conducive to improving patients' understanding of their diseases, enhancing their self-management abilities, and subsequently promoting patient rehabilitation and reducing disease recurrence rates. Based on this, this study explores the clinical application effects of applying the three-subject, dual-track interactive nursing model based on smart nursing for patients with intestinal polyps, aiming to provide new ideas and methods for postoperative care in these patients.

2. Materials and methods

2.1. General information

The study included 200 patients with intestinal polyps admitted to our hospital from July 2024 to February 2025. They were divided into a control group and an observation group based on different nursing methods, with 100 patients in each group. The male-to-female ratio in the control group was 58:42, with an average age of (50.27 ± 4.25) years. The male-to-female ratio in the observation group was 59:41, with an average age of (50.78 ± 4.31) years. There were no significant differences in baseline data between the two groups, allowing for comparative study ($p > 0.05$).

2.1.1. Inclusion criteria

- (1) Meeting the relevant diagnostic criteria outlined in the "Standardized Diagnosis and Treatment of Colorectal Polyps", with confirmation via colonoscopy and pathological biopsy ^[3,4].
- (2) Aged between 18–75 years old, with clear consciousness and the ability to communicate normally.
- (3) Willing to participate in this study voluntarily and sign an informed consent form.

2.1.2. Exclusion criteria

- (1) Patients with severe dysfunction of vital organs.
- (2) Patients with mental illness or cognitive impairment who are unable to cooperate with the study and nursing care.
- (3) Patients with a history of abdominal surgery.

2.2. Methods

2.2.1. Control group

Patients received routine nursing care. Nurses guided patients on proper medication use according to the doctor's advice and reminded them to take medication on time during their hospital stay. Nurses explained disease-related knowledge to patients with intestinal polyps, such as the causes of intestinal polyps, possible symptoms, and the necessity of subsequent treatment. Patients and their families were advised on postoperative dietary precautions,

such as avoiding spicy, greasy, and irritating foods. During the patient's hospital stay, vital signs such as body temperature, blood pressure, and heart rate were closely monitored. In case of any abnormalities, the attending physician was immediately notified, and corresponding treatment measures were actively taken.

2.2.2. Observation group

Patients received a three-entity, dual-track interactive nursing approach based on smart nursing.

(1) Smart nursing

(a) Intelligent ward system

Smart screens were installed at the bedside to display basic patient information and nursing risk alerts. The ward was equipped with a multi-directional call system, allowing patients to initiate calls through different terminals such as the bedside call system, bathroom call bell, and nurse station, ensuring prompt assistance when needed. The nurse station was equipped with an electronic display screen that continuously played information related to intestinal polyps, such as disease prevention knowledge and bowel preparation instructions. The intelligent system at the nurse station displayed nurse scheduling and handover records, simplifying the handover process through electronic means and effectively enhancing the efficiency and accuracy of information transmission. It also allowed for viewing of patient colonoscopy reports, saving time in handovers with the medical team and improving work efficiency.

(b) Perioperative health education system

The latest literature, including guidelines and consensus statements, was integrated to create educational materials. Health education knowledge on the perioperative management of intestinal polyps was disseminated through WeChat groups and official WeChat accounts, including text, images, and videos. Combined with corridor display boards, this approach enabled patients and their families to quickly and clearly learn relevant knowledge, which they could review repeatedly.

(2) Three-party, dual-track interactive nursing intervention

(a) Hospital nursing track

Before the patient is discharged, medical staff record their vital signs and request the patient or their family members to provide contact information and home address. Based on the individual differences of patients, medical staff negotiate with patients and their family members to determine the appropriate timing and convenient communication channels for subsequent follow-up. Within one week after discharge, patients and their family members are required to report on the patient's rehabilitation status, including diet, bowel movements, and physical discomfort. If patients and their family members encounter unresolvable emergencies after discharge, they can contact medical staff at any time through the provided contact information to receive timely answers and assistance.

(b) Community nursing track

Community healthcare workers serve as the primary service providers, establishing a cross-institutional collaboration model. After patients complete their treatment in the hospital, hospital physicians must comprehensively transfer patient information to community healthcare workers and establish patient files. Both parties share communication channels to support subsequent nursing consultations. After patient discharge, the community healthcare team will conduct a systematic health assessment based on the rehabilitation status reported by family members and provide customized

nursing guidance. Based on a comprehensive analysis of the patient's lifestyle, values, and functional recovery, a personalized nursing plan is jointly developed.

2.3. Observation indicators

(1) Gastrointestinal function

Observe and record the time to first bowel movement for both groups of patients.

(2) Self-care ability and self-efficacy

Assessed using the Exercise of Self-Care Agency Scale (ESCA), which includes four dimensions and has a total score of 164 points. A higher score indicates stronger self-care ability. Self-efficacy is evaluated using the General Self-Efficacy Scale (GSES), which comprises 10 dimensions with a total score ranging from 10 to 40 points. A higher score indicates stronger self-efficacy.

(3) Bowel preparation qualification rate

The Boston Bowel Preparation Scale (BBPS) is used to assess bowel preparation. Developed by the Boston University Medical Center, this scale has a Cronbach's α of 0.987. Scoring was jointly completed during the withdrawal phase of colonoscopy by two experienced endoscopists educated in the Boston Bowel Preparation Scale (BBPS) and one endoscopy nurse, using standardized equipment and a single-operator approach, with single-blind assessment. Scoring was performed separately for the right colon, transverse colon, and left colon, with the cleanliness of each segment rated on a scale of 0 to 3, resulting in a total score that is the sum of the scores for the three segments. The total score ranges from 0 to 9, with a total score of ≥ 6 and/or each segment scoring ≥ 2 considered as "acceptable" bowel preparation. The number of patients with acceptable bowel preparation was then counted. The formula for calculating the acceptable bowel preparation rate is as follows: The total number of cases of bowel preparation during the perioperative period of intestinal polyps within a unit time / The reasonable number of cases of bowel preparation during the perioperative period of intestinal polyps within a unit time $\times 100\%$.

(4) Nursing satisfaction

Assessed using a self-designed nursing satisfaction questionnaire, which includes options for satisfied, somewhat satisfied, and dissatisfied. Overall satisfaction = (Number of satisfied + Number of somewhat satisfied) / Total number of cases $\times 100\%$.

2.4. Statistical methods

The study data were analyzed using SPSS 22.0 statistical software. Continuous data are presented as ($\bar{x} \pm s$) and analyzed using t -tests, while categorical data are presented as n (%) and analyzed using χ^2 tests. A p -value < 0.05 indicates statistical significance.

3. Results

3.1. Comparison of gastrointestinal function between the two groups

The observation group had shorter times for anal exhaust, first defecation, and restoration of bowel sounds compared to the control group ($p < 0.05$). See **Table 1**.

Table 1. Comparison of gastrointestinal function between the two groups ($\bar{x} \pm s$, h)

Group	n	First defecation time (hours)
Observation group	100	33.12 \pm 5.24
Control group	100	39.57 \pm 5.11
<i>t</i> -value	-	8.813
<i>p</i> -value	-	0.000

3.2. Comparison of self-care ability and self-efficacy scores between the two groups

The observation group had higher ESCA and CSES scores after nursing compared to the control group ($p < 0.05$). See **Table 2**.

Table 2. Comparison of self-care ability and self-efficacy scores between the two groups ($\bar{x} \pm s$, points)

Group	n	ESCA		CSES	
		Before care	After care	Before care	After care
Observation group	100	83.27 \pm 3.41	120.32 \pm 4.21	18.76 \pm 2.25	30.25 \pm 2.73
Control group	100	82.87 \pm 3.36	103.76 \pm 3.66	19.07 \pm 2.32	23.64 \pm 2.41
<i>t</i> -value	-	0.836	29.895	0.959	18.152
<i>p</i> -value	-	0.404	0.000	0.339	0.000

3.3. Comparison of bowel preparation qualification rates between the two groups

The right colon, transverse colon, left colon, total BBPS score, and bowel preparation qualification rate in the observation group were all higher than those in the control group ($p < 0.05$). See **Table 3**.

Table 3. Comparison of bowel preparation qualification rates between the two groups

Group	n	Left colon (Score)	Transverse colon (Score)	Right colon (Score)	Total BBPF (Score)	Adequate bowel preparation rate
Observation group	100	2.28 \pm 0.38	2.11 \pm 0.44	2.16 \pm 0.52	7.45 \pm 0.66	93 (93.00)
Control group	100	2.01 \pm 0.52	1.96 \pm 0.47	1.81 \pm 0.52	5.82 \pm 1.35	74 (74.00)
<i>t</i> / χ^2 value		4.192	2.329	4.759	10.847	5.171
<i>p</i> -value		0.000	0.021	0.000	0.000	0.023

3.4. Comparison of nursing satisfaction between the two groups

The nursing satisfaction in the observation group was higher than that in the control group ($p < 0.05$). See **Table 4**.

Table 4. Comparison of nursing satisfaction between the two groups [n (%)]

Group	n	Satisfied	Somewhat satisfied	Dissatisfied	Total satisfaction rate [n (%)]
Observation group	100	75	21	4	96 (96.00)
Control group	100	64	19	17	83 (83.00)
χ^2 value	-	-	-	-	8.992
<i>p</i> -value	-	-	-	-	0.003

4. Discussion

The results of this study indicate that the first defecation time in the observation group was shorter than that in the control group ($p < 0.05$), suggesting that the three-subject, dual-track interactive nursing model, through close collaboration between hospital and community nursing staff, developed personalized rehabilitation plans for patients in the early postoperative period and emphasized guidance on diet and activities during the in-hospital nursing phase^[3]. Simultaneously, leveraging the intelligent nursing platform, nursing staff were able to monitor patients' condition changes in real-time and adjust nursing measures promptly, ensuring the precision and effectiveness of nursing care.

Furthermore, the ESCA and CSES scores in the observation group after nursing were higher than those in the control group ($p < 0.05$), indicating that intelligent nursing provided patients with a wealth of health education content, which was continuously displayed on bedside smart screens. Patients could access knowledge about intestinal polyps and self-care through official accounts, WeChat groups, telephone communication, and other means, enhancing their understanding of the disease and self-care awareness. Under the dual influence of hospital and community nursing tracks, patients received comprehensive nursing support. Healthcare professionals not only focused on patients' physical recovery but also paid attention to their psychological state and coping strategies^[4]. Through effective communication and collaboration, hospital and community healthcare professionals provided psychological counseling and coping strategy guidance, helping patients build confidence in overcoming the disease and improving their ability to cope with it. In addition, the right colon, transverse colon, left colon, total BBPS score, and the qualification rate of bowel preparation in the observation group were all higher than those in the control group ($p < 0.05$), indicating that the three-subject, dual-track interactive nursing model helps improve the quality of bowel preparation in patients. Under this model, hospital healthcare professionals and community healthcare workers work closely together to conduct comprehensive information handovers and assessments of patients.

Hospital healthcare professionals gain a detailed understanding of a patient's condition before their discharge, while community healthcare workers provide targeted nursing advice based on this information and feedback from patients after discharge. This comprehensive nursing support enables patients to better follow medical advice during bowel preparation, make dietary adjustments, and perform bowel cleansing, thereby increasing the qualification rate of bowel preparation^[5]. Furthermore, nursing satisfaction in the observation group was higher than that in the control group ($p < 0.05$). This can be attributed to the patient-centered approach of the model, which fully considers patients' needs and feelings. By optimizing nursing processes, strengthening education related to bowel preparation, and improving nursing efficiency across all stages of the perioperative period for intestinal polyps, the model enhances patient satisfaction. Meanwhile, through the intelligent nursing platform, patients can evaluate and provide feedback on nursing services at any time, allowing nursing staff to promptly understand patients' opinions and suggestions and continuously improve the quality of nursing services, thereby increasing patient satisfaction^[6].

5. Conclusion

In summary, the three-subject, dual-track interactive nursing model based on intelligent nursing can effectively improve the recovery of intestinal function in patients with intestinal polyps, increase the qualification rate of bowel preparation, enhance patients' self-care abilities, coping abilities, and quality of life, and boost patient

satisfaction with nursing services.

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The authors declare no conflict of interest.

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Analysis of the Application Effect of Community Health Center Nursing Models in Elderly Health Examinations

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Abstract: *Objective:* To explore the application effect of optimizing the nursing model in community health centers for elderly health examinations, providing a reference for enhancing the management level of elderly health at the grassroots level. *Methods:* A total of 300 elderly individuals who underwent health examinations at our center from January 2024 to December 2024 were selected as the study subjects. They were randomly divided into a control group and an observation group, with 150 cases in each group. The control group underwent the conventional health examination nursing process, while the observation group adopted an optimized community nursing model, which included stratified education and appointment scheduling before the examination, full-time accompaniment and safety care during the examination, and the establishment of electronic medical records and continuous follow-up after the examination. Differences in health management awareness rates and satisfaction with health examination services between the two groups of elderly individuals were compared. *Results:* The health management awareness rate in the observation group was 94.67%, significantly higher than that in the control group (78.00%; $p < 0.001$). The satisfaction rate with health examination services in the observation group was 96.00%, also significantly higher than that in the control group (82.00%; $p < 0.001$). *Conclusion:* The optimized community nursing model can effectively enhance the health awareness level and service satisfaction of elderly individuals during health examinations, demonstrating strong practicality and promotion value. It contributes to achieving continuity and precision in grassroots elderly health management.

Keywords: Community health center; Nursing model; Elderly health examination; Health management; Service satisfaction

Online publication: Dec 5, 2025

1. Introduction

In recent years, the process of social aging in China has been accelerating, with a persistently high and rising prevalence of chronic diseases among the elderly population ^[1]. Addressing the contradiction between the high incidence of chronic diseases in the elderly and the inadequate management services is one of the urgent issues

currently facing us^[2]. Community health service institutions are the primary venues for conducting elderly health management work, with community health centers serving as the main platform for delivering basic public health services to residents in their respective jurisdictions^[3]. Therefore, evaluating the quality of elderly health examinations provided by community health centers can effectively provide insights into the health status and disease conditions of the elderly in the community, directly relating to the effectiveness of early chronic disease screening and health risk prevention and control^[4]. However, the conventional physical examination and care model currently adopted by most communities has significant limitations: before the examination, only a single phone call is used for notification, without fully considering the elderly's thirst for health knowledge and their difficulties in mobility; during the examination, the focus is on process coordination, neglecting environmental adaptability and emotional care; after the examination, reports are simply issued without in-depth interpretation of abnormal indicators or long-term health management follow-up^[5,6]. This results in insufficient health awareness among the elderly, making it difficult to meet the health management goal of "early prevention and early intervention". The "Healthy China 2030" Plan clearly proposes to strengthen the health management functions of primary-level medical and health institutions. This study takes elderly individuals who underwent community physical examinations in 2024 as the subjects, explores the application value of optimizing care models, and provides data support for improving the primary-level elderly care system.

2. Materials and methods

2.1. General information

A total of 300 elderly individuals who underwent health examinations at our center from January 2024 to December 2024 were selected as the subjects. The control group consisted of 150 individuals, including 79 males and 71 females, aged between 65 and 82 years, with an average age of (70.34 ± 5.12) ; 42 had a history of hypertension, and 28 had a history of diabetes. The observation group consisted of 150 individuals, including 81 males and 69 females, aged between 65 and 83 years, with an average age of (71.02 ± 4.89) ; 45 had a history of hypertension, and 26 had a history of diabetes. The general information of the two groups was comparable ($p > 0.05$).

2.1.1. Inclusion criteria

The inclusion criteria were as follows

- (1) Aged 65 years or older
- (2) Individuals with normal communication and expression abilities
- (3) Individuals who could understand, read, and fill out the questionnaire content, were willing to participate in the study, and signed the informed consent form.

2.1.2. Exclusion criteria

The exclusion criteria were as follows

- (1) Patients with severe dementia who were unable to complete interviews or lacked cooperation
- (2) Individuals who had experienced acute cardiovascular diseases (such as stroke) or other critical conditions requiring hospitalization within the past three months
- (3) Individuals who needed to rest in bed for more than one month due to various reasons and could not

undergo examinations and follow-ups.

2.2. Nursing methods

2.2.1. Control group

Implement routine medical examination nursing: Notify patients by phone about the time and precautions before the examination; assist in completing measurements such as height, blood pressure, and blood glucose during the examination; distribute reports after the examination and briefly inform patients of any abnormal indicators.

2.2.2. Observation group

The optimized community nursing model was adopted, which included the following.

(1) Pre-examination intervention

A team consisting of nurses, general practitioners, and nutritionists was established to conduct health education through community announcements and home visits, explaining the significance of medical examinations for early screening of chronic diseases. Through phone calls or in-person communication, medical examinations were scheduled in time slots based on the elderly's daily routines (e.g., avoiding morning exercise and medication times), with 30-minute intervals between slots and a daily limit of 30 appointments. For elderly individuals with mobility issues, living alone, or without their children nearby, community volunteers were coordinated to provide dedicated transportation services, equipped with wheelchairs, first-aid kits, and other supplies to ensure safe travel. A phone reminder was given one day before the examination to confirm the time and reiterate precautions such as fasting and medication discontinuation.

(2) Nursing during the examination

A dedicated waiting area for elderly patients was set up, with nurses guiding them through the relevant examinations. For those with psychological burdens, communication was conducted using the "listen-empathize-explain" approach (e.g., "Many uncles and aunts share your concerns. Let's conduct a comprehensive physical examination from head to toe for you."). Full accompaniment was provided, along with timely care and attention. Before conducting electrocardiograms and other examinations for the elderly, necessary assistance with dressing/undressing was offered. Simultaneously, safety precautions were taken, including continuous pressure on the wound for at least five minutes after blood collection before leaving the blood collection station, closely monitoring the patient's blood loss and symptoms such as dizziness, and ensuring no abnormalities before guiding them to the next examination item. A lifestyle assessment was also conducted simultaneously, recording dietary habits, sleep patterns, and exercise levels.

(3) Post-physical examination management

Establish electronic health records and provide feedback on results within five working days through community lectures and one-on-one consultations. Create electronic health records for the elderly, encompassing physical examination results, intervention plans, follow-up records, and other content, to enable dynamic management. Utilize a combined approach of "telephone follow-up + home visit follow-up", conducting monthly follow-ups. Telephone follow-ups primarily inquire about health status and the implementation of intervention plans, while home visit follow-ups focus on elderly individuals with mobility issues, checking medication usage, measuring blood pressure and blood glucose levels, and

updating health records simultaneously. If abnormalities are detected during follow-ups (e.g., a sudden increase in blood pressure), promptly assist in arranging referrals to higher-level hospitals for treatment.

2.3. Observation indicators

(1) Awareness rate of health management

Assessed through a self-designed questionnaire covering 10 items, including chronic disease prevention, rational drug use, and health monitoring. Respondents who correctly answer ≥ 8 items are considered aware, and the awareness rate is calculated accordingly.

(2) Satisfaction with physical examination services

Evaluated using a Likert 5-point scale, assessing dimensions such as process convenience and personnel professionalism. Scores ≥ 4 indicate satisfaction, and the satisfaction rate is calculated accordingly.

2.4. Statistical methods

Data analysis was conducted using SPSS 26.0 software. Count data are presented as [n (%)], and χ^2 tests were performed. A p -value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of health management awareness rates between the two groups

The awareness rate of health management in the observation group was significantly higher than that in the control group ($\chi^2 = 17.657, p < 0.001$). See **Table 1** for details.

Table 1. Comparison of health management awareness rates between the two groups [n (%)]

Group	Number of cases	Understood	Not understood	Understanding rate (%)
Control	150	117	33	78.00
Observation	150	142	8	94.67
χ^2				17.657
p				0.000

3.2. Comparison of satisfaction with physical examination services between the two groups

The satisfaction rate with physical examination services in the observation group was significantly higher than that in the control group ($\chi^2 = 15.015, p < 0.001$). See **Table 2** for details.

Table 2. Comparison of satisfaction with medical examination services between the two groups [n (%)]

Group	Number of cases	Satisfied	Dissatisfied	Satisfaction rate (%)
Control	150	123	27	82.00
Observation	150	144	6	96.00
χ^2				15.015
p				0.000

4. Discussion

The community nursing model, structured as a closed loop of “prevention–intervention–management”, emphasizes the integration of individual health with community resources. Its core lies in breaking through the limitations of traditional medical examinations’ “one-time service” by establishing health awareness through pre-examination education, optimizing service experiences through nursing during the examination, and achieving continuous management through post-examination follow-up, aligning with the needs of the elderly for continuous health services ^[7]. Leveraging the geographical advantages of community service centers, this model combines professional medical resources with life-oriented care, reflecting the core concept of “supportive nursing” in Orem’s Self-Care Theory ^[8].

In terms of health management awareness, the observation group achieved a rate of 94.67%, significantly higher than the control group’s 78.00%. This outcome aligns closely with the core logic of the Health Belief Model. This theory posits that an individual’s acquisition of health knowledge and behavioral changes depend on the cognitive balance of three key elements: “disease risk-health benefits-action barriers”.

The observation group employed a tiered approach to education (home-based face-to-face counseling + short video presentations + distribution of brochures), translating complex knowledge points into specific objects and life scenarios easily understandable to elderly patients (e.g., “Poorly controlled hypertension may lead to stroke”). Additionally, measures such as dedicated transportation and staggered appointment scheduling were implemented to overcome physical limitations, transforming the elderly from “passive recipients of information” to “active seekers of solutions”, thereby achieving a deeper cognitive impact. In contrast, the control group merely provided telephone notifications, failing to truly address the elderly’s latent awareness and concerns about diseases, resulting in limited improvements in awareness rates ^[9].

Regarding satisfaction with medical examination services, the observation group’s satisfaction rate of 96.00% was significantly higher than the control group’s 82.00%, aligning closely with the principles of “patient-centered” holistic nursing theory. This theory emphasizes that the core of evaluating service quality lies in “demand matching” rather than mere procedural completeness. From the perspective of the elderly themselves: Their declining physical functions, such as blurred vision, slow walking; and the personality trait of craving attention determine their specific demands for medical check-ups. To address the issue of “mobility difficulties”, measures have been taken, including the establishment of a green channel in the waiting area, the installation of non-slip handrails, and the provision of reading glasses. To solve the problem of “poor vision”, a “three-step communication method” has been adopted, along with the use of voice announcements to read out the examination items ^[10].

To minimize queuing, full-time escort and reminders of precautions have been provided. All these measures have been considered with the aim of addressing the practical difficulties faced by the elderly, thereby achieving excellent results. In contrast, the control group merely completed the basic workflow, consisting of three steps: notification, assistance, and report issuance, without taking into account the actual needs of the elderly population, resulting in a significant difference in satisfaction.

This study enriches the empirical data on community-based elderly care and expands the empirical resources in related fields. The “multidimensional intervention—multidirectional change” pathway clearly demonstrates the effectiveness and scientific validity of the “three-step” approach, laying a solid theoretical foundation and basis for subsequent explorations of elderly care models grounded in primary institutions. The model exhibits strong operational feasibility: it does not require the procurement of large-scale equipment and can be fully implemented

by leveraging existing human and material resources, making it well-suited to the current conditions of most community health centers in China. The establishment of health records facilitates the smooth implementation of future health management initiatives for the elderly and enables data sharing with other healthcare institutions. This contributes to the goal of joint prevention and control in chronic disease management, while also supporting the nationally promoted hierarchical medical system. It is worth noting that the model's adaptability to the oldest-old and disabled elderly populations requires further investigation. Future iterations could incorporate intelligent monitoring devices to enhance the precision of services.

5. Conclusion

In summary, the optimized nursing model in community health centers significantly improves the awareness rate of health management and service satisfaction among the elderly through precise interventions throughout the entire medical check-up cycle. This model aligns closely with the realities of primary healthcare, enabling a shift in health services from passive to proactive management and providing a viable approach to addressing the issues of homogenization and diminished effectiveness in health examination services for the elderly.

Disclosure statement

The authors declare no conflict of interest.

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Benefit Analysis and Discussion of the Same Disease in Different Departments of Public Hospitals under the DIP Payment Method

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Abstract: *Objective:* This study aims to explore the benefit analysis of the same disease in different departments of public hospitals under the DIP payment method. *Methods:* This study is a retrospective analysis that selected clinical data from patients who received treatment in the Department of Orthopedics and the Department of Acupuncture and Moxibustion at our hospital from January 1, 2023, to December 31, 2023. The study compared the costs of medications, examinations, treatments, laboratory tests, nursing and other expenses, and total treatment costs between the two departments. It analyzed the cost structure of the two departments and proposed further improvement suggestions. *Results:* The study results indicated that the total costs in the Department of Acupuncture and Moxibustion were significantly higher than those in the Department of Orthopedics. Among medication costs, the total medication costs in the Department of Orthopedics were higher than those in the Department of Acupuncture and Moxibustion, with costs for Western medicine, proprietary Chinese medicine, and herbal medicine all being higher ($p < 0.05$). Regarding examination costs, consultation fees in the Department of Orthopedics were lower than those in the Department of Acupuncture and Moxibustion, while examination costs were higher ($p < 0.05$). In terms of treatment costs, orthopedic treatment and surgical fees were higher than those in the Department of Acupuncture and Moxibustion ($p < 0.05$). For laboratory test costs, orthopedic laboratory fees were significantly higher than those in the Department of Acupuncture and Moxibustion ($p < 0.05$). Among nursing and other expenses, orthopedic blood transfusion, bed fees, and other expenses were higher than those in the Department of Acupuncture and Moxibustion, while nursing fees were lower ($p < 0.05$). *Conclusion:* Treatment fees in the Department of Acupuncture and Moxibustion are the core and account for a relatively high proportion of the total costs. The benefits generated by the Department of Orthopedics are primarily derived from medication, examination, and laboratory fees, aligning with the characteristics of combining diagnosis, medication, and surgical intervention in orthopedic treatment. Consultation fees, nursing fees, and bed fees in the Department of Acupuncture and Moxibustion are higher than those in the Department of Orthopedics, indicating a longer treatment cycle in acupuncture, which warrants clinical attention.

Keywords: DIP payment method; Public hospitals; The same disease; Different departments; Benefit analysis; Application

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1. Introduction

With the deepening reform of China's medical security system, the medical insurance payment method is undergoing a transformation from traditional project-based payment to Diagnosis-Intervention Packet (DIP) payment ^[1]. The DIP payment model centers on disease diagnosis and treatment methods, constructing a disease score system through big data technology ^[2]. It links the allocation of medical insurance funds to the actual service volume provided by medical institutions, achieving refined management characterized by total budget control, point-based allocation, surplus retention, and overspending sharing. This reform aims to curb unreasonable growth in medical expenses, optimize the allocation of medical resources, and enhance the efficiency of medical insurance fund utilization, posing a core challenge to the operational management of public hospitals. Data statistics indicate that over 90% of the coordinated regions nationwide have fully implemented DIP payment, covering more than 80% of inpatient cases ^[3]. Against this backdrop, public hospitals face dual pressures. On the one hand, they must adapt to the changes in medical insurance payment rules by achieving cost control and efficiency improvements to retain surpluses ^[4].

On the other hand, they must maintain medical quality and patient satisfaction, avoiding service degradation due to excessive cost control. Under the DIP payment model, there are also certain differences in the diagnosis and treatment of the same disease across different departments. Based on this, this study employs a retrospective analysis approach to examine the clinical data of patients treated in the Orthopedics and Acupuncture Departments of our hospital from January 1, 2023, to December 31, 2023. It explores the benefit analysis of the same disease across different departments in public hospitals under the DIP payment method, with a detailed report presented as follows.

2. Materials and methods

2.1. General information

This study adopts a retrospective research approach to analyze the clinical data of patients treated in the Orthopedics and Acupuncture Departments of our hospital from January 1, 2023, to December 31, 2023.

2.1.1. Inclusion criteria

- (1) Meet the disease coverage criteria specified in the DIP disease catalog
- (2) Represent the same disease
- (3) Exhibit homogeneity in clinical pathways
- (4) Possess complete clinical data
- (5) Have completed medical insurance settlement and payment

2.1.2. Exclusion criteria

- (1) Present complex complications
- (2) Involve special treatment methods
- (3) Are transfer cases
- (4) Belong to departments with abnormal cost data
- (5) Have missing key data
- (6) Are extreme value cases

2.2. Methodology

Under the Diagnosis-Intervention Packet (DIP) payment system, a detailed analysis was conducted on the economic benefits of the same medical condition across different departments. The medical condition selected for this study was lumbar disc herniation, with the specific application methods as follows.

(1) Data collection and organization

DIP settlement data was obtained from the hospital's medical insurance department for each department, including disease score, medical insurance settlement amount, actual cost, etc. The actual costs of different departments were organized, including expenses for medications, examinations, treatments, laboratory tests, nursing, and other fees.

(2) Economic benefit analysis

Calculating the medical insurance settlement amount, actual cost, and surplus rate for the treatment of lumbar disc herniation in each department.

(3) Problem identification

Based on the analysis results, identifying issues related to economic benefits in each department.

(4) Strategy formulation

Developing improvement strategies for the identified issues.

2.3. Observation indicators

For patients admitted to the acupuncture and orthopedics departments of our hospital diagnosed with lumbar disc herniation, direct records were kept of their expenses for medications, examinations, treatments, laboratory tests, nursing, and other fees, as detailed below.

(1) Medication expenses include costs for Western medicines, Chinese patent medicines, and herbal medicines.

(2) Examination expenses include consultation fees and examination costs.

(3) Treatment expenses include costs for treatments and surgical procedures.

(4) Laboratory test expenses refer to the costs for laboratory tests.

(5) Nursing and other expenses include costs for blood transfusions, bed fees, nursing fees, and other miscellaneous expenses.

2.4. Statistical methods

Data statistics for this study were conducted using the statistical software SPSS 23.00 for data comparison. Measurement data were expressed as (mean \pm standard deviation) and subjected to a *t*-test, while count data were expressed as *n* (%) and subjected to a chi-square test. A *p*-value less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of drug costs across different departments

A comparison of drug costs revealed that the orthopedic department had higher costs for Western medicine, Chinese patent medicine, Chinese herbal medicine, and total drug expenses compared to the acupuncture

department. These differences were statistically significant ($p < 0.05$), as detailed in **Table 1**.

Table 1. Comparison of drug costs across different departments

Department	Total medication cost (¥)	Western medicine cost (¥)	Chinese patent medicine cost (¥)	Chinese herbal medicine cost (¥)
Orthopedics	2,350.27	1,373.42	411.10	565.75
Acupuncture	262.27	25.28	30.34	206.64
<i>t</i> -value	1476.44	1346.46	1846.96	615.87
<i>p</i> -value	< 0.001	< 0.001	< 0.001	< 0.001

3.2. Comparison of examination costs across different departments

The research findings indicate that the orthopedic department had lower consultation fees but higher examination costs compared to the acupuncture department. These differences were statistically significant ($p < 0.05$), as shown in **Table 2**.

Table 2. Comparison of examination costs across different departments

Department	Consultation cost (¥)	Examination cost (¥)
Orthopedics	182.74	1003.69
Acupuncture	322.63	379.98
<i>t</i> -value	239.91	620.615
<i>p</i> -value	< 0.001	< 0.001

3.3. Comparison of treatment costs across different departments

According to the research results, the orthopedic department had significantly lower treatment costs but slightly higher surgical costs compared to the acupuncture department. These differences were statistically significant ($p < 0.05$), as presented in **Table 3**.

Table 3. Comparison of treatment costs across different departments

Department	Treatment cost (¥)	Surgery cost (¥)
Orthopedics	1,898.39	15.46
Acupuncture	7,126.03	11.05
<i>t</i> -value	1653.12	122.311
<i>p</i> -value	< 0.001	< 0.001

3.4. Comparison of laboratory test costs across different departments

The study results demonstrate that the orthopedic department had significantly higher laboratory test costs compared to the acupuncture department ($p < 0.05$), with statistical significance in the data comparison, as detailed in **Table 4**.

Table 4. Comparison of laboratory test costs across different departments

Department	Laboratory test cost (¥)
Orthopedics	914.54
Acupuncture	257.41
<i>t</i> -value	587.75
<i>p</i> -value	< 0.001

3.5. Comparison of nursing and other costs across different departments

The research findings show that the orthopedic department had significantly lower bed and nursing costs but higher other costs compared to the acupuncture department ($p < 0.05$), with statistical significance in the data comparison, as shown in **Table 5**.

Table 5. Comparison of nursing and other costs across different departments

Department	Bed cost (¥)	Nursing cost (¥)	Other costs (¥)
Orthopedics	284.76	246.81	108.53
Acupuncture	356.20	428.16	37.17
<i>t</i> -value	198.139	345.44	319.13
<i>p</i> -value	< 0.001	< 0.001	< 0.001

4. Discussion

Under the Diagnosis-Intervention Packet (DIP) payment model, the revenue structure of public hospitals undergoes fundamental changes. Medical insurance payments are no longer directly linked to project costs but are instead related to disease scores, treatment difficulty, and resource consumption intensity^[5]. This places higher demands on hospitals, requiring them to focus on cost-effective diseases and reduce the admission rate for inefficient diseases.

Standardized clinical pathways can effectively reduce actual costs. Ensuring accurate coding of diagnoses and surgical procedures is crucial to prevent payment deviations caused by coding errors^[6]. However, public hospitals currently face widespread issues such as scattered disease types, imbalanced treatment efficiency across departments, and inadequate cost control, which directly impact disease-related benefits. Significant differences may exist in treatment approaches, resource consumption, and clinical pathways for the same disease across different departments. Studies have indicated that diseases requiring surgical procedures tend to have higher scores, highlighting the need to guard against payment downgrades caused by mismatches between primary diagnoses and surgical procedures^[7].

For internal medicine, the focus is primarily on drug treatment and chronic disease management. While existing research often examines the impact of DIP payment on overall hospital benefits or compares benefits across different diseases, there is a lack of analysis on the benefits of the same disease across different departments^[8]. Analyzing disease-related benefits across departments can optimize the allocation of regional medical insurance budgets, prevent funds from being allocated to inefficient departments, and ensure that medical insurance funds are used for high-value medical services.

In the analysis of this study, treatment costs for patients in the acupuncture department were significantly higher than those in the orthopedics department, with statistical significance ($p < 0.05$). The reasons for this are as follows: orthopedics primarily involves surgical procedures, with resource consumption concentrated on consumables and disposable equipment, the costs of which can be reduced through centralized procurement. In contrast, acupuncture focuses on long-term traditional Chinese medicine treatments, relying heavily on human resources and time, resulting in higher treatment costs^[9]. In the comparison of drug costs, the acupuncture department had significantly lower drug costs than the orthopedics department, with statistical significance ($p < 0.05$). The reasons for this are that orthopedics primarily deals with single diseases with clear treatment pathways, making resource consumption easily standardizable. The proportion of drug costs may appear relatively reasonable due to higher costs associated with consumables and surgical procedures, but overall cost controllability is stronger. Furthermore, for rare or highly complex combined disease conditions, the adjustment coefficient for DIP scores may not accurately reflect the true costs, leading to a situation where the acupuncture department experiences low drug expenses but overall losses, while the orthopedics department can partially compensate for insufficient scores through surgical grading management. Examination costs in the acupuncture department are significantly lower than those in the orthopedics department ($p < 0.05$).

Analyzing the reasons, the acupuncture department often admits patients with complex disease conditions, necessitating comprehensive evaluations through multiple examinations. In contrast, the orthopedics department primarily treats single diseases with relatively fixed examination items, focusing on surgeries. Examination costs are concentrated on preoperative assessments and postoperative follow-ups. These examination items are well-defined, with controllable costs, albeit relatively high. Bed and nursing fees in the acupuncture department are higher than those in the orthopedics department ($p < 0.05$).

Analyzing the reasons, the acupuncture department primarily relies on long-term acupuncture and physical therapy, which are dependent on the technical expertise and multiple consultations of physicians. Patients require acupuncture three times a week for four weeks, resulting in high labor and time costs. Although bed and nursing fees are calculated on a daily basis, the cumulative costs are higher than those in the orthopedics department due to the prolonged treatment period. Additionally, acupuncture treatment often requires supplementary therapies such as “Tuina” (Chinese therapeutic massage) and cupping, further driving up nursing costs. The orthopedics department primarily focuses on surgical procedures, with short surgical cycles and lower cumulative bed and nursing fees. Although postoperative rehabilitation requires some nursing care, the overall cost proportion is significantly lower than that in the acupuncture department.

5. Conclusion

In summary, in the current context of the widespread implementation of the DIP payment model, conducting an in-depth analysis of the profitability of the same disease condition across different departments in public hospitals holds immense practical significance. This not only pertains to the hospital’s own operational management and sustainable development but also has far-reaching implications for enhancing the efficiency of medical resource utilization, safeguarding patient rights, and promoting the fairness and efficiency of the healthcare insurance system. Clinically, this warrants significant attention.

Disclosure statement

The authors declare no conflict of interest.

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Identification of Health Literacy Gaps in Preschool Teachers Regarding Students' Vision Protection: A Targeted Analysis Based on Item Response Rates

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Abstract: *Objective:* To investigate the current status of health literacy regarding children's vision protection among preschool teachers and to provide a basis for targeted training. *Methods:* A convenience sampling method was employed to conduct a questionnaire survey among 1,442 preschool teachers in Xiangyang City from April to June 2024. The questionnaire covered five dimensions: knowledge, beliefs, behaviors, skills, and policies. Item response rates were used to identify literacy gaps. *Results:* The overall vision protection literacy of preschool teachers exhibited characteristics of "strong beliefs but weak knowledge and skills". The item response rates for each dimension, from highest to lowest, were: beliefs (92.7%), policies (81.9%), behaviors (74.8%), knowledge (67.5%), and skills (58.3%). The core gaps were concentrated in the "knowledge" and "skills" dimensions, with significant deficiencies particularly in the understanding of the concept of "hyperopia reserve" (awareness rate: 27.6%), skills in guiding behaviors for myopia prevention and control (mastery rate: < 50%), and the ability to interpret vision screening results (complete mastery rate: 35.0%). *Conclusion:* Currently, there are significant structural deficiencies in the health literacy of kindergarten teachers regarding children's vision protection. In the future, greater emphasis should be placed on practical skills training, particularly in enhancing their practical abilities in areas such as "hyperopia reserve" cognition and interpretation of vision screening results.

Keywords: Kindergarten teachers; Myopia prevention and control; Health literacy; Shortcoming identification and targeted analysis

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1. Introduction

Childhood myopia is a major global public health challenge, showing a significant trend towards younger ages^[1,2]. The overall myopia rate among children and adolescents in China remains high, with the primary battleground for

prevention and control gradually shifting to the kindergarten stage^[3]. Health literacy refers to the ability to acquire, understand, and apply health information to make informed decisions. As key implementers of children's vision protection, kindergarten teachers' health literacy levels directly determine the effectiveness of early prevention and control efforts. Existing research has mostly focused on teachers' infectious disease or nutritional health literacy, with insufficient attention paid to vision protection literacy and a lack of in-depth analysis of the multidimensional literacy structure^[4,5]. The training that has been conducted has been relatively generalized, making it difficult to address such structural deficiencies^[6]. Therefore, this study introduced the "item response rate" as an assessment tool and conducted a questionnaire survey among kindergarten teachers to identify the weakest links in the literacy system and achieve "targeted positioning", providing a basis for constructing efficient intervention strategies.

2. Research subjects and methods

2.1. Research subjects

A questionnaire survey was conducted among in-service teachers from 32 kindergartens (20 public and 12 private) in Xiangyang City from April to June 2024 using convenience sampling. A total of 1,442 valid questionnaires were ultimately collected. This study has been approved by the hospital ethics committee (Approval No.: XYYYE20230110).

2.1.1. Inclusion criteria

- (1) On-the-job teachers with a kindergarten teacher qualification certificate
- (2) Voluntary participation in this study
- (3) On-the-job working time ≥ 3 months

2.1.2. Exclusion criteria

- (1) Questionnaire completion time less than 5 minutes
- (2) Obvious patterned responses
- (3) Missing key information exceeding 20%

2.2. Research methods

2.2.1. Survey instruments

- (1) General information questionnaire
This questionnaire encompasses eight aspects, including demographic characteristics, occupational attributes, and features of the workplace.
- (2) Health literacy evaluation questionnaire for student vision protection
Developed by Wang Yujie, it comprises 23 items across five dimensions: mastery of core knowledge about myopia, daily teaching behaviors, guidance on students' eye-use behaviors, promotion of outdoor activities, and creation of a conducive lighting environment for teaching^[7]. The Cronbach's α coefficient for this questionnaire in our study was 0.810.

2.3. Data collection and quality control

Questionnaires were distributed using a combination of online (via Questionnaire Star) and offline methods. Prior to the formal survey, surveyors underwent unified training, and consent was obtained from relevant school

departments. All questionnaire items were set as mandatory, and after collection, invalid questionnaires were identified and excluded through double verification.

2.4. Statistical analysis

Statistical analysis was conducted using SPSS 26.0. Continuous data conforming to a normal distribution were expressed as $M \pm SD$, while those not conforming to a normal distribution were presented as median (P25, P75). Categorical data were described using frequencies and percentages.

3. Research findings

3.1. Basic information of survey participants

A total of 1,450 questionnaires were distributed in this study, with 1,442 valid questionnaires retrieved, yielding an effective response rate of 99.7%. The survey participants were predominantly female (98.2%), with an average age of 32.5 ± 6.8 years and a median teaching experience of 5 years (IQR: 3–9 years). Detailed demographic characteristics are presented in **Table 1**.

Table 1. General information (N = 1,442)

Item	n	%	Item	n	%
Age			Married	1241	86.1
20–29 years	315	21.8	Divorced or widowed	16	1.1
30–39 years	785	54.4	Professional Title		
40–49 years	281	19.5	Junior	1034	71.7
≥ 50 years	61	4.2	Intermediate	339	23.5
Gender			Senior	69	4.8
Male	26	1.8	Teaching Experience (years)	5.0 (3.0, 9.0)	
Female	1416	98.2	Homeroom Teacher		
Education Level			Yes	625	43.3
College or below	1188	82.4	No	817	56.7
Bachelor's Degree	249	17.3	School Type		
Master's Degree or above	5	0.3	Public	447	31.0
Marital Status			Private	995	69.0
	185	12.8			

3.2. Analysis of literacy in each dimension

3.2.1. Mastery of core knowledge on myopia

Table 2 reveals significant differences among teachers in their mastery of core knowledge on myopia. While there is a high recognition rate (91.9%) for typical myopia symptoms (such as squinting when viewing objects), the awareness rate for “inattention as an early sign” is only 53.0%. Additionally, 34.6% of teachers mistakenly believe that traditional Chinese medicine therapies can cure myopia, and the awareness rate for knowledge about hyperopia reserve is the lowest (27.6%).

Table 2. Dimension of mastery of core knowledge on myopia (N = 1442, %)

Item & description	Response	n	%
Q1: Knowledge of early signs of myopia			
1) Head tilting, squinting	Yes	1201	83.3
	No	137	9.5
	Don't know	104	7.2
2) Frequent blinking, pulling corner of eye	Yes	1208	83.8
	No	136	9.4
	Don't know	98	6.8
3) Poor concentration	Yes	764	53.0
	No	495	34.3
	Don't know	183	12.7
4) Squinting, frequent eye rubbing	Yes	1325	91.9
	No	70	4.9
	Don't know	47	3.3
5) Close viewing distance	Yes	1373	95.2
	No	46	3.2
	Don't know	23	1.6
Q2: Knowledge of factors influencing myopia			
1) Correct reading/writing posture	Yes	1437	99.7
	No	2	0.1
	Don't know	3	0.2
2) Limiting electronic device use	Yes	1430	99.2
	No	8	0.6
	Don't know	4	0.3
3) Daytime outdoor activity	Yes	1413	98.0
	No	15	1.0
	Don't know	14	1.0
4) Relaxing eyes (e.g., looking into distance) after prolonged near work	Yes	1415	98.1
	No	10	0.7
	Don't know	17	1.2
5) Adequate sleep	Yes	1430	99.2
	No	5	0.3
	Don't know	7	0.5
Q3: After detecting early signs of myopia in students, they can promptly remind the students or provide feedback to their parents.	No responsibility	25	1.7
	A little responsibility	283	19.6
	Neutral	10	0.7

Table 2 (Continued)

Item & description	Response	n	%
	Considerable responsibility	501	34.7
	Great responsibility	623	43.2
Q4: Knowledge that myopia is preventable but not yet curable, and how to respond			
1) Measures can be taken to prevent worsening after onset	Agree	1283	89.0
	Disagree	85	5.9
	Don't know	74	5.1
2) Child should visit a professional ophthalmology clinic after onset	Agree	1421	98.5
	Disagree	12	0.8
	Don't know	9	0.6
3) Glasses are currently an effective correction method	Agree	1137	78.8
	Disagree	180	12.5
	Don't know	125	8.7
4) Myopia is preventable	Agree	1407	97.6
	Disagree	15	1.0
	Don't know	20	1.4
5) TCM therapies (acupuncture, massage) can cure myopia	Agree	499	34.6
	Disagree	442	30.7
	Don't know	501	34.7
Q5: Understanding of hyperopic reserve knowledge			
	Completely unaware	72	5.0
	Slightly aware	263	18.2
	Moderately aware	709	49.2
	Quite aware	245	17.0
	Very aware	153	10.6
Q6: Willingness to actively seek information on student myopia prevention			
	Very unwilling	36	2.5
	Reluctant	16	1.1
	Neutral	27	1.9
	Willing	439	30.4
	Very willing	924	64.1
Q7: Perceived difficulty of myopia prevention knowledge disseminated by health departments			
	Very difficult	19	1.3
	Difficult	83	5.8
	Somewhat difficult	251	17.4
	Fairly easy	855	59.3
	Very easy	234	16.2

3.2.2. Daily teaching behaviors

Teaching behaviors exhibit the following characteristics: 86.1% of teachers refuse to use electronic products as rewards, yet 38.2% believe that teaching and caregiving behaviors have little relation to vision. The implementation rate of fine handicraft teaching is relatively low (56.4%), as shown in **Table 3**.

Table 3. Dimension of daily teaching (caregiving) behaviors (N = 1442, %)

Item & description	Response	n	%
Q8: Understanding of appropriate use of multimedia devices and scientific childcare/education			
1) Teaching children hard pen calligraphy	Agree	583	40.4
	Disagree	758	52.6
	Don't know	101	7.0
2) Teaching children fine motor activities (e.g., beading, cross-stitch)	Agree	814	56.4
	Disagree	567	39.3
	Don't know	61	4.2
3) Using multimedia devices for less than 30% of teaching activity time	Agree	1241	86.1
	Disagree	151	10.5
	Don't know	50	3.5
4) Paying attention to the clarity and resolution of videos/images used in multimedia teaching	Agree	1257	87.2
	Disagree	133	9.2
	Don't know	52	3.6
5) Using phone/tablet time as a reward for good behavior	Agree	164	11.4
	Disagree	1242	86.1
	Don't know	36	2.5
Q9: Understanding the relationship between teaching practices and children's vision	No relationship	34	2.4
	A slight relationship	326	22.6
	Moderate relationship	190	13.2
	Strong relationship	365	25.3
	Very strong relationship	527	36.5
Q10: Perceived necessity of strictly following kindergarten schedules	Very unnecessary	67	4.6
	Sometimes necessary	121	8.4
	Neutral	17	1.2
	Quite necessary	290	20.1
	Very necessary	947	65.7

3.2.3. Guidance on eye-use behaviors

There is a polarization in the ability to guide eye-use behaviors: 98.2% of teachers can correctly guide reading postures, but 15.2% agree with continuous reading for 1 hour, and 87.7% disagree with continuous video viewing for 40 minutes, as seen in **Table 4**.

Table 4. Dimension of guidance on students' eye-use behaviors (N = 1442, %)

Item & description	Response	n	%
Q11: Knowledge of correct reading posture and eye rest methods/frequency			
1) Continuous reading of picture books for one hour	Agree	219	15.2
	Disagree	1202	83.4
	Don't know	21	1.5
2) Continuous viewing of teaching videos for 40 minutes	Agree	157	10.9
	Disagree	1265	87.7
	Don't know	20	1.4
3) Eye rest methods can include looking into the distance by a window, doing eye exercises	Agree	1405	97.4
	Disagree	28	1.9
	Don't know	9	0.6
4) Maintaining correct posture while reading: eyes one foot from book, chest one fist from desk edge	Agree	1416	98.2
	Disagree	18	1.2
	Don't know	8	0.6
5) Daily screen time for children should not exceed 3 hours	Agree	1133	78.6
	Disagree	280	19.4
	Don't know	29	2.0
Q12: Remind young children to rest their eyes by looking into the distance, closing their eyes, or doing eye exercises after prolonged eye use.	No responsibility	14	1.0
	A little responsibility	186	12.9
	Neutral	14	1.0
	Considerable responsibility	501	34.7
	Great responsibility	727	50.4

3.2.4. Promotion of outdoor activities

The results in **Table 5** indicate misconceptions about outdoor activities: 77.0% of teachers agree with the importance of 2 hours of daily outdoor activities, but 66.3% disagree that “only outdoor activities can prevent myopia”, and 17.8% are unaware that indoor activities can also have a preventive effect.

Table 5. Dimension of promotion of outdoor activities (N=1442, %)

Item & description	Response	n	%
Q13: Perceived requirement from education department/school for children's daily daytime outdoor activity duration	0.5 hours	67	4.6
	1 hour	179	12.4
	2 hours	881	61.1
	3 hours	229	15.9
	No specific requirement	86	6.0

Table 5 (Continued)

Item & description	Response	n	%
Q14: Understanding the role of daytime outdoor activity in myopia prevention			
1) Exposure to outdoor natural light can effectively prevent myopia	Agree	1199	83.1
	Disagree	162	11.2
	Don't know	81	5.6
2) High-intensity indoor exercise can prevent myopia	Agree	343	23.8
	Disagree	951	66.0
	Don't know	148	10.3
3) Only outdoor activity can prevent myopia onset	Agree	395	27.4
	Disagree	956	66.3
	Don't know	91	6.3
4) Both indoor and outdoor activities can prevent myopia	Agree	1186	82.2
	Disagree	158	11.0
	Don't know	98	6.8
5) If no time during day, more outdoor activity at night can prevent myopia	Agree	318	22.1
	Disagree	1015	70.4
	Don't know	109	7.6
Q15: Understanding the importance of assigning physical exercise homework during holidays	Not important	31	2.1
	Slightly important	44	3.1
	Moderately important	257	17.8
	Important	595	41.3
	Very important	515	35.7

3.2.5. Lighting environment for teaching

There is a relatively good awareness of light environment management: 96.0% of teachers attach importance to classroom lighting, and 78.8% pay attention to the choice of wall colors. However, there is a relatively weak awareness of lighting equipment maintenance (61.4%), as shown in **Table 6**.

Table 6. Dimensions of creating a lighting environment for teaching (N = 1,442, %)

Item & description	Response	n	%
Q16: Knowledge of classroom lighting standards and requirements			
1) Ensure adequate and uniform lighting in the classroom	Agree	1426	98.9
	Disagree	9	0.6
	Don't know	7	0.5
2) Install and use curtains properly to avoid direct sunlight	Agree	1397	96.9
	Disagree	36	2.5
	Don't know	9	0.6
3) Appropriate light fixture placement to reduce glare	Agree	1415	98.1

Table 6 (Continued)

Item & description	Response	n	%
4) Blackboard/TV should ideally be over 3 meters from children	Disagree	20	1.4
	Don't know	7	0.5
	Agree	1384	96.0
	Disagree	45	3.1
	Don't know	13	0.9
5) Classroom walls should use high-chroma, low-brightness colors	Agree	1136	78.8
	Disagree	202	14.0
	Don't know	104	7.2
	Very unnecessary	29	2.0
	Sometimes necessary	220	15.3
Q17: Perceived necessity of adjusting curtains based on weather or multimedia use	Neutral	39	2.7
	Quite necessary	443	30.7
	Very necessary	711	49.3
	Very unnecessary	26	1.8
	Sometimes necessary	205	14.2
Q18: Perceived necessity of adjusting lights based on weather or multimedia use	Neutral	24	1.7
	Quite necessary	431	29.9
	Very necessary	756	52.4
	Very unnecessary	28	1.9
	Sometimes necessary	179	12.4
Q19: Perceived necessity of adjusting front lighting to reduce screen glare	Neutral	24	1.7
	Quite necessary	452	31.3
	Very necessary	759	52.6
	Very unnecessary	34	2.4
	Sometimes necessary	175	12.1
Q20: Perceived necessity of adjusting screen brightness based on classroom light	Neutral	19	1.3
	Quite necessary	417	28.9
	Very necessary	797	55.3
	Very unnecessary	31	2.1
	Sometimes necessary	182	12.6
Q21: Perceived necessity of using appropriate color schemes in teaching slides	Neutral	31	2.1
	Quite necessary	431	29.9
	Very necessary	767	53.2
	Very unnecessary	32	2.2
	Sometimes necessary	93	6.4
Q22: Perceived necessity of frequently asking students if they can see clearly	Neutral	16	1.1
	Quite necessary	339	23.5
	Very necessary	962	66.7
	Very unnecessary	32	2.2
	Sometimes necessary	93	6.4
Q23: Sense of responsibility to report faulty equipment	Neutral	25	1.7
	Considerable responsibility	414	28.7
	Great responsibility	886	61.4
	No responsibility	11	0.8
	A little responsibility	106	7.4

4. Discussion

4.1. Knowledge dimension: The coexistence of core concept deficiencies and cognitive biases

Teachers have three significant weaknesses in their knowledge of myopia prevention and control. Firstly, there are misconceptions regarding the early manifestations of myopia. Over half of the teachers consider “inattention” as a typical symptom, reflecting that their understanding remains at the level of behavioral manifestations and lacks knowledge of the neurobehavioral manifestations involved in “myopia precursor syndrome”^[8]. Secondly, there are cognitive biases such as the belief that “traditional Chinese medicine therapies can cure myopia”. Research indicates that traditional Chinese medicine therapies can only assist in relieving visual fatigue and cannot provide a radical cure^[9]. Such cognitions may mislead prevention and control decisions and delay scientific interventions. The most prominent issue is the severe lack of awareness of “hyperopia reserve”^[10,11]. As a key physiological indicator for predicting the onset of myopia, its awareness rate is only 27.6%. This is partly due to the relatively short period of time this concept has been popularized as an academic frontier, and partly reflects the lag in updating the content of post-employment training for teachers^[12].

4.2. Behavioral dimension: The coexistence of disconnection between knowledge and action and cognitive misunderstandings

This study found that teachers exhibit significant “disconnection between knowledge and action” and key cognitive misunderstandings in the behavioral dimension. Firstly, there is a clear disconnect between cognition and behavior: although over 80% of teachers agree that multimedia usage time should be limited, less than 60% of teachers support activities such as calligraphy with a hard-tipped pen and fine handicrafts as alternatives. This indicates that correct eye care concepts have not been effectively translated into specific alternative teaching behaviors. Secondly, nearly four in ten (38.2%) teachers believe that daily teaching and care behaviors have “little relationship” with children’s vision. This cognitive bias directly leads them to overlook the timely correction of children’s eye habits and the reasonable arrangement of outdoor activities during the teaching process.

4.3. Guidance dimension: Shortcomings in time management and hazard awareness

In the guidance dimension, teachers exhibit two notable deficiencies. Some teachers misjudge the safe duration of eye use, overlooking the necessity of intermittent eye-use guidance, resulting in the ineffective implementation of scientific rules such as the “20-20-20” principle. Additionally, while teachers can recognize the hazards of prolonged electronic screen viewing, they generally lack effective non-electronic alternatives and classroom management strategies in practical teaching. This indicates that guidance training should focus on two key areas: first, reinforcing intermittent rest norms for all near-vision activities, including picture book reading; and second, providing systematic, low-electronic-dependence teaching strategies to help teachers genuinely integrate protective measures such as outdoor activities into daily teaching schedules.

4.4. Outdoor activity promotion dimension: Limitations in activity quality awareness

Research indicates that outdoor activities are crucial for preventing myopia, as natural light stimulates the retina to release dopamine, effectively inhibiting excessive axial elongation of the eye^[13]. In contrast, high-intensity indoor exercises have limited myopia prevention effects due to the lack of sufficient opportunities for distant viewing and natural light exposure; they may even exacerbate visual strain when conducted in poorly lit indoor environments.

This study reveals that teachers have significant limitations in their understanding of outdoor activity quality, specifically manifested as: insufficient awareness of key parameters such as light intensity and spectral composition; unclear understanding of the prevention effects of different activity forms; and, additionally, some teachers' skepticism about the positive effects of indoor activities. Therefore, it is essential to enhance professional training for teachers to deepen their understanding of the photobiological mechanisms of outdoor activities in preventing myopia and to equip them with methods for scientifically organizing indoor and outdoor activities. Simultaneously, the role of families in myopia prevention must be emphasized, with coordinated interventions in areas such as home lighting and eye-use behavior supervision, to establish a comprehensive prevention system involving "school-family-society" collaboration ^[14].

4.5. Teaching lighting environment dimension: Disconnect between cognition and practice

This study found that teachers demonstrated a relatively high level of cognitive proficiency in creating optimal lighting environments for teaching, indicating a satisfactory effectiveness in disseminating relevant knowledge. However, a notable gap between "cognition and practice" persists in the specific selection and daily maintenance of lighting equipment. This discrepancy arises because the selection of lighting equipment involves professional parameters such as color temperature, illuminance, and glare control, which exceed the current knowledge scope of most teachers. Additionally, variations in classroom structure, area, and natural lighting conditions among different classrooms complicate the application of uniform standards. Therefore, future improvements should include providing teachers with practical training on the selection and maintenance of lighting equipment, transforming theoretical knowledge into specific actionable guidelines. Furthermore, schools should increase investment to upgrade hardware facilities and create a scientifically designed visual lighting environment.

5. Summary and prospects

Through targeted analysis of item response rates, this study systematically identified the shortcomings in the literacy of kindergarten teachers across five dimensions: core knowledge on myopia prevention and control, teaching behaviors, guidance on eye use, outdoor activities, and lighting environment creation. These findings provide empirical evidence for implementing precise interventions. However, the study has two limitations: constrained by the questionnaire survey method, it was unable to obtain the scoring algorithms of the original scales, which limited the construction of a comprehensive scoring system and the application of complex models. Additionally, the sample was limited to the kindergarten stage, so the generalizability of the conclusions requires further validation through cross-grade studies. Future research could focus on developing more refined assessment tools and employing various methods such as field observations and interviews to deeply explore the mechanisms influencing teacher behaviors. Simultaneously, expanding the research scope to include primary and secondary schools and conducting cross-grade comparisons and follow-up studies will facilitate the construction of a more comprehensive vision protection network within the educational system.

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Multidisciplinary Collaborative and Refined Nursing for a Patient with Severe Toxic Epidermal Necrolysis

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Abstract: This paper summarizes the nursing experience of a 75-year-old patient who developed exfoliative dermatitis-type drug eruption induced by cold medicine and progressed to toxic epidermal necrolysis (TEN). The core nursing measures included (1) Establishing a multidisciplinary team and implementing bundled care led by trauma specialist nurses; (2) Precise wound management using the “three-stage debridement method” and silver ion dressings; (3) Implementing multimodal analgesia based on dynamic pain assessment; (4) Strengthening fluid, electrolyte, and nutritional management; and (5) Providing individualized psychological support. After 14 days of treatment and nursing, the patient's wounds were completely epithelialized, infection indicators returned to normal, pain was effectively controlled, and the patient was discharged successfully. No serious complications were observed during the 6-month follow-up. For elderly critically ill patients with TEN, constructing a systematic nursing model based on multidisciplinary collaboration and centered on trauma care is crucial for improving patient outcomes.

Keywords: Toxic epidermal necrolysis; Exfoliative dermatitis-type drug eruption; Multidisciplinary collaboration; Critical care nursing; Wound management

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1. Introduction

Toxic epidermal necrolysis (TEN), as the ultimate critical manifestation of drug eruptions, continuously challenges the limits of clinical care with its high mortality rate and complex nursing requirements. Although international consensus guidelines have underscored the centrality of supportive care, translating universal recommendations into efficient and precise nursing pathways tailored to vulnerable elderly patients remains a challenge in clinical practice^[1]. This paper reports a case of an elderly patient with rapidly progressing TEN induced by cold medicine, demonstrating the practical efficacy of a bundled nursing approach led by trauma specialist nurses and deeply

integrated with multidisciplinary collaboration.

2. Clinical data

2.1. Case overview

A 75-year-old female patient was admitted to the emergency department with a 3-day history of erythema, blisters, and extensive epidermal desquamation across her entire body following the oral administration of cold medication. Three days prior to admission, she had a clear history of taking cold medicine. The skin lesions initially appeared on the hands and feet and rapidly spread to cover over 90% of her body surface area, accompanied by high fever and severe pain.

2.1.1. Past medical history

40-year history of hypertension; a long-standing history of rheumatoid arthritis, for which she had been taking immunosuppressants regularly; and a history of chronic bronchitis for many years.

2.1.2. Physical examination upon admission

T 37.6°C, P 110 beats/min, R 20 breaths/min, BP 152/85 mmHg. BMI 18.4 kg/m². Dermatological examination: diffuse dark red patches across the body, with numerous flaccid blisters, bullae, and widespread epidermal desquamation. Positive Nikolsky's sign. Significant serous exudate from eroded areas with marked tenderness. Erosions visible on the oral mucosa.

2.2. Auxiliary examinations

2.2.1. Laboratory tests

PCT 2.19 ng/mL, CRP 296.2 mg/L, neutrophil percentage 85.2%. Red blood cell counts $2.98 \times 10^{12}/L$, hemoglobin 91 g/L, potassium 2.7 mmol/L, albumin < 30 g/L.

2.2.2. Imaging studies

Chest CT indicated infection in the lower lobes of both lungs.

2.3. Treatment and outcome

The patient was transferred to the ICU for treatment of septicemia on the second day after admission. Core treatments included: immediate discontinuation of the suspected allergenic drug and intravenous administration of hydrocortisone; empirical anti-infective therapy; specialized wound management; and systemic supportive care. Following treatment, the patient's condition was rapidly controlled. On the third day after transfer to the ICU, the procalcitonin (PCT) level decreased to 0.57 ng/mL. On the seventh day, the patient was transferred back to the dermatology ward and was discharged in improved condition on the 14th day. No long-term sequelae were observed during the 6-month follow-up.

3. Nursing assessment and intervention

For this critically ill TEN patient with a high risk of complications, this study has established a multidisciplinary

team (MDT) and implemented an evidence-based bundled nursing strategy. The core of nursing practice focused on wound management, infection prevention and control, systemic functional support, and patient comfort, as detailed below.

3.1. MDT collaboration and holistic nursing management

An MDT team comprising dermatologists, critical care physicians, specialist nurses, clinical pharmacists, nutritionists, and rehabilitation therapists was formed. Daily joint rounds were conducted to collaboratively determine treatment plans. The charge nurse coordinated the development of a “TEN Bundled Nursing Protocol”, which integrated the following core elements: (1) precise wound care and sterile isolation; (2) systemic functional support and maintenance of internal environment stability; (3) multimodal analgesia and comfort-oriented care; and (4) individualized nutrition and psychological support. This framework ensured the proactive, systematic, and consistent delivery of nursing care.

3.2. Precision nursing for wound and infection management

As wounds represent the primary portal of infection and a key focus of care in TEN patients, the team abandoned traditional aggressive debridement methods and adopted a gentle “three-stage debridement approach”. First, the wound was irrigated with a large volume of warm normal saline to soften and remove loosened necrotic epidermis. Second, sterile iodophor solution was applied using a “rolling ball” technique for gentle disinfection, minimizing physical trauma to newly formed epithelium. Finally, sterile scissors were used to precisely excise fully detached necrotic tissue.

3.2.1. Dressing selection and application

After debridement, a double-layer dressing consisting of “silver ion dressing + non-adhesive gauze” was applied. The silver ion dressing directly covers all the eroded areas, leveraging its broad-spectrum antibacterial properties and ability to absorb exudate to effectively control local bacterial load. The outer layer was secured with soft, non-adhesive gauze, ensuring breathability while minimizing secondary injury and pain during dressing changes. All procedures were performed under strict aseptic technique.

3.2.2. Environmental isolation and monitoring

The patient was placed in a single-room negative-pressure ward and subjected to contact isolation. The environment was disinfected daily using an air disinfection machine. The wound was closely monitored, with daily records kept of changes in its area, color, characteristics of exudate, and odor. This has provided intuitive evidence for doctors to assess the status of infection control.

3.3. Supportive nursing for systemic functions

TEN can lead to dysfunction in multiple systemic systems, and systemic support is the cornerstone for maintaining stable vital signs.

3.3.1. Fluid management and electrolyte balance

An accurate 24-hour fluid intake and output record sheet was established, with summaries and analyses conducted at each shift. The infusion rate and crystalloid-to-colloid ratio were dynamically adjusted based on the

patient's central venous pressure, blood pressure, urine output, and skin turgor. For issues such as hypokalemia and hypocalcemia, electrolyte solutions were administered at a constant rate through a deep venous access as prescribed, with electrolyte levels monitored every 4 hours until stable.

3.3.2. Liver function maintenance

Considering the patient's advanced age, long-term use of immunosuppressants, and potential risk of liver injury, the team closely observes for jaundice of the skin and sclera and dynamically monitors liver function indicators. When administering medications, preference was given to regimens with minimal impact on the liver, avoiding known hepatotoxic drugs.

3.3.3. Respiratory support and airway care

Given the patient's chronic bronchitis and pulmonary infection, the team provides nasal cannula oxygen to maintain SpO₂ above 95%. Airway humidification was enhanced, and the patient was assisted in effective coughing and deep breathing. Oral care was performed with sodium bicarbonate solution to prevent fungal infections and maintain airway patency.

3.4. Multimodal analgesia and comfort care

Pain is the most distressing symptom for patients with TEN. The team employs a multimodal analgesia approach, combining pharmacological and non-pharmacological interventions.

3.4.1. Pain assessment

Systematic pain assessments were conducted every 4 hours using the Numerical Rating Scale (NRS), with dynamic assessments particularly performed before, during, and after dressing changes.

3.4.2. Pharmacological interventions

Pregabalin was administered orally as prescribed to control neuropathic background pain. Short-acting analgesics were preemptively given before procedural pain, such as dressing changes, to manage anticipated pain.

3.4.3. Non-pharmacological interventions

The ward environment was kept quiet with an appropriate room temperature. A specially designed burn support bed was used to prevent direct contact between bedding and the wound. Patients were assisted into comfortable positions and regularly repositioned along the axis. Thirty minutes before dressing changes, cold compresses were applied to non-injured areas near the wound to divert attention and reduce pain sensitivity. During procedures, attention was diverted through verbal communication and playing soothing music.

3.5. Individualized nutrition and psychological support

The patient presented with hypoproteinemia and malnutrition upon admission. In addition to parenteral nutrition support, the team successfully established a jejunal feeding tube within 48 hours of admission, initiating early enteral nutrition. Based on the patient's energy expenditure and protein requirements, a dietitian formulated a high-protein, high-vitamin nutritional regimen. Daily monitoring of gastric residual volume was conducted to assess feeding tolerance, ensuring the smooth implementation of nutritional support and providing a material foundation

for wound healing.

Faced with the sudden onset of a severe illness and changes in physical appearance, the patient exhibited significant anxiety and fear. The team implemented the following measures.

(1) Establishing a trusting relationship

Proactive communication was initiated, using empathetic language to understand the patient's distress.

(2) Cognitive intervention

The disease process and the purposes of various treatments were explained in layman's terms to help rebuild a sense of control.

(3) Enhancing social support

While strictly adhering to infection control protocols, family members were encouraged to provide emotional support through video calls and other means.

Through systematic psychological interventions, the patient's level of cooperation significantly improved, creating a positive psychological environment for recovery.

4. Discussion

Toxic epidermal necrolysis (TEN) is a life-threatening, severe dermatological condition, and its management is a complex undertaking that involves multiple systems and stages. The successful treatment of a 75-year-old patient in this case depended not only on timely medical diagnosis but also on a systematic, meticulous, and compassionate nursing management system. Based on this case, this paper delves deeply into the critical aspects of nursing care.

4.1. Multidisciplinary collaboration and specialist nurse leadership: Laying the foundation for efficient treatment

The treatment of TEN cannot be accomplished by a single department alone; this study fully demonstrates the core value of the multidisciplinary team (MDT) model. By leveraging resources from multiple disciplines, the MDT optimizes decision-making processes ranging from anti-infective strategies and immunomodulatory regimens to nutritional support^[1]. Critically, within the MDT framework, the "Specialized Wound Care Team", led by wound ostomy continence nurses, plays a pivotal role. This team was responsible not only for performing complex wound debridement and dressing selection but also for wound assessment, fine-tuning treatment plans, and providing feedback on outcomes, ensuring continuity and expertise in wound management. This model of "medical decision-making with nursing-led execution" elevates the role of specialized nursing from mere order execution to that of a problem solver and manager for specific nursing challenges^[2]. This represents a key distinction from routine basic nursing and a core element in enhancing nursing quality and patient outcomes.

4.2. Addressing both physical and psychological needs: Recognizing the dual suffering of elderly ten patients

Advanced age is one of the risk factors for poor prognosis in TEN, necessitating particular attention to both physiological and psychological dimensions during nursing care. Physiologically, elderly patients exhibit heightened pain sensitivity and reduced tolerance, often accompanied by cognitive and communicative impairments. In this case, we employed a "baseline analgesia + breakthrough pain control" strategy, combined

with dynamic assessment using multiple tools such as the Numerical Rating Scale (NRS), Behavioral Pain Scale (BPS), and Critical-Care Pain Observation Tool (CPOT), effectively achieving personalized and precise pain management. This approach helps avoid stress responses and complications caused by pain itself ^[3,4]. Psychologically, the body image disturbances resulting from extensive skin lesions can be devastating to patients, often triggering severe anxiety, depression, and even treatment refusal ^[4]. We constructed a safe psychological environment for patients by establishing a therapeutic trust relationship, employing open communication techniques, and actively mobilizing the family support system. This intervention, which places equal emphasis on “technical skills” and “empathy”, effectively fills the psychological void often overlooked in critical care. It serves as an intrinsic driving force for promoting active patient cooperation and achieving holistic recovery.

4.3. Precision infection control amidst barrier failure: Safeguarding the last line of defense for life

The skin is the most crucial physical barrier of the human body. The widespread failure of this barrier in patients with TEN renders them nearly equivalent to a “massive open wound”, with infection posing the most direct and lethal threat ^[5,6]. Therefore, the significance of the “environment-wound-personnel” trinity infection control measures adopted in this case cannot be overstated. The use of protective isolation and sterile laminar flow wards cuts off exogenous infection pathways; wound management based on the “three-stage debridement method” aims to control endogenous sources of infection; and strict adherence to hand hygiene and sterile procedures serves as a critical link connecting all aspects to prevent cross-infection. Our practice closely aligns with the standardized procedures recommended in the literature, with an added emphasis on thorough and consistent execution. This approach successfully kept infection indicators within safe limits, thereby winning precious time for subsequent treatment ^[6].

4.4. Systematic homeostasis support: The foundation for maintaining organ function

Faced with continuous loss of body fluids, proteins, and electrolytes due to extensive exudation over the entire body surface, maintaining internal environmental stability is central to preventing shock and multiple organ failure (MOF) ^[3]. The nursing focus in this case was on precise fluid management, timely albumin supplementation, and electrolyte correction. By closely monitoring central venous pressure (CVP), hourly urine output, and daily weight, we fine-tuned fluid replacement protocols to ensure effective tissue perfusion while avoiding excessive volume overload. Simultaneously, dynamic supplementation based on serum albumin and electrolyte levels provided the necessary material foundation for wound repair. This series of systematic supportive measures directly counteracts the core pathophysiological processes of TEN, serving as the fundamental guarantee to help patients navigate through the acute critical phase and create conditions for tissue regeneration.

5. Conclusion

The successful treatment of an elderly patient with TEN demonstrates that a comprehensive nursing model, framed by multidisciplinary collaboration, centered on trauma specialist nursing, and incorporating precise infection control and systematic support, can effectively improve patient prognosis. Future nursing practices should focus on transforming such experiences into standardized nursing pathways and enhancing specialized training for nurses to provide high-quality nursing services for complex and critically ill patients.

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Disclosure statement

The authors declare no conflict of interest.

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A Qualitative Study on Diagnosing Myopia Using the Ratio of Axial Length to Corneal Radius of Curvature

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Abstract: *Objective:* To investigate the influence of axial length (AL), corneal curvature (CR), and the ratio of axial length to corneal radius of curvature (AL/CR) on myopia in children, and to evaluate the accuracy and specificity of AL/CR in diagnosing myopia in children. *Methods:* A cross-sectional study was conducted. A total of 200 children (400 eyes) aged 6–12 years were recruited from the ophthalmology outpatient clinic of Fuling District People's Hospital from December 2022 to December 2023. AL, CR, and AL/CR were measured, and comprehensive optometry was performed under cycloplegia, with the results recorded in spherical equivalent (SE) form. *Results:* A total of 200 subjects (400 eyes) were included in this study, of which 330 eyes (82.50%) were myopic. No significant differences in CR were observed among different refractive groups, while significant differences were noted in SE, AL, and AL/CR. The AL and AL/CR ratios were higher in myopic eyes compared to emmetropic and hyperopic eyes. Using cycloplegia as the gold standard, SE in the myopia group was correlated with AL, AL/CR, and CR, with stronger correlations observed with AL and AL/CR. An AL/CR value > 3 demonstrated a sensitivity of 0.918, specificity of 0.786, misdiagnosis rate of 0.214, missed diagnosis rate of 0.082, and accuracy of 89.5% in diagnosing myopia. *Conclusion:* AL and AL/CR values are highly correlated with SE, with the strongest correlation observed in the myopia group. The AL/CR value exhibits high diagnostic value in determining myopia in children.

Keywords: Axial length; Corneal radius of curvature; Ratio of axial length to corneal radius of curvature; Myopia; Children

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1. Introduction

With the widespread use of electronic products and changes in human eye habits, the incidence of myopia is increasingly affecting younger populations and progressing at a faster rate, making it a primary cause of impaired eye health in children and adolescents ^[1]. According to 2023 data from China's National Health Commission,

myopia affects over half (52.7%) of the nation's children and adolescents. The prevalence escalates with educational stages, starting at 14.3% among 6-year-olds and climbing to a striking 80.5% by senior high school^[2]. According to the "2023 National Key Work Plan for Comprehensive Prevention and Control of Myopia in Children and Adolescents", the current focus of myopia prevention and control efforts remains on early diagnosis and timely intervention. The gold standard for clinically diagnosing myopia primarily involves examining uncorrected visual acuity, conducting retinoscopy and subjective refraction under cycloplegia, and using trial lenses. This standard offers high accuracy but has drawbacks such as cumbersome examination procedures and potential drug side effects. With advancements in ocular optical technology, parameters such as axial length (AL) and corneal radius (CR) can now be rapidly and accurately measured. Clinical studies have shown a correlation between the ratio of axial length to mean corneal radius (AL/CR) and myopia^[3]. This study aims to investigate the impact of AL, CR, and AL/CR values on myopia status in children aged 6–12 years by performing cycloplegic refraction and measuring AL, CR, and AL/CR. Additionally, it will conduct a correlation analysis of the aforementioned data to evaluate the sensitivity, specificity, and clinical practicality of AL/CR in diagnosing myopia.

2. Materials and methods

2.1. Materials

A cross-sectional study was conducted. This study collected data from 200 children (400 eyes), aged 6–12 years, who visited the ophthalmology clinic at Fuling District People's Hospital from December 2022 to December 2023. Among them, 102 were male (51%) and 98 were female (49%), with an average age of 9.3 ± 2.85 years.

This study adhered to the Declaration of Helsinki, and consent was obtained from both the participants and their guardians, who signed informed consent forms. The study was approved by the hospital's ethics committee (Ethics Review No.: KY2022-015-01).

2.1.1. Inclusion criteria

- (1) Children aged 6–12 years in primary school
- (2) Ability to cooperate with ophthalmic examinations such as cycloplegic refraction and slit-lamp examination
- (3) Signed informed consent

2.1.2. Exclusion criteria

- (1) Concurrent ocular conditions such as amblyopia or strabismus
- (2) History of ocular surgery or trauma
- (3) Concurrent systemic diseases

2.2. Methods

In this study, basic information such as age and gender of the participants was collected through a questionnaire survey. Ocular biological parameters, including refractive diopter, axial length, and corneal curvature, were measured to establish refractive profiles. Volunteers participating in the study were instructed to instill 0.5% compound tropicamide eye drops (Shenyang Xingqi Ophthalmic Pharmaceutical Co., Ltd.; 230901; 5 mL: 5 mg

tropicamide, 25 mg adrenaline hydrochloride) into both eyes, with 1–2 drops each time, every 5 minutes for a total of 4 times. Thirty minutes after the eye drops were administered, the degree of pupil dilation was examined using a laptop, followed by retinoscopy and trial lens examination. Relevant data were recorded in the refractive profiles^[5]. Refractive status was expressed as spherical equivalent (SE). Participants were classified based on their SE values as follows: myopia ($SE \leq -0.50D$), emmetropia ($-0.50D < SE < +0.50D$), and hyperopia ($SE \geq +0.50D$). All subjects were grouped according to the refractive diopter of a single eye. AL and CR were measured using the IOL.Master 300 (Carl Zeiss, Germany) optical biometer, and the average values were automatically calculated by the computer. The axial length-to-corneal radius ratio (AL/CR ratio) was calculated as AL divided by CR. All the aforementioned procedures were performed by the same senior optometrist.

2.3. Observation indicators

2.3.1. Spherical equivalent

Calculated using the formula: $SE = \text{Sphere} + 1/2 \text{ Cylinder}$.

2.3.2. Axial length

Measured using the IOL.Master 300 (Carl Zeiss, Germany) optical biometer, with the average value automatically calculated by the computer.

2.3.3. Corneal radius of curvature

Measured using the IOL.Master 300 (Carl Zeiss, Germany) optical biometer, with the average value automatically calculated by the computer.

2.4. Statistical analysis

Data management and statistical analysis were performed using SPSS 25.0. Quantitative data were described using mean \pm standard deviation ($\bar{x} \pm s$), while qualitative data were described using frequency and percentage [n(%)]. Single-factor analysis of variance was employed to compare refractive parameters between groups. For quantitative data following a normal distribution, Pearson correlation analysis was conducted, and regression equations were fitted. The diagnostic value of AL and AL/CR was compared using the area under the ROC curve.

3. Results

3.1. Comparison of refractive factors among subjects in different refractive groups

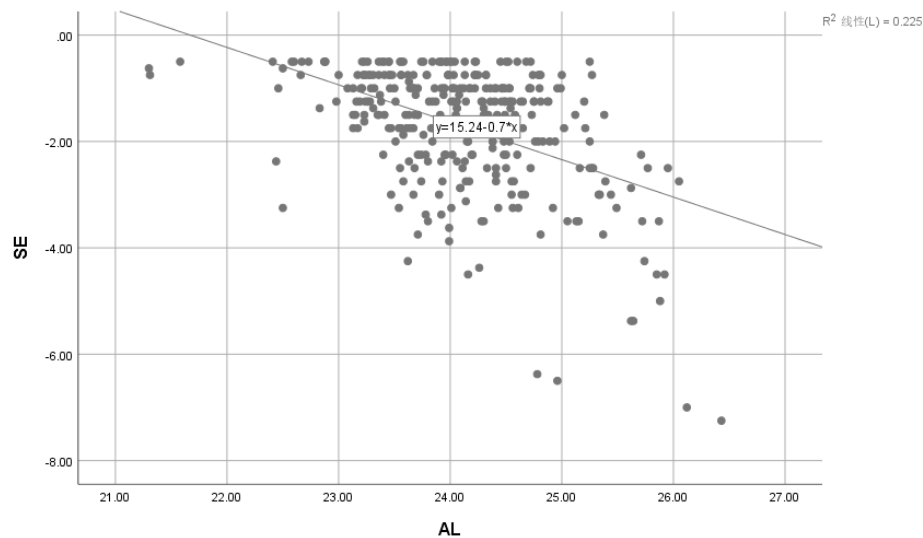
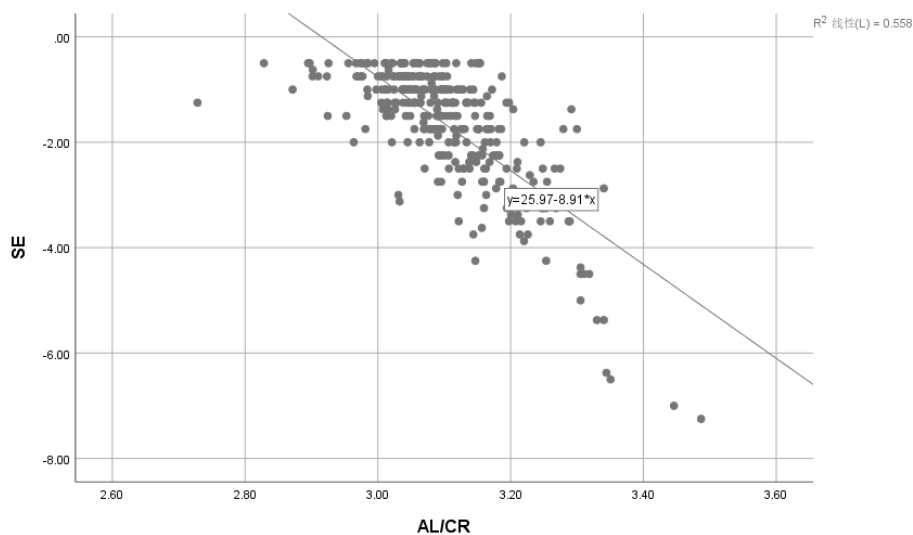
While the corneal radius (CR) did not differ significantly across refractive groups, significant variations were found in spherical equivalent (SE), axial length (AL), and the AL/CR ratio. The AL of myopic eyes was higher than that of emmetropic and hyperopic eyes, with statistically significant differences ($p < 0.001$). The AL/CR ratio in the myopic group was higher than that in the emmetropic and hyperopic groups, with statistically significant differences ($p < 0.001$). See **Table 1** for details.

Table 1. Comparison of refractive factors among subjects in different refractive groups

Group	Eyes n (%)	SE (D)	AL (mm)	CR (mm)	AL/CR
Myopia	330 (82.50)	-1.71 ± 1.15	24.10 ± 0.77	7.76 ± 0.25	3.11 ± 0.10
Emmetropia	45 (11.25)	0.04 ± 1.16	23.10 ± 0.81	7.74 ± 0.23	2.98 ± 0.06
Hyperopia	25 (6.25)	$+1.10 \pm 0.96$	22.24 ± 0.72	7.71 ± 0.22	2.89 ± 0.10
<i>F</i> -value		116.98	91.70	0.53	92.24
<i>p</i> -value		< 0.001	< 0.001	0.59	< 0.001

3.2. Correlation analysis of ocular parameters in the myopic group

The results indicated a significant correlation between SE and AL, AL/CR, and CR in the myopic group ($r = -0.474, -0.747, 0.244$, all $p < 0.001$). The linear relationships were as follows: $SE = 15.24 - 0.7 \times AL$ (see **Figure 1**), $SE = 25.97 - 8.91 \times AL/CR$ ratio (see **Figure 2**), and $SE = -10.53 + 1.14 \times CR$ (see **Figure 3**).

**Figure 1.** Linear regression analysis of SE and AL values in the myopic group (R^2 : 0.22).**Figure 2.** Linear regression analysis of SE and AL/CR values in the myopic group (R^2 : 0.56).

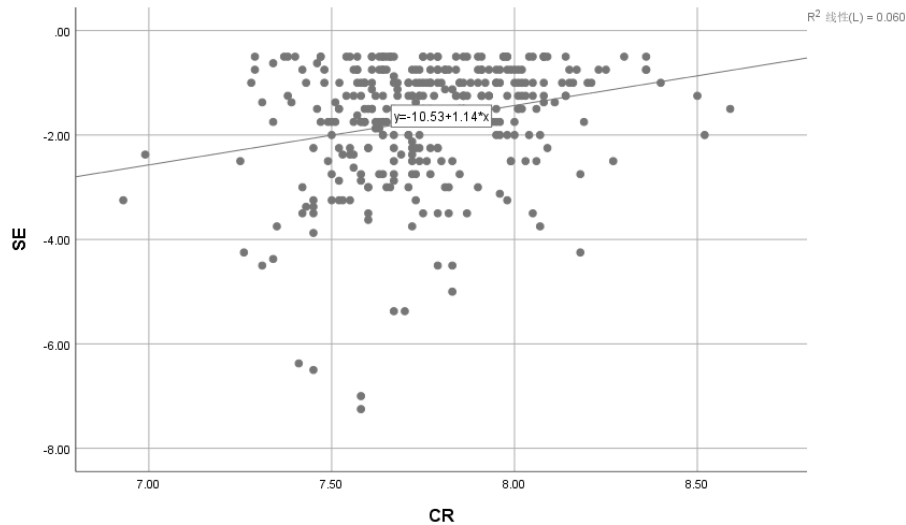


Figure 3. Linear regression analysis of SE and CR values in the myopic group (R^2 : 0.06).

Pearson correlation analysis was used to analyze the three groups, revealing a strong correlation between SE and AL and AL/CR ratios in the myopic group (both $p < 0.01$). See **Table 2** for details.

Table 2. Correlation of SE, AL, and AL/CR ratio among different groups of examinees

Refractive group	Eyes (n)	AL (mm)		AL/CR ratio	
		r	p-value	r	p-value
Myopia	330	-0.474	< 0.001	-0.747	< 0.001
Emmetropia	45	-0.165	0.279	-0.130	0.394
Hyperopia	25	-0.405	0.045	-0.756	< 0.001

3.3. Reliability analysis

Using cycloplegic optometry-derived spherical equivalent (SE) as the reference standard, the diagnostic performance of the axial length-to-corneal radius (AL/CR) ratio for myopia was evaluated. The analysis demonstrated high diagnostic reliability, with a sensitivity of 0.918 and an accuracy of 89.5%. The specificity was 0.786, resulting in a false positive rate of 0.214 and a false negative rate of 0.082. Furthermore, the positive and negative predictive values were 0.953 and 0.671, respectively, while the positive and negative likelihood ratios were 4.285 and 0.104. Excellent agreement with the reference standard was confirmed by a Kappa coefficient of 0.659. See **Table 3** for details.

Table 3. Diagnosis of myopia using se from optometry under cycloplegia and AL/CR ratio

Spherical equivalent (SE)	AL/CR Ratio		Total
	Non-Myopic (Negative)	Myopic (Positive)	
Non-Myopic (Negative)	55	15	70
Myopic (Positive)	27	303	330
Total	82	318	400

Note: In this study, myopia was diagnosed when SE from optometry under cycloplegia was $\leq -0.50D$ and the AL/CR ratio was > 3 .

Using the results of optometry under cycloplegia as the gold standard (reference line), the diagnostic performance of AL and AL/CR for myopia was analyzed using the ROC curve. The results showed that compared to AL, AL/CR had higher discriminatory power. The area under the ROC curve for AL was 0.863, with a standard error of 0.025 and a 95% confidence interval of 0.814–0.913; whereas the area under the ROC curve for AL/CR reached 0.904, with a standard error of 0.019 and a 95% confidence interval of 0.867–0.940. Regression analysis of AL, AL/CR, and SE revealed that for every 1-unit increase in the AL/CR ratio, myopia increased by 8.582D; for every 1mm increase in AL, myopia increased by 0.23D. Compared to the single AL indicator, an AL/CR ratio > 3 demonstrated a stronger correlation in reflecting changes in myopia in children. See **Figure 4** for details.

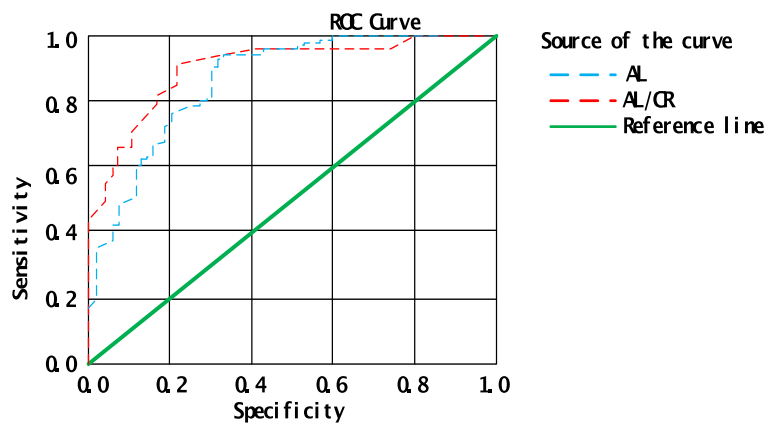


Figure 4. ROC curve of the model.

4. Discussion

The global prevalence of myopia is on the rise, with projections suggesting that by 2025, approximately 4.76 billion people worldwide will be affected by myopia, nearly one billion of whom will have high myopia ^[4]. The progression of myopia can lead to a variety of vision-impairing conditions, such as retinal degeneration, retinal tears, and vitreous opacities. Therefore, preventing the onset and progression of myopia is of paramount importance ^[5,6]. Myopia screening can aid in the early identification of children at high risk, enabling more timely and effective interventions to slow down the progression of myopia, thereby improving visual performance and enhancing quality of life ^[7]. Previous studies have indicated that childhood myopia is predominantly axial myopia, with the ratio of axial length (AL) to corneal radius (CR) being highly correlated with the degree of myopia ^[8]. In this study, 200 primary school students aged 6–12 years (400 eyes) were included, comprising 102 males (51%) and 98 females (49%). The average age was 9.3 ± 2.85 years. Among them, 45 eyes (11.25%) were emmetropic, 330 eyes (82.50%) were myopic, and 25 eyes (6.25%) were hyperopic. The proportion of myopic eyes significantly exceeded that of the other two groups, with findings similar to those of a study by Li Keran et al., which reported an 88.6% myopia rate in the 7–12-year-old primary school group among a 3–16-year-old population ^[9]. This indicates that myopia prevention and control remain a focal point in pediatric refractive clinics.

This study found statistically significant differences in AL, CR, and AL/CR values among different refractive groups by comparing these parameters in the subjects ($p < 0.01$). The hyperopic group had the shortest AL, while the myopic group had the longest AL. There was no statistically significant difference in CR among different

refractive groups ($p > 0.05$). However, there were statistically significant differences in AL/CR values among different refractive groups, with the myopic group having the highest AL/CR value and the hyperopic group having the lowest. These findings are similar to those of a study by Du Qibo et al. on 340 adolescents aged 4–16 years^[10]. Another study by Wang Hong et al. on 1011 individuals aged 3–17 years also demonstrated a high correlation between spherical equivalent (SE) and AL, AL/CR in the myopic group, with no statistically significant difference in CR^[11]. Pearson correlation analysis of ocular parameters in the myopic group in this study revealed correlations between SE and AL/CR, CR, and AL ($r = -0.474, -0.747, 0.244$, respectively, all $p < 0.001$), with strong correlations observed between SE and AL/CR, AL. These findings suggest that the onset of myopia is associated with a disproportionate ratio of ocular biological parameters. As myopia progresses, AL gradually increases, while CR shows little variation, leading to an increase in the AL/CR ratio. Some scholars believe that $AL/CR = 3$ is the critical point for the compensatory limit of ocular biometric parameters, and $AL/CR > 3$ can be regarded as a sensitive indicator for diagnosing myopia^[12–14]. He et al. argued that the optimal threshold for diagnosing myopia in children aged 6–12 is $AL/CR > 2.99$, but this conclusion only has a sensitivity of 83.05%^[15].

Based on the strong correlation between SE and AL/CR, this study used an AL/CR value > 3 as the positive threshold for diagnosing myopia. By comparing it with the gold standard SE results under cycloplegia, the accuracy and diagnostic value of this parameter in diagnosing myopia in children aged 6–12 in the primary school group were evaluated. The AL/CR ratio demonstrated high diagnostic efficacy for myopia, with a sensitivity of 0.918 and an accuracy of 89.5%. The test's ability to rule in myopia was strong, as evidenced by a positive predictive value of 0.953 and a positive likelihood ratio of 4.285. This means that using a cutoff of $AL/CR > 3$ correctly identified 95.3% of myopic cases. However, its ability to rule out myopia was more moderate, with a negative predictive value of 0.671 and a negative likelihood ratio of 0.104, indicating a 67.1% probability of non-myopia when the ratio was below the cutoff. The possibility of correctly diagnosing myopia was 4.285 times that of incorrectly diagnosing it. The possibility of incorrectly diagnosing non-myopia was 0.104 times that of correctly diagnosing it. Under the criterion of AL/CR ratio > 3 , the accuracy of correctly determining myopia in the 6–12 primary school group was 89.5%. The Kappa coefficient was 0.659, indicating moderate agreement. ROC curve analysis showed that compared with AL, AL/CR had the highest discriminatory power, with an area under the ROC curve of 0.863, a standard error of 0.025, and a 95% confidence interval of 0.814–0.913. This indicates that under the criterion of $AL/CR > 3$, the accuracy of diagnosing myopia is superior to that of AL. Simultaneously, regression analysis of AL, AL/CR, and SE revealed that for every unit increase in the AL/CR ratio, myopia will increase by 8.582D; for every 1 mm increase in AL, myopia will increase by 0.23D. Compared to the single AL indicator, AL/CR may be more sensitive in predicting the progression of myopia in children. The above indicates that $AL/CR > 3$ has a high diagnostic value in diagnosing myopia in children aged 6–12 in the primary school group.

Using ocular biometric instruments to assess AL, CR, and AL/CR values is an accurate, objective, and simple method for evaluating myopia. Compared with other methods, this approach is safe and convenient to operate, making it suitable for the professional classification of refractive status in children and adolescents. The measurement process for axial length (AL) and corneal radius (CR) is quick and easily accepted by children and adolescents. In scenarios involving large-scale population screenings or situations where effective cycloplegic refraction is not feasible, the AL/CR ratio can swiftly and efficiently diagnose myopia and predict its progression trends. However, this study has limitations, including a relatively small sample size and a cross-sectional design limited to a hospital-based population. It lacks large-sample random sampling studies in natural populations and

does not include long-term follow-up observations of the study population. In the future, we will expand the scope of sample collection and establish a long-term dynamic follow-up process to provide more comprehensive data support for myopia assessment, thereby better utilizing the AL/CR ratio as a tool for evaluating myopia in clinical practice.

5. Conclusion

Based on the findings, it can be concluded that both axial length (AL) and the ratio of axial length to corneal radius (AL/CR) are strongly associated with spherical equivalent (SE), particularly among children with myopia. The AL/CR ratio, in particular, demonstrates high diagnostic value and can serve as a reliable indicator for detecting myopia in pediatric populations. This underscores its potential utility in clinical screening and myopia management strategies for children.

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Disclosure statement

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Research on the Relationship Between Imaging Characteristics Changes of Pulmonary Infections in Patients with Hypo-immunity and NLR, PCT Levels and Their Severity

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Abstract: *Objective:* To explore the imaging characteristics changes of pulmonary infections in patients with hypo-immunity and analyze the correlation between NLR, PCT levels and their severity. *Methods:* This study included 80 patients with hypo-immunity and pulmonary infections who were diagnosed and treated at our hospital from October 2022 to October 2024. Imaging examinations were performed on the patients. Subsequently, the patients were divided into a severe group and a mild group based on the severity of their disease. Univariate analysis was conducted, and variables with statistical significance from the univariate analysis were included in a multivariate logistic regression analysis to clarify the correlation between plasma NLR, PCT levels, and their severity. *Results:* Imaging examinations revealed that ground-glass opacities in the lungs were centered around the hilum, with patchy or map-like distributions accompanied by reticular shadows. The affected areas and normal lung areas were interspersed, with a tendency to merge. Some patients also developed pneumothorax. Ground-glass opacities were the most characteristic manifestation, which could also present as reticular shadows, interstitial thickening, miliary shadows, multiple small nodules, intrathoracic lymphadenopathy, and a small amount of pleural effusion. In the correlation analysis, NLR and PCT were statistically significant in the univariate analysis ($p < 0.05$). When included in the multivariate logistic regression analysis, NLR (OR = 2.846, 95% CI: 2.402–3.358) and PCT (OR = 1.958, 95% CI: 1.554–2.601) were found to be positively correlated with the severity of pulmonary infections in patients with hypo-immunity. *Conclusion:* The imaging manifestations of patients with impaired immune function are complex and diverse, primarily including patchy, linear, massive, cavitary, and diffuse lesions, among other forms. These manifestations not only assist physicians in identifying the presence of pulmonary infections but also provide crucial information for diagnosing the type, severity, and complications of the infections. The levels of NLR (Neutrophil-to-Lymphocyte Ratio) and PCT (Procalcitonin) exhibit a positive correlation with the severity of pulmonary infections in patients with impaired immune function, warranting significant attention.

Keywords: Impaired immune function; Pulmonary infection; Imaging characteristics; Disease severity; Correlation

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1. Introduction

Patients with impaired immune function experience damage to their immune barriers, leading to certain differences in the clinical manifestations and imaging characteristics of pulmonary infections ^[1]. Generally, after the onset of pulmonary infection, the pathogen spectrum is broad, and the infection process may exhibit atypical disease manifestations due to abnormal host immune status. Consequently, clinical diagnosis poses significant challenges and may result in delayed treatment, substantially increasing the risk of infection. Some studies have directly pointed out that, compared to individuals with normal immune function, patients with impaired immune function experience a significantly higher mortality rate following pulmonary infection ^[2]. This is particularly true in cases of multidrug-resistant bacterial infections, where the disease progresses rapidly, severely compromising patient prognosis ^[3]. Following neutropenia, the reduction in neutrophils weakens the inflammatory response. The Neutrophil-to-Lymphocyte Ratio (NLR), as a biomarker of systemic inflammatory response, holds significant value in infectious diseases ^[4]. An elevated NLR reflects the dual mechanism of an absolute increase in neutrophils and an absolute decrease in lymphocytes. Procalcitonin (PCT) is a specific marker of bacterial infection, with its levels positively correlating with the severity of infection ^[5]. However, in patients with impaired immune function, PCT levels are typically directly related to bacterial infection, particularly in neutropenic patients, where dynamic changes in PCT hold substantial reference value for guiding antibiotic therapy ^[6]. Based on this, this study included 80 patients with impaired immune function complicated by pulmonary infection who were diagnosed and treated at our hospital from October 2022 to October 2024. It aimed to explore the imaging characteristic changes of pulmonary infections in patients with impaired immune function and the correlation between NLR, PCT levels, and their severity.

2. Materials and methods

2.1. General information

Eighty patients with immunodeficiency complicated by pulmonary infection who were treated in our hospital from October 2022 to October 2024 were selected and divided into a severe group and a mild group based on the severity of their conditions.

2.1.1. Inclusion criteria

- (1) Meeting the diagnostic criteria outlined in the “Chinese Guidelines for the Diagnosis and Treatment of Community-Acquired Pneumonia in Adults (2016 Edition)”
- (2) Aged ≥ 18 years
- (3) High compliance with treatment and follow-up
- (4) Patients and their family members signed informed consent forms, indicating their voluntary participation in this study

2.1.2. Exclusion criteria

- (1) Simple infection with special pathogens
- (2) Simple pulmonary fungal disease
- (3) Non-infectious diseases
- (4) Contraindications to bronchoscopy

2.2. Methods

2.2.1. Imaging examination

Patients were examined using CT, with the following specific steps

(1) Pre-examination preparation

Evaluate the patient's symptoms, have the patient remove their upper garments and any metallic objects to reduce metallic artifacts. Instruct the patient to practice holding their breath after deep inhalation to minimize respiratory motion artifacts

(2) CT scan parameter settings

The scan range extends from the apex of the lung to the base, covering the entire lung field, including the costophrenic angles. Routine CT scans are performed with a slice thickness of 5 mm, tube voltage of 120 kVp, matrix of 512×512 , and FOV of 350 mm

(3) Scan procedure

The patient lies in a supine position with their shoulders lowered and head advanced to ensure consistent scan orientation. An anterior-posterior scout view is obtained to determine the scan range and angle. The patient is prompted to hold their breath after deep inhalation 3 seconds before scanning, and to continue holding their breath during the scan. After scanning, coronal and sagittal reconstructions are performed to aid in observing the distribution of lesions.

2.2.2. Correlation analysis

In this study, the severity of the patient's condition was selected as the dependent variable, while general patient information and laboratory indicators were chosen as independent variables. General information includes the patient's gender, age, presence of respiratory failure, onset time, and history of underlying diseases. Laboratory indicators include white blood cell count (WBC), C-reactive protein (CRP), procalcitonin (PCT), and the neutrophil-to-lymphocyte ratio (NLR).

2.3. Statistical methods

Statistical analysis was performed using SPSS 24.00 software. Count data were analyzed using the chi-square test and expressed as $n(\%)$, while measurement data were analyzed using the t -test and expressed as (mean \pm standard deviation). A p -value of less than 0.05 was considered statistically significant. For univariate analysis, ANOVA was used, while multivariate analysis employed stepwise linear regression. The significance level (α) was set at 0.05, and a p -value of less than 0.05 was considered statistically significant.

3. Results

3.1. Analysis of patient imaging results

Imaging analysis revealed that patients with compromised immune function exhibited complex imaging manifestations, including patchy, linear, mass-like, cavitary, and diffuse lesions, among others. These findings are helpful for identifying pulmonary infections, as shown in **Figure 1**.

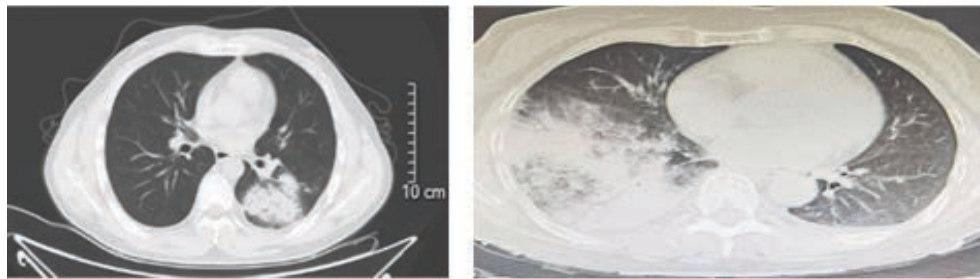


Figure 1. Analysis of patient imaging results.

3.2. Univariate analysis of NLR, PCT levels, and disease severity

The study results indicated that the severe group included 34 patients, while the mild group included 46 patients. NLR and PCT levels showed statistically significant differences in the univariate analysis ($p < 0.05$), while other variables did not show statistical significance in the data comparison ($p > 0.05$). Specific data are shown in **Table 1**.

Table 1. Univariate analysis of NLR, PCT levels, and disease severity

Variable	Category	Severe group (n = 34)	Mild group (n = 46)	χ^2/t	<i>p</i> -value
Gender (%)	Male (n = 42)	18 (52.94)	24 (52.17)	0.005	0.946
	Female (n = 38)	16 (47.06)	22 (47.83)		
Age (years)	Mean Age	67.29 ± 8.49	66.98 ± 8.35	0.163	0.871
Respiratory failure	Yes (n = 16)	7 (20.59)	9 (19.57)	0.013	0.910
	No (n = 64)	27 (79.41)	37 (80.43)		
Time of onset (h)	Mean	8.53 ± 1.28	8.49 ± 1.22	0.142	0.888
Medical history	Yes (n=47)	19 (55.88)	28 (60.87)	0.201	0.654
	No (n = 33)	15 (44.12)	18 (39.13)		
WBC (10 ⁹ /L)	Mean	8.27 ± 2.15	8.09 ± 2.21	0.364	0.717
CRP (mg/L)	Mean	49.29 ± 7.53	48.89 ± 7.43	0.237	0.814
PCT (ng/ml)	Mean	0.31 ± 0.06	0.15 ± 0.03	15.654	< 0.001
NLR	Mean	4.58 ± 0.82	4.03 ± 0.64	3.370	0.001

3.3. Multifactorial logistic regression analysis

The study results revealed a positive correlation between NLR (OR = 2.846, 95% CI: 2.402–3.358), PCT (OR = 1.958, 95% CI: 1.554–2.601), and the severity of pulmonary infections in patients with compromised immune function. Specific data are presented in **Table 2**.

Table 2. Multifactorial analysis of NLR and PCT levels and their correlation with disease severity

Variable	β	S.E.	<i>p</i> -value	OR	95% CI
NLR	0.96	0.99	< 0.05	2.846	2.402–3.358
PCT	0.84	0.86	< 0.05	1.958	1.554–2.601

4. Discussion

Pulmonary infections in patients with compromised immune function exhibit certain imaging differences under various infection modalities, with imaging characteristics closely related to the type of pathogen causing the infection ^[7]. In bacterial infections, the main imaging manifestation is segmental consolidation, which may be accompanied by small abscesses. In fungal infections, typical imaging findings include nodules with a halo sign and crescentic air sign, reflecting vascular invasive lesions ^[8]. In viral infections, the primary imaging manifestation is diffuse bilateral ground-glass opacities. NLR primarily reflects systemic inflammatory responses and immune balance, with its level changes closely related to the severity of pulmonary infections. In patients with pulmonary infections, neutrophils are extensively activated and accumulate at the site of infection, leading to a significant increase in neutrophil count in peripheral blood ^[9]. Additionally, lymphocyte function is suppressed, elevating the NLR ratio. Relevant studies indicate that an elevated NLR suggests severe infection, necessitating anti-infective treatment. PCT is a sensitive marker for bacterial infections, with its level changes reflecting the severity and prognosis of the infection. Following bacterial infections, extrathyroidal tissues are stimulated by inflammatory factors to synthesize large amounts of PCT, resulting in a significant increase in blood concentration. In contrast, after viral infections, PCT levels remain unchanged or slightly elevated ^[10].

Based on this, the present study selected 80 patients with compromised immune function and concurrent pulmonary infections who were diagnosed and treated at our hospital from October 2022 to October 2024. Imaging analysis revealed complex and diverse imaging manifestations in patients with compromised immune function, including patchy, linear, mass-like, cavitary, and diffuse lesions, among others. It provides new ideas for clinical decision-making. In the correlation analysis, it was found that NLR (Neutrophil-to-Lymphocyte Ratio) and PCT (Procalcitonin) exhibited a positive correlation with the severity of pulmonary infections in patients with immunodeficiency. In other words, as NLR and PCT levels increase, the severity of the condition tends to worsen.

5. Conclusion

In summary, this study delves into the imaging characteristic changes of pulmonary infections in patients with immunodeficiency and the relationship between NLR, PCT levels, and the severity of these infections. It not only enhances our understanding of pulmonary infections in this patient group but also offers new insights and methods for clinical diagnosis and treatment. In the future, research in this field will continue to be deepened to explore more precise and effective diagnostic and therapeutic strategies, making greater contributions to improving the prognosis and quality of life of patients with immunodeficiency. With the continuous advancement of research and technology, the diagnostic and therapeutic level for pulmonary infections in patients with immunodeficiency will see significant improvements, bringing hope to more patients.

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Pathogen Distribution, Imaging Features, and Clinical Manifestations of Pulmonary Infections in Patients with Impaired Immune Function (Project No.:2023-1-NS-017)

Disclosure statement

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A Retrospective Analysis of Higher Vocational Medical Education Based on the CIPP Model

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Abstract: Higher vocational medical education plays a crucial role in the cultivation of outstanding medical talents. Based on the CIPP evaluation model (Context, Input, Process, Product), this paper conducts a systematic analysis of the development of higher vocational medical education, explores the achievements and challenges faced at each stage from multiple dimensions, and puts forward improvement suggestions. This study uses the CIPP model to carry out a systematic review of medical education programs and analyzes their application value from both theoretical and practical perspectives.

Keywords: CIPP model; Project evaluation; Higher vocational medical education

Online publication: Dec 5, 2025

1. Introduction

The quality of higher education is a key element in achieving a country's sustainable and comprehensive development. When higher education activities are implemented based on appropriate standards, their effectiveness and efficiency will be significantly enhanced. To reach this quality level, it relies on scientific research and systematic evaluation methods. As a multi-dimensional and complex construct, the quality of educational programs is quite challenging to assess accurately. Therefore, evaluation has become a core mechanism for measuring and documenting quality, as well as an important approach to promoting the achievement of educational goals and the realization of visions. Through evaluation, we can identify the alignment between programs and the needs of individuals and society, clarify key influencing factors, and systematically optimize strengths and weaknesses. This provides a basis for educational decision-making and academic improvement, driving the transformation of the education system from a static to a dynamic one.

Effective evaluation depends on reliable models and tools. Among various evaluation models, the CIPP model covers four dimensions, namely the Context, Input, Process, and Product; and provides a systematic evaluation framework for educational programs^[1]. Context evaluation aims to establish the rationality of educational goals and identify problems, needs, and opportunities in the environment. Input evaluation focuses on human resources, financial support, policies and strategies, as well as constraints during implementation. Process evaluation centers on teaching execution and performance issues, testing the appropriateness of implementation paths. Outcome

evaluation assesses the effectiveness of educational activities and the degree of goal achievement.

Stufflebeam emphasized that CIPP is a cyclic process that emphasizes improvement rather than mere documentation of outcomes. Its core lies in the continuous enhancement of the quality of educational programs ^[2]. This model covers the entire process of educational revision, and is particularly suitable for the complexity of medical education programs, capable of providing systematic and constructive information for program optimization and decision-making. CIPP not only addresses specific issues but also emphasizes the evaluation of overall and systematic capabilities.

Most current medical research still focuses on verifying the achievement of preset educational goals, while CIPP is more committed to comprehensively improving educational quality. To explore the current application status and methodological characteristics of this model in medical education, this study adopts a systematic review to analyze its scope of use and practical models.

2. Materials and methods

This study is a systematic review. Relevant papers applying the CIPP model to evaluate medical education programs were retrieved from 14 international and Chinese academic databases, covering the period from April 22, 2019, to June 22, 2025. Given the limited number of literatures in this field, no time limit was set for the retrieval. Literature screening and data extraction were independently conducted by two researchers. In case of disagreements, a third expert was invited to participate in the adjudication, and the final result was based on consensus.

2.1. Search strategy

A specific search strategy was adopted for paper retrieval, with no time restriction. The search covered the period from April 22, 2019, to June 22, 2025. Based on the combination of subject terms and free words, the search was conducted across Chinese and English databases including CNKI, Scopus, PubMed, Web of Science, ProQuest Dissertations, Embase, CINAHL, and ERIC. Supplementary retrieval was also performed on the Google Scholar platform. Keywords included “evaluation”, “program evaluation”, “educational assessment”, “CIPP model”, and “medical education”, used individually or in combinations. It should be noted that there is no corresponding MeSH term for CIPP ^[3].

Literature screening was divided into three stages: first, Endnote was used to manage the title records and abstracts, with initial screening conducted to remove duplicates and exclude irrelevant topics; second, abstracts were reviewed to select literatures that matched the research topic; third, the full texts were rechecked and finally selected in accordance with the preset inclusion and exclusion criteria (**Table 1**).

Table 1. Inclusion and exclusion criteria of the study

Inclusion criteria	Exclusion criteria
Studies published in English or Chinese	Studies published in languages other than English or Chinese
Full text available for retrieval	Full text not available for retrieval
Related to the evaluation of medical education	Evaluations in fields other than medical education
Evaluations based on the CIPP model	Evaluations based on other evaluation models
Note: CIPP = Context, Input, Process, Product	-

Finally, 41 studies that met the research objectives, were written in English or Chinese, and had full texts accessible to the researchers were selected for qualitative analysis.

2.2. Data extraction and analysis

Two researchers independently extracted data using a pre-designed form. The extracted content included the first author, publication year, region, study design, and research objective. The extraction results were cross-checked. In case of discrepancies, a third researcher was involved in rechecking until a consensus was reached.

2.3. Quality assessment

The quality of studies was evaluated using the CASP (Critical Appraisal Skills Programme) checklist. This tool consists of 18 items, which are categorized into four dimensions: participant characteristics, assessment tools, study design, and results. It uses a “Yes/No” scoring system (1/0 point), with a total score ranging from 0 to 18^[4]. Each literature was independently evaluated by two researchers, and inconsistencies were resolved through negotiation to reach a consensus. Finally, the literatures were classified into three levels based on the total score: Excellent (≥ 13 points), Good (6–12 points), and Poor (≤ 5 points).

For mixed-methods studies, the Mixed Methods Appraisal Tool (MMAT) was adopted^[5]. The evaluation covered four aspects: rationality of sampling, data analysis, contextual effects, and researchers’ stance. An overall score (0–100%) was given according to the degree of compliance. The MMAT includes four qualitative criteria.

- (1) Appropriateness of participant eligibility and sampling process
- (2) Data analysis process, including data collection procedures, data format, and data analysis;
- (3) Attention to the impact of setting on data collection
- (4) Attention to the impact of researchers’ ontological and epistemological beliefs

The critical evaluation of mixed methods also includes the relevance of the mixed-methods design, data integration, and attention to methodological limitations. According to the MMAT scoring system, each study was given an overall quality score (Unscored, 25%, 50%, 75%, or 100%).

3. Results

A total of 1,275 literatures were initially retrieved. After removing 836 duplicate literatures via Endnote and manual checking (**Figure 1**), 439 literatures remained and entered the initial screening stage. Two researchers independently reviewed the abstracts, excluding 395 literatures that were inconsistent with the research topic. The remaining 44 literatures proceeded to the full-text review stage. After final full-text reading, 3 studies that did not meet the inclusion criteria were excluded, and a total of 41 literatures on the application of the CIPP model in medical education were included in the analysis.

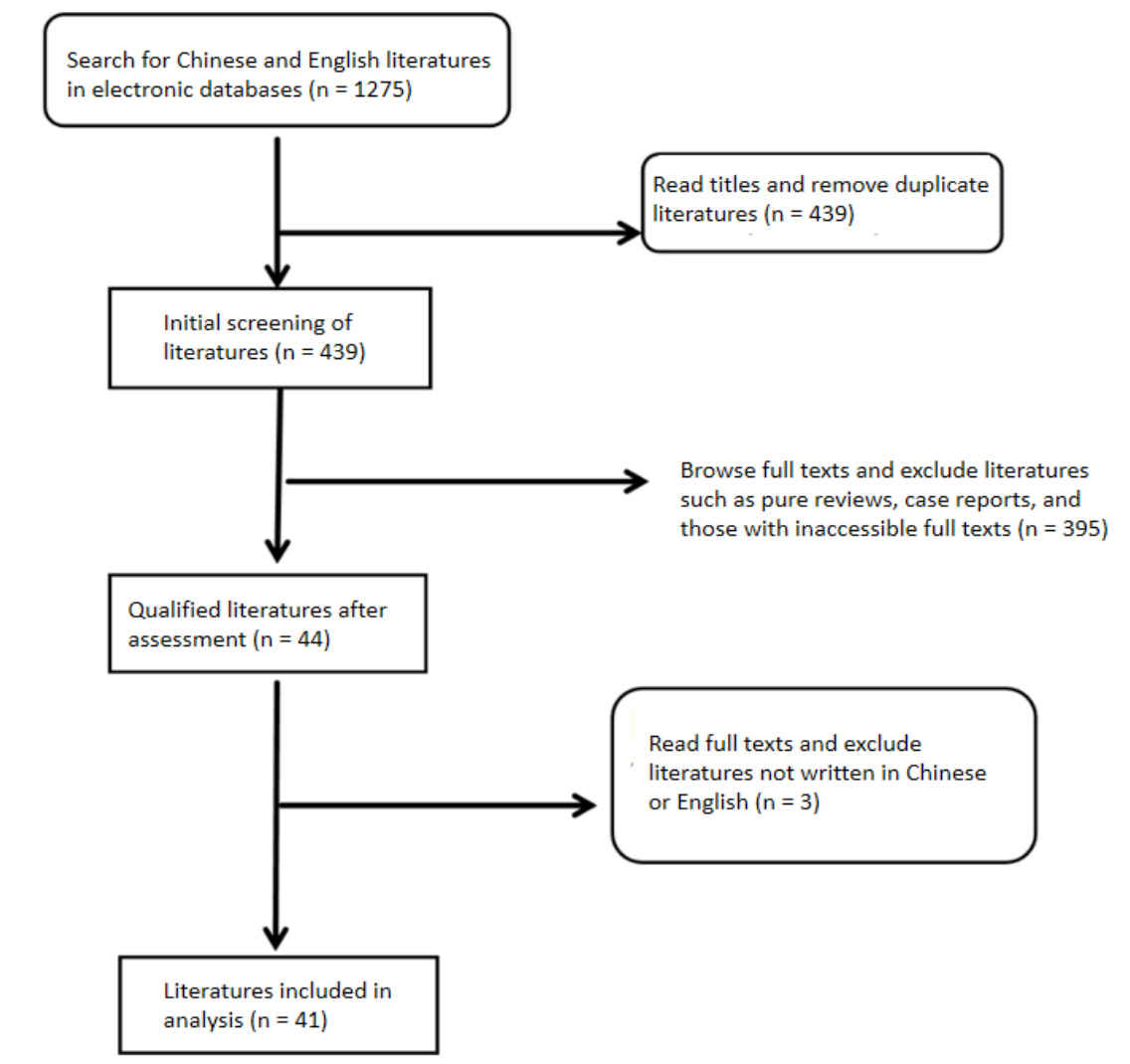


Figure 1. Literature screening process.

The results showed that the application of quantitative research methods was relatively common (**Table 2**). This study mainly focused on the attitudes and quality evaluations of students and teachers towards medical education programs based on the CIPP model, with most studies focusing on the student perspective. A total of 29 studies were descriptive cross-sectional surveys, which used self-designed questionnaires for evaluation; 9 were mixed-methods studies, combining questionnaires and interviews; 2 were qualitative studies, based on individual interviews; and 1 was a review of studies related to the CIPP model.

Table 2. Study types

Language	Quantitative research	Qualitative research	Review	Mixed research
English	13	2	1	8
Chinese	16	0	0	1

According to the quality evaluation results using the CASP tool, 23 studies were of good quality, 13 were of moderate quality, and 5 were of poor quality. From the perspective of evaluation objects, the CIPP model was most widely used in the evaluation of medical courses, while the number of case-based assessment studies was the smallest (Table 3).

Table 3. Frequency distribution of CIPP model evaluation in medical education programs

Discipline	n (%)
Midwifery	4 (10)
Medical sciences	14 (34)
Stomatology	4 (10)
Clinical medicine	11 (27)
Healthcare	7 (17)
Medical record research	1 (2)

4. Discussion

4.1. Context evaluation

The CIPP model provides a systematic framework for the evaluation of medical education programs. Its context evaluation dimension aims to comprehensively examine the educational environment, identify strengths, weaknesses, needs, and opportunities. This provides a basis for goal-setting and policy planning, and supports the continuous improvement of educational programs and the optimization of decision-making.

Key factors affecting the satisfaction of educational programs include faculty quality, facility conditions, budget support, content quality, and teaching environment. All these factors are systematically evaluated in the CIPP model. Most studies show high student satisfaction, while some indicate moderate or low levels. This reflects the comprehensiveness of the model in the four-dimensional evaluation of environment, input, process, and outcome ^[6].

Differences exist in the methods and focuses of context evaluation across different studies. For example, Okhovati et al. evaluated the Health Services Management course at Kerman University of Medical Sciences in Iran and found that the course scored low in goal clarity but performed well in scientific services ^[7]. Most scholars such as Akhlaghi, Yazdani, Moradi, and Mohebbi have reported positive context evaluation results, indicating that the overall curriculum environment is attractive and reasonable.

However, some studies have also revealed problems at the context level. For instance, in humanities courses, the goal statements are unclear and inconsistent with students' expectations. Niazi's study on a department in Tehran further found that students had insufficient understanding of teaching goals and policies ^[8]. These problems can be attributed to multiple factors, such as the lack of regular review of goals, disconnection from actual needs, vague expressions, excessive expectations, and differences in environmental structures.

4.2. Input evaluation

Input evaluation aims to systematically examine various resources and strategies invested to achieve educational goals, covering elements such as faculty, students, administrators, financial resources, and academic resources. The core of this dimension is to identify strengths and weaknesses in resource allocation and utilization, providing

a basis for optimizing program design and improving the effectiveness and outcomes of educational programs.

Multiple studies have pointed out obvious shortcomings at the input level. Okhovati et al. found that curriculum management settings were outdated and teaching facilities were insufficient; Yazdani and Moradi noted that although resources were generally abundant, the proportion of theoretical courses to practical courses was unbalanced, and educational facilities still needed improvement. Studies by Mohebbi and Yarmohammadian showed poor conditions of educational budgets and financial resources; Alimohammadi et al. also reported multiple problems in student capabilities, educational content, and equipment. Hemati et al. similarly identified insufficient investment in neonatal intensive care courses.

Phattharayuttawat's evaluation of clinical psychology courses indicated that while investment in faculty-student ratio and educational content was appropriate, clinical wards and case resources were still insufficient. Nagata et al. also found significant deficiencies in infrastructure such as the number of teachers, libraries, and computer systems in Japanese medical courses. In summary, updating educational content and improving resource conditions are key directions for enhancing input quality.

4.3. Process evaluation

Our focus is on how to carefully develop and effectively implement educational plans, as this directly determines the impact of educational plans on students' learning outcomes. Process evaluation mainly includes a comprehensive assessment of various teaching activities, as well as instructors' behaviors, knowledge reserves, and practical experience. It also involves testing and evaluating corresponding management and supervision mechanisms. In other words, this so-called "process" covers all links and activities involved during the entire program implementation period. On this basis, this evaluation system also provides us with a valuable opportunity to further refine and improve the implementation of educational plans by leveraging the valuable results from the previous two evaluation stages.

4.4. Product evaluation

Product evaluation systematically compares the goals of educational plans with actual outcomes to assess the substantial impact of educational programs on graduates' competencies and development. This evaluation not only focuses on graduation rates but also covers multiple outputs such as knowledge innovation and program achievements. Its core lies in objectively judging the appropriateness and effectiveness of educational activities.

Tazakkori's study based on the CIPP model pointed out that a certain medical program had obvious deficiencies in aspects such as philosophy, mission, and goal-setting. Although the curriculum content was consistent with the goals, serious problems occurred during the implementation process, resulting in the final outcomes failing to meet expectations^[9]. Ehsanpour's evaluation of midwifery students showed that they lacked experience in clinical management of rare cases. Pakdaman et al. found that while students had high satisfaction with the curriculum, teachers' enthusiasm and professional competence still needed improvement, and the overall learning process and the quality of outputs of some courses were not ideal. Studies by Okhovati et al. indicated that the teaching process performed well in terms of student participation and research interaction; however, graduates' professional skills still did not fully meet the preset standards. In contrast, the courses evaluated by Phattharayuttawat et al. performed excellently in aligning goal-setting with social needs, achieved outstanding performance in the educational process, and most graduates reached the expected competencies^[10].

Numerous studies have shown that the connections between internal elements of the education system

have not been fully clarified and even have inconsistencies, with some students failing to achieve the expected educational goals. Therefore, the system should make timely adjustments and establish clear improvement guidelines.

Most current studies tend to use quantitative methods to evaluate educational programs, but to achieve a comprehensive evaluation, it is necessary to integrate quantitative and qualitative data. Although many studies aim to examine the achievement of established goals, the core of the CIPP model emphasizes the continuous improvement of educational quality. This model advocates that evaluation should be forward-looking and run through the entire process of the program. However, existing literatures mostly rely on static methods such as cross-sectional questionnaires. Merely covering the four elements (Context, Input, Process, and Product) does not equate to the actual implementation of CIPP evaluation. For example, studies by Makarem, Pakdaman, and Hemati collected feedback from beneficiaries through questionnaires, but they overemphasized the achievement of outcomes while ignoring systematic and multi-stage improvement, failing to reflect the core principles of CIPP, the comprehensiveness, dynamism, and multi-stakeholder participation^[11].

Most evaluations are conducted from the perspective of a single group, failing to integrate diverse viewpoints and in-depth qualitative insights. A comprehensive review of educational programs from the perspectives of different participant groups helps identify potential problems and culturally appropriate strategies. Future studies should advocate mixed methods and build an evaluation framework that is more inclusive and has guiding significance for intervention.

5. Conclusion

This study indicates that the systematic application of the CIPP model (Context, Input, Process, and Product evaluations) combined with formative assessment methods is of crucial significance in the implementation of educational and teaching programs. Based on quantitative and qualitative evidence, continuous adjustments and improvements should be made to all aspects of educational planning to enhance practical effectiveness. Numerous scholars have explored the CIPP model from a forward-looking perspective. Although their studies reveal certain complexities in the implementation of this model, they still strongly support the advancement of educational reforms. Especially when evaluating those often-overlooked qualitative dimensions, the CIPP model helps compensate for the limitations of pure quantitative assessment and obtain diverse and in-depth perspectives. Furthermore, it is necessary to move beyond data collection methods that rely solely on a single group, such as students. Instead, efforts should be made to actively integrate the perspectives of multiple stakeholders, such as teachers, administrators, and industry experts. This will enhance the reliability and validity of the assessment and provide a solid basis for educational decision-making.

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A Case of Medical Damage Identification of Balloon Rupture and Retention Complicated with Acute Ischemic Stroke

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Abstract: Percutaneous transluminal angioplasty and endovascular stenting have become very important methods for the treatment of carotid artery stenosis and vertebrobasilar artery stenosis. In this case, the patient suffered from balloon rupture during the operation, with the tip of the balloon catheter retained and fixed on the stent in the subclavian artery segment, and subsequent acute ischemic stroke complicated by balloon rupture and retention. This is a rare type of device and operation-related complication. Through this case, a detailed analysis of the faults and deficiencies in the diagnosis and treatment of balloon rupture during interventional surgery is conducted, in order to provide a reference for solving similar problems.

Keywords: Balloon rupture; Stroke; Stent implantation; Medical damage

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1. Clinical case

1.1. Brief case introduction

Wu, male, 76 years old, was admitted to a local Grade A tertiary hospital on February 1 due to “dizziness for 3 weeks, aggravated for 1 day”. On February 8, he underwent cerebral angiography + percutaneous vertebral artery stenting + percutaneous vertebral artery balloon angioplasty. During the operation, the balloon ruptured, and the tip of the balloon catheter was retained and fixed on the stent in the subclavian artery segment. At 5 a.m. on February 9, the patient developed right limb weakness and decreased muscle strength. MRI showed multiple recent subcortical small infarcts in the brain tissue. The patient was discharged on February 27, with right limb weakness confirmed by the discharge examination. For the needs of medical dispute mediation, both the doctor and the patient entrusted a forensic identification institution to conduct a medical damage identification.

1.2. Summary of medical history

Wu was admitted to the hospital on February 1 due to “dizziness for 3 weeks, aggravated for 1 day”.

(1) Past medical history

He underwent coronary artery bypass grafting in a hospital 11 years ago due to coronary heart disease, had diabetes for many years, and received cervical artery stenting in a hospital 8 years ago due to multiple cerebrovascular stenosis.

(2) Specialist examination

Conscious, with appropriate answers. Muscle strength of all limbs was Grade 4, without fasciculation or involuntary movement. Pathological reflexes were not elicited. Urination and defecation were normal.

Admission diagnosis including

- (1) Post bilateral vertebral artery stenting
- (2) Coronary atherosclerotic heart disease, post bypass grafting
- (3) Type 2 diabetes mellitus
- (4) Post bilateral subclavian artery stenting
- (5) Dizziness to be investigated

Cerebral infarction? Posterior circulation ischemia?

(6) Cerebral atrophy

On February 4, Wu underwent “aortic arch angiography + cerebral angiography”. Intraoperative findings included extensive cerebral arteriosclerosis, severe stenosis in the right vertebral artery stent, occlusion of the V4 segment of the right vertebral artery, severe stenosis of the C4 segment at the origin of the right internal carotid artery, moderate to severe stenosis of the right external carotid artery, and severe stenosis at the origin of the inferior trunk of the right middle cerebral artery. On February 8, the patient underwent “cerebral angiography + percutaneous vertebral artery stenting + percutaneous vertebral artery balloon angioplasty”. During the operation, a balloon inflation device was used to slowly inflate the balloon to dilate the blood vessel and release the stent. However, the balloon dilation was still unsatisfactory. Angiography showed that there was still severe stenosis at the opening of the right vertebral artery, with a slight improvement compared with before. Cerebral angiography was performed, which showed that severe stenosis still existed at the origin of the right vertebral artery, the distal vascular opacification and blood flow velocity were slightly improved compared with before the operation, and the tip of the balloon catheter was retained and fixed on the stent in the subclavian artery segment.

The nursing record showed that the patient developed right limb weakness at about 5 a.m. on February 9. The right upper limb could still be lifted off the bed surface, and obvious flexion of the right lower limb was observed under pinprick. The muscle strength of the right upper limb was Grade 3-, the right lower limb was Grade 3-, and the left limb was Grade 4, without fasciculation or involuntary movement. The on-duty doctor was reported and instructed to observe. No changes in muscle strength were recorded in the examinations at 6 a.m. and 7 a.m. At 7:40 a.m., the patient’s right muscle strength decreased to Grade 2. The on-duty doctor was reported, symptomatic treatment was given, and tirofiban solution was continuously pumped. The temporary medical order showed that “cranial plain scan and magnetic resonance functional imaging” were issued at 9:01 a.m. Head MRI showed that:

- (1) Multiple recent subcortical small infarcts (acute phase, subacute phase) in the left frontal lobe, right temporal occipital lobe, right corona radiata, pons, right margin of the medulla oblongata, and right cerebellar hemisphere.

- (2) Consider multiple recent cerebral infarcts in the left frontal lobe, right temporal occipital lobe, right corona radiata, pons, right margin of the medulla oblongata, and right cerebellar hemisphere.

On February 9, the patient underwent “cerebral angiography”. During the operation, a snare was extended and slowly advanced upward in an attempt to snare the retained balloon from the lower end. However, multiple attempts failed to firmly snare the balloon. After withdrawing the snare, routine anteroposterior and lateral angiography was performed. The blood flow of the patient’s right subclavian artery and right vertebral artery had no significant change compared with before this operation, and the broken end of the balloon was anchored on the stent in the right subclavian artery segment without displacement. After treatment, the patient’s condition did not improve.

On February 27, the family requested voluntary discharge. Physical examination at discharge: Conscious, tired spirit, reluctant to speak and move, right limb weakness. Muscle strength of the right upper limb was Grade 1, the right lower limb was Grade 1+, and the left limb was Grade 3. Blood pressure was low. NIHSS score: 9 points (right sensation 1 + right limb 4 + 4), mRS: 5 points.

1.3. Focus of dispute

The focuses of dispute in this case are:

- (1) Whether the medical institution’s disposal measures after the balloon rupture during the operation on February 8 were in line with specifications
- (2) Whether the medical institution’s disposal was timely after the postoperative occurrence of limb weakness
- (3) Whether the medical institution fully fulfilled the informed consent obligation during the diagnosis and treatment activities

1.4. Identification opinions

The medical institution had faults in the diagnosis and treatment activities:

- (1) Failed to timely remove the broken balloon
- (2) Failed to timely recheck muscle strength and perform head CT or MRI examination
- (3) Insufficient preoperative informed consent
- (4) Irregular medical record writing. The analysis holds that there is a direct causal relationship between the medical institution’s faulty acts and the damage consequences suffered by Wu

2. Discussion

2.1. On the disposal of intraoperative broken balloon

The 76-year-old patient in this case underwent “cerebral angiography + percutaneous vertebral artery stenting + percutaneous vertebral artery balloon angioplasty” due to illness. During the operation, the surgical device (balloon) ruptured and remained in the blood vessel. According to clinical routines, the broken balloon catheter should be removed as soon as possible^[1]. In particular, the patient had underlying diseases such as diabetes mellitus and coronary heart disease. Intraoperative findings included severe stenosis in the right vertebral artery stent, occlusion of the V4 segment of the right vertebral artery, multiple stenosis of the right internal and external carotid arteries, and severe stenosis at the origin of the inferior trunk of the right middle cerebral artery. The local blood flow after this operation was not improved, so the possibility of postoperative neurological complications

was extremely high. However, medical record data showed that after the balloon rupture during the operation, the medical institution only fixed it on the stent in the subclavian artery segment and did not take measures to remove the broken balloon. Even in the first postoperative course record on February 8, there was no subsequent treatment plan by the medical institution for the disposal of the retained broken balloon. It was not until the patient suffered an acute ischemic stroke on February 9 that the medical institution considered surgical removal of the retained balloon. It can be seen that during the diagnosis and treatment process, the medical institution failed to timely take measures to remove the retained balloon, which was inconsistent with clinical routines and constituted a fault ^[1].

Despite the unprecedented development of treatment equipment and technology, various intraoperative and postoperative complications of percutaneous transluminal angioplasty and endovascular stenting still occur from time to time. The “Guidelines for Interventional Diagnosis and Treatment of Carotid Artery Stenosis in China” issued by the National Health Commission points out that the complications of carotid artery stenting include not only puncture site complications, but also neurological complications caused by embolism, thrombosis and cerebral hemorrhage, as well as injuries to blood vessels at the lesion site, operation path blood vessels and distal blood vessels, cardiovascular events and death, and in-stent restenosis. Research results by Wholey et al. show that within 30 days after carotid artery stenting, the incidence of transient ischemic attack is 3.07%, minor stroke is 2.14%, and major stroke is 1.20% ^[2].

In this case, the intraoperative balloon rupture with the tip of the balloon catheter retained and fixed on the stent in the subclavian artery segment is a rare type of device and operation-related complication, and there are currently few relevant reports in domestic literature. Based on current clinical experience analysis, the causes of catheter and guidewire rupture may be related to problems with the quality of the equipment or rough surgical operation. It may also be related to the patient’s own multiple severe arterial stenosis, as well as the performance of bilateral subclavian artery and vertebral artery stenting, especially the severe stenosis in the right vertebral artery stent, which led to high surgical complexity and difficulty. In addition, relevant reports have pointed out that it is relatively difficult to remove the broken catheter and guidewire, which requires targeted improvements to surgical instruments and methods on the basis of conventional operations. This has reference value for the clinical disposal of relevant situations ^[3,4].

It is worth noting that Article 1223 of the Civil Code stipulates: “If a patient is harmed due to defects in drugs, disinfection products, or medical devices, or the transfusion of unqualified blood, the patient may claim compensation from the drug marketing authorization holder, producer, or blood supply institution, or from the medical institution. If the patient claims compensation from the medical institution, the medical institution has the right to recover compensation from the liable drug marketing authorization holder, producer, or blood supply institution after making compensation.” If the balloon catheter rupture in this case is caused by product quality problems, the medical institution has the right to recover compensation from the liable producer after compensating the patient. However, in practice, medical institutions often become the subject of compensation liability due to problems such as the difficulty in accurately identifying medical product defects and the relative difficulty in medical product identification ^[5].

After the balloon catheter rupture in this case, it could not be removed even after surgery, making medical product identification impossible, and thus the product defect problem could not be determined. At present, there is no standardized handling process for the identification and rights protection related to medical damage caused by medical product quality, which still needs to be studied and improved by experts and scholars in the industry.

2.2. Discussion on postoperative duty of care

According to clinical routines, postoperative neurological function assessment should be conducted in a timely manner and compared with that before treatment to determine the therapeutic effect and promptly detect any new neurological symptoms. When new neurological damage is suspected, cranial CT or MRI scanning should be performed immediately^[6].

In this case, the 76-year-old patient underwent cerebrovascular interventional therapy on February 8, during which the balloon ruptured and remained in the blood vessel. As a foreign body in the human body, a broken and retained balloon can activate the coagulation mechanism. In addition, the fixation of the balloon on the stent changes the local hemodynamics of the blood vessel after surgery, reducing local blood flow shear stress and making it easy for exogenous thrombi to attach to the stent. The risk of complications such as thrombosis and embolism is significantly higher than that of ordinary people. Considering the patient's underlying diseases such as diabetes mellitus and coronary heart disease, as well as complex lesions including severe stenosis in the right vertebral artery stent and occlusion of the V4 segment of the right vertebral artery at the surgical site, the medical institution should have closely monitored the patient's condition changes after surgery, conducted thorough neurological function assessments, prepared risk predictions and response measures, and provided corresponding diagnosis and treatment in a timely manner when complications might occur to avoid serious damage consequences.

However, medical record data show that the patient suddenly developed unilateral limb weakness at 5 a.m. the day after surgery, indicating new neurological damage. The medical institution should have considered the possibility of acute ischemic stroke, conducted timely systematic physical examination and cranial CT or MRI scanning for differential diagnosis, and provided a basis for subsequent treatment plans. But nursing records indicate that the medical institution did not recheck the patient's muscle strength until 7:40 a.m., 2 hours and 40 minutes after the onset of right limb weakness, and did not perform cranial MRI until 9:01 a.m. It is evident that when the patient showed signs of neurological damage such as unilateral muscle strength decline, the medical institution failed to fulfill its duty of care during diagnosis and treatment, did not timely recheck muscle strength or perform cranial CT/MRI to confirm the diagnosis, which constituted a fault.

2.3. Causal relationship analysis

Preoperatively, the medical institution did not mention the possibility of balloon rupture in the preoperative discussion or informed consent, indicating that it failed to predict this complication before surgery. Intraoperatively, given the patient's high-risk factors including a history of coronary artery bypass grafting, diabetes mellitus, and cerebrovascular stenosis interventional surgery, as well as the persistent severe stenosis of the right vertebral artery after balloon angioplasty, the medical institution failed to promptly remove the broken and retained balloon, leading to its prolonged retention in the blood vessel, which could induce severe complications such as acute ischemic stroke.

Additionally, postoperatively, when right limb weakness occurred, the medical institution did not timely recheck muscle strength or perform cranial CT/MRI, delaying the timely detection and diagnosis of the condition, which was not conducive to alleviating the damage consequences. In summary, the medical institution had multiple faults in the perioperative management, and there was a direct causal relationship between these faulty acts and the damage suffered by Wu.

On the other hand, considering the patient's advanced age of 76, underlying diseases such as diabetes mellitus

and coronary heart disease, history of cerebrovascular stenosis interventional surgery, as well as complex lesions at the surgical site (severe stenosis in the right vertebral artery stent and occlusion of the V4 segment of the right vertebral artery), the interventional surgery involved complex vascular lesions with high difficulty and increased risks. Furthermore, although the medical institution attempted to remove the broken balloon the next day, multiple attempts failed, indicating the certain difficulty in removing such broken balloons. Therefore, there was also a direct causal relationship between the patient's own underlying diseases, medical risks, and the resulting damage.

3. Conclusion

There are few reports on device-related complications of vascular interventional surgery in relevant literature at home and abroad, and there is a lack of mature treatment measures. This indicates that such situations have not attracted the attention of the academic community and are likely to be overlooked by clinicians in terms of potential risks during diagnosis and treatment. Although rare, the rupture of guidewires and catheters, stent detachment, and other complications will not only increase the difficulty and risk of surgery but also seriously affect the clinical prognosis of patients. Therefore, through this case report, the authors hope to conduct in-depth research on the causes, mechanisms, and response measures, so as to attract the attention of clinical experts and scholars to relevant content and provide reference for clinical practice. On the other hand, it reminds clinicians not to ignore the occurrence of relevant complications during diagnosis and treatment. They should conduct sufficient risk assessment and formulate emergency response plans during the perioperative period, take timely and effective response measures when similar conditions occur, and fully fulfill relevant legal obligations such as the obligation of informed consent and duty of care to avoid or reduce damage consequences.

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Disclosure statement

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Integrated Traditional Chinese and Western Medicine in the Treatment of Biliary Cholestatic Liver Disease in an Infant with ABCB4 Gene Mutation: A Case Report

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Abstract: *Objective:* To summarize the clinical manifestations, gene mutation type, treatment, and follow-up results of one admitted infant with biliary cholestatic liver disease caused by ABCB4 gene mutation, so as to improve the understanding of this rare disease. *Methods:* A retrospective analysis was conducted on the clinical manifestations, laboratory examinations, gene mutation type, treatment, and follow-up data of one infant with biliary cholestatic liver disease caused by ABCB4 gene mutation. *Results:* The patient was a 1 month 23-day old male infant. His main clinical manifestations included dark yellow skin, rash, and pruritus. The disease onset was early, and his serum gamma-glutamyl transpeptidase level was elevated. Genetic analysis revealed two newly identified point mutations in the ABCB4 gene, namely c.1576G > A and c.2596A > G heterozygotes, which were inherited from his father. The infant was cured after treatment with integrated traditional Chinese and Western medicine, and no recurrence was observed during a 6-month follow-up. *Conclusion:* This study reports a case of biliary cholestatic liver disease caused by ABCB4 gene mutation in an infant, which expands the mutation spectrum of the ABCB4 gene. It also provides a reference for the early diagnosis and treatment of this rare disease using integrated traditional Chinese and Western medicine.

Keywords: Cholestasis; Intrahepatic; ABCB4 gene; Infant; Integrated traditional Chinese and Western medicine

Online publication: Dec 9, 2025

1. Introduction

Infantile biliary cholestatic liver disease is the leading cause of hospitalization for pediatric liver diseases in China. Progressive Familial Intrahepatic Cholestasis (PFIC) is one of its etiologies. PFIC is a group of rare, heterogeneous liver diseases with autosomal recessive inheritance. Its estimated incidence is 1 in 50,000 to 100,000. It usually presents with manifestations of biliary cholestatic liver disease in infancy, accompanied by pruritus and malabsorption. The disease progresses rapidly and eventually leads to liver failure.

At present, there are 6 known subtypes of PFIC, namely PFIC type 1 (ATP8B1 deficiency), PFIC type 2 (ABCB11 deficiency), PFIC type 3 (ABCB4 deficiency), PFIC type 4 (TJP2 deficiency), PFIC type 5 (NR1H4 deficiency), and PFIC type 6 (MYO5B deficiency).

Case reports of PFIC type 3 are relatively few, and most cases are distributed among white populations in North Africa, Europe, and Western Asia ^[1,2]. In China, the first case was reported in 2012, followed by a small number of subsequent reports, especially rare reports of infant cases ^[3–8]. The epidemiological characteristics of this disease are unclear, and there is limited experience in its diagnosis and treatment.

Herein, this study has reported the clinical characteristics, gene mutation features, and therapeutic effect of integrated traditional Chinese and Western medicine in an infant with biliary cholestatic liver disease caused by ABCB4 (ATP-binding cassette, sub-family B, member 4) gene mutation.

2. Subjects and methods

2.1. Subject

One infant visited our hospital on September 28, 2021. The infant was male, aged 1 month and 23 days.

2.2. Methods

2.2.1. Genetic testing

A 2 mL sample of the infant's peripheral venous blood was collected and sent for testing (Guangzhou Sheng'an Medical Laboratory). Capture-based high-throughput sequencing technology was used. Genomic DNA was extracted from the blood sample, and then specific primers were used to amplify the exon regions of the target genes (including ABCB4) to be detected.

After the quality of the obtained products met the control standards, a sequencing library was constructed. A high-throughput sequencer was used to sequence the constructed library, with the reference genome version being GRCH/37hg19. After mutations were detected, 2 mL samples of peripheral venous blood were collected from each of the infant's parents and sent for testing. Sanger sequencing was used to verify the DNA in the parents' blood samples.

2.2.2. Medical history collection and condition at the time of consultation

The infant sought medical attention because skin jaundice had persisted since the neonatal period, and the skin color had turned dark yellow in the past more than 10 days. The infant was the first child of the first pregnancy, born at full term via normal vaginal delivery. Regular prenatal examinations were conducted, and there were no abnormalities during delivery. The birth weight was 3400 g. Jaundice appeared a few days after birth, initially bright yellow. The jaundice fluctuated but persisted without treatment. In the more than 10 days before consultation, the infant's skin color was found to turn dark yellow. The stool was pasty with a pale color, and the urine color was yellowish. A rash also appeared, which might have been accompanied by pruritus (manifested as head turning, twisting, and crying).

The infant's milk intake did not decrease. The infant was breastfed after birth, with good weight gain. The mother took loratadine for about 2 weeks due to "skin allergy" after delivery. At admission, the infant's weight was 4900 g, with normal crying and responsiveness. The skin was dark yellow, and fine granular, spine-like, densely distributed rashes were seen on the neck and upper chest. The rashes were slightly whiter than the dark yellow

base skin color, with a natural transition to normal skin and no obvious boundary. There were no petechiae. The sclera was slightly yellow, the lip color was pale, and the tongue coating was white and greasy. The abdomen was slightly distended and soft, with no visible veins.

The liver was palpable about 2 cm below the costal margin, with a blunt edge and moderate texture. The spleen was not palpable. Auxiliary examinations at admission (see **Table 1** for details): Liver function and color Doppler ultrasound of the liver, gallbladder, spleen, and pancreas were normal. The quantitative level of alpha-fetoprotein (AFP) was 340.8 ng/mL, total cholesterol was 3.24 mmol/L, and triglyceride was 1.91 mmol/L. Tests for TORCH infection-related IgM antibodies, hepatitis B, hepatitis C, syphilis, and AIDS were negative. Blood glucose, blood ammonia, activated partial thromboplastin time (APTT), prothrombin time (PT), blood routine, C-reactive protein (CRP), renal function, myocardial enzymes, electrolytes, and routine urine and stool tests were all normal.

Table 1. Laboratory tests, ultrasound findings, and symptoms at different ages

Indicator	1 Month 23 Days (At Admission)	2 Months 1 Day (At Discharge)	3 Months 8 Days	4 Months	6–7 Months	Normal Range
Tbil (umol/L)	74.19	19.46	5.18	4.3	1.64	3.40–17.0
Dbil (umol/L)	44.87	8.86	1.81	1.3	0.81	0–6.0
TBA (umol/L)	136.9	46.3	38.4	27.2	6.9	0–9.67
ALT (U/L)	59.1	63.8	22.10	19.4	30.1	7–40
AST (U/L)	73.8	81.8	33.30	36.0	43.3	8–40
GGT (U/L)	104.8	53.3	18.00	9.7	6.1	9–45
ALP (U/L)	529.70	376.7	297.44	-	229.33	20–220
ALB (g/L)	37.4	44.7	35.2	40.4	42.5	35.0–55.0
TP (g/L)	51.3	54.4	55.2	58.0	60.2	49–71
Blood Ammonia	17.4	23.50	-	-	-	10–47
CHOL	-	3.24	-	3.79	-	3.00–5.20
TG	-	1.91	-	0.73	-	0.40–1.70
AFP (ng/mL)	-	340.8	-	-	-	—
Four Coagulation Tests	Normal	-	-	-	-	—
Hepatobiliary Ultrasound	No Abnormality	Slightly Enhanced Biliary Echo	-	No Abnormality	No Abnormality	—
Skin Color	Obvious Dark Yellow	Slightly Dark Yellow	Normal	Normal	Normal	—
Spine-Like Rash	Neck and Upper Chest	Significantly Faded	None	None	None	—
Pruritus	Suspected	Suspected	None	None	None	—
Stool	Pale Yellow-Brown	Yellow-Brown	Normal	Normal	Normal	—

Tbil: Total Bilirubin, Dbil: Direct Bilirubin, TBA: Total Bile Acid, ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, GGT: Gamma-Glutamyl Transpeptidase, ALP: Alkaline Phosphatase, ALB: Albumin, TP: Total Protein, AFP: Alpha-Fetoprotein, CHOL: Cholesterol, TG: Triglyceride, -: Not Tested.

2.2.3. Diagnosis and treatment

(1) Admission diagnosis

Infantile biliary cholestatic liver disease. Traditional Chinese Medicine (TCM) diagnosis: Fetal Jaundice (Tai Huang Bing), syndrome of cold-dampness obstruction.

(2) Treatment

Lidan Mixture (concentrated granule formulation), containing Yinchen (*Artemisiae scopariae herba*), Lianqiao (*Forsythiae fructus*), Heshouwu (*Polygoni multiflori radix*), Rougui (*Cinnamomi cortex*), Chishao (*Paeoniae radix rubra*), Guizhi (*Cinnamomi ramulus*), Zhiqiao (*Aurantii fructus*), Baizhu (*Atractylodis macrocephalae rhizoma*), Wuweizi (*Schisandrae chinensis fructus*), Chuanshanjia (*Manitis squama*), and Gancao (*Glycyrrhizae radix et rhizoma*). One dose was administered daily, dissolved in 50 mL of water, and taken in 2 divided doses. A 2-week period constituted one course of treatment. Oral administration of ursodeoxycholic acid (UDCA) and glucuronolactone for choleretic and hepatoprotective therapy.

2.2.4. Efficacy evaluation

The TCM Syndrome Scoring Table for cholestatic hepatitis was developed with reference to the Guiding Principles for Clinical Research of New Chinese Medicines. The efficacy index was calculated using the formula: $[(\text{Pre-treatment score} - \text{Post-treatment score}) / \text{Pre-treatment score}] \times 100\%$.

(1) Clinical cure

Main symptoms and signs disappeared or basically disappeared, with an efficacy index $\geq 95\%$.

(2) Marked effect

Main symptoms and signs improved significantly, with an efficacy index ranging from 70% to $< 95\%$.

(3) Effective

Main symptoms and signs improved obviously, with an efficacy index ranging from 30% to $< 70\%$.

(4) Ineffective

Main symptoms and signs showed no significant improvement or even worsened, with an efficacy index $< 30\%$.

3. Results

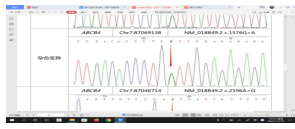
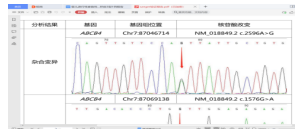
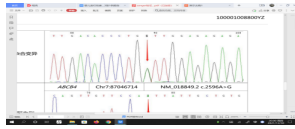
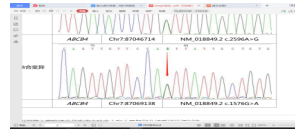
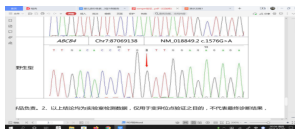
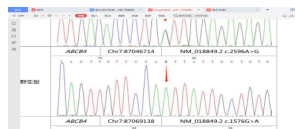
3.1. Genetic testing results

For the genetic testing of common hereditary diseases causing jaundice (Guangzhou Sheng'an Medical Laboratory), exon capture high-throughput sequencing detected two heterozygous mutations in the infant's ABCB4 gene. Both were missense mutations, namely c.1576G>A and c.2596A > G (see **Table 2**). Sanger sequencing verification confirmed that the infant carried the above two heterozygous mutations, both inherited from the father, while the mother had the wild-type genotype (see **Table 3**). In addition, one heterozygous insertion mutation (IVS16ins3KB) was detected in the infant's SLC25A13 gene, but no further Sanger sequencing verification was performed as blood samples from the parents were not collected. A search of the Wanfang, CNKI, VIP, PubMed, and HGMD databases showed that the above two ABCB4 gene mutations were newly identified types that had not been reported previously.

Table 2. ABCB4 gene detection results of the infant

Chromosomal location	Transcript	Nucleotide change	Amino Acid change	Genotype
Chr7:87069138	NM_018849.2	c.1576G > A	p.Val526Ile	Heterozygous
Chr7:87046714	NM_018849.2	c.2596A > G	p.Ile866Val	Heterozygous

Table 3. Sanger sequencing electropherograms of the proband and his parents

Subject	Analysis result	Chr7:87069138, c.1576G > A	Chr7:87046714, c.2596A > G
Proband (Infant)	Heterozygous		
Proband's father	Heterozygous		
Proband's mother	Wild type		

3.2. Results of blood and urine metabolite tests

Tandem mass spectrometry analysis of blood metabolites showed elevated levels of Arg (arginine), CO (carbon monoxide), C₂ (acetylcarnitine), C₃ (propionylcarnitine), Arg/Phe (arginine/phenylalanine), Met/Phe (methionine/phenylalanine), C₃/C₁₆ (propionylcarnitine/palmitoylcarnitine), CO/(C₁₆+C₁₈) (carbon monoxide/(palmitoylcarnitine+stearoylcarnitine)), and Orn/Ala (ornithine/alanine).

It also showed decreased levels of C₁₆DC (hexadecenoylcarnitine), C₁₄/C₃ (myristoylcarnitine/propionylcarnitine), C₁₆/C₂ (palmitoylcarnitine/acetylcarnitine), C₁₆/C₃ (palmitoylcarnitine/propionylcarnitine), C₁₈/C₃ (stearoylcarnitine/propionylcarnitine), and (C₁₆+C_{18:1})/C₂ ((palmitoylcarnitine+oleoylcarnitine)/acetylcarnitine). No abnormalities were found in the urine GS-MS (gas chromatography-mass spectrometry) results.

3.3. Treatment and follow-up results

After one course of integrated Traditional Chinese and Western medicine treatment, the therapeutic effect was significant. Laboratory test results improved rapidly, and clinical symptoms gradually alleviated. The infant achieved clinical cure at discharge.

During the 3-month follow-up, no symptoms occurred. Ultrasound results and laboratory tests tended to be normal, and the infant had good growth and development. The clinical manifestations, laboratory data, and auxiliary examination results at different time points are shown in **Table 1**. The infant's father was in good health. His serum total bilirubin, direct bilirubin, total bile acid, alanine aminotransferase, aspartate aminotransferase, gamma-glutamyl transpeptidase, alkaline phosphatase, albumin, alpha-fetoprotein, cholesterol, and triglyceride levels were all normal. He denied having pruritus, jaundice, or other liver disease histories, as well as such histories in his relatives.

4. Discussion

Among infantile biliary cholestatic liver diseases, Progressive Familial Intrahepatic Cholestasis (PFIC) is a group of hereditary diseases mainly manifested as cholestatic hepatitis. PFIC type 3, caused by ABCB4 gene mutation, is one of its subtypes. The main clinical features of PFIC type 3 are as follows: it usually onsets in children or adolescents, with elevated gamma-glutamyl transpeptidase (GGT) levels; except for pruritus, there are few other extrahepatic manifestations. Pathologically, it is characterized by extensive bile duct proliferation and periportal fibrosis, and may eventually progress to cirrhosis and liver failure in early adulthood. The diagnosis of PFIC type 3 requires the exclusion of other causes of cholestasis, such as biliary atresia, Alagille syndrome, and alpha-1-antitrypsin deficiency. To date, there are no clinical or laboratory diagnostic criteria for PFIC type 3, and its confirmation relies on genetic diagnosis. Reports on genetic diagnosis of PFIC type 3 first appeared overseas, mostly involving white Europeans and North African Arabs. With the popularization of genetic testing, domestic reports have gradually emerged.

ABCB4 gene mutation can lead to decreased expression or absence of multidrug resistance protein 3 (MRP3). This results in phospholipid deficiency in bile, causing free bile salts to exert toxic detergent effects on the capillary bile duct membrane. Consequently, bile duct damage, proliferation, and inflammatory infiltration occur, which gradually develop into periportal fibrosis, cirrhosis, and portal hypertension^[1]. The ABCB4 gene is located at chromosome 7q21.1, spanning 74 kb and containing 28 exons. More than 100 types of ABCB4 gene mutations have been reported so far, including missense mutations, nonsense mutations, deletion mutations, insertion mutations, and splice site mutations. Family members may carry homozygous mutations, heterozygous mutations, compound heterozygous mutations, or multiple heterozygous mutations. It is generally believed that the type of gene mutation is associated with the severity of the disease. Nonsense mutations, deletion mutations, and homozygous mutations in family members are more likely to cause severe clinical symptoms. A multicenter study in Europe defined ABCB4 gene mutations as disease-causing mutations (DCM) or benign substitution mutations by determining whether the mutation leads to premature termination of translation and using the PolyPhen algorithm^[9]. Patients with severe ABCB4 genotypes usually show no response to ursodeoxycholic acid (UDCA) and often develop cirrhosis and end-stage liver disease within the first 20 years of life. Although children carrying a single ABCB4-related benign substitution mutation may remain asymptomatic for many years or only present with non-jaundiced pruritus, studies have found that even a single missense heterozygous point mutation in the ABCB4 gene can impair MDR3 function^[10]. Patients with mild genotypes, including those with a single heterozygous mutation, may present with various liver disease manifestations. These manifestations may be influenced by comorbidities or triggering factors, or regulated by as-yet-unknown genetic modifiers^[11,12]. Domestic literature has also reported that hepatitis B virus infection and cytomegalovirus infection may be comorbidities or triggering factors affecting MDR3 function in patients with ABCB4 gene mutations^[8,13].

This study also detected a heterozygous mutation (IVS16ins3KB) in the infant's SLC25A13 gene. Mutations in the SLC25A13 gene can cause neonatal intrahepatic cholestasis caused by citrin deficiency (NICCD). IVS16ins3KB is the most common mutation type in patients, but heterozygous mutations do not cause the disease. NICCD usually onsets early, presenting with intrahepatic cholestasis, often accompanied by galactosemia, hypoproteinemia, bleeding tendency, hypoglycemia, and a significant increase in alpha-fetoprotein. Elevations of multiple amino acids, such as citrulline, methionine (Met), phenylalanine (Phe), and threonine (Thr), may also occur; early elevation of citrulline is of great significance for diagnosis. In this case, the infant had an early onset and presented with intrahepatic cholestasis, but lacked the other above-mentioned characteristics, so NICCD could

not be diagnosed. Through further inquiry about the medical history, we learned that the infant was exclusively breastfed, and the mother had a history of using the antiallergic drug loratadine. Whether the heterozygous mutation of the SLC25A13 gene and loratadine in this infant are triggering factors or comorbid factors for the onset of PFIC type 3 requires further investigation.

The epidemiological characteristics of PFIC type 3 in China remain unclear. In this case, the infant had an early onset, with jaundice persisting since the neonatal period, and presented with typical manifestations of biliary cholestatic liver disease at the time of consultation. Two heterozygous missense mutations were detected in the ABCB4 gene; Sanger sequencing confirmed that both mutations were inherited from the father, while the mother had the wild-type genotype. Through family history inquiry, it was found that the infant's father and his relatives had no history of pruritus, jaundice, or other liver diseases. A literature search showed that the above two heterozygous mutations were newly identified types that had not been reported previously. Onset in the late neonatal period or early infancy may be one of the characteristics of the pathogenicity of these gene mutations. ABCB4 gene deficiency can manifest in adulthood. Both the infant and his father in this case carried two heterozygous mutations of the ABCB4 gene. Although the father had no history of suspected liver diseases such as pruritus or jaundice, and all laboratory tests were normal, both the father and the son still need regular follow-up.

For PFIC type 3 patients with non-DCM benign substitution mutations, symptoms are usually mild, and they respond well to UDCA ^[14]. In this case, the infant was treated with integrated Traditional Chinese and Western medicine, including glucuronolactone, UDCA, and the TCM Lidan Mixture. After one course of treatment, the therapeutic effect was significant: laboratory indicators quickly returned to normal, and clinical symptoms were relieved rapidly. In TCM theory, this case belongs to the category of "Fetal Jaundice (Tai Huang)", with the syndrome type of cold-dampness obstruction ^[15]. The prescription was formulated based on the principles of detoxifying and promoting bile flow, activating blood circulation to remove blood stasis, and protecting the spleen and stomach. The TCM preparation exerts effects through multiple pathways and targets, such as resisting free radical damage, anti-inflammation, and anti-apoptosis, thereby improving cholestasis ^[16]. Through syndrome differentiation and treatment, TCM corrects the imbalance of Yin and Yang in the body as a whole, and can address various discomforts of the infant, such as pruritus and fussy crying, resulting in a more comprehensive therapeutic effect ^[17]. The good therapeutic effect of integrated Traditional Chinese and Western medicine was demonstrated in this infant case.

5. Conclusion

This case demonstrates that integrated traditional Chinese and Western medicine can achieve significant therapeutic effects in an infant with biliary cholestatic liver disease caused by novel ABCB4 gene mutations. The combination of UDCA, hepatoprotective agents, and the TCM formula Lidan Mixture effectively resolved cholestasis and clinical symptoms, with no recurrence during follow-up. This approach provides a valuable reference for the early diagnosis and comprehensive management of rare genetic cholestatic diseases in infants.

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Disclosure statement

The authors declare no conflict of interest.

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End-of-Life Care: A Case Study on Palliative Care Practice for a Child with Pineal Tumor

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Abstract: Palliative care extends beyond the individual child to encompass their family, healthcare providers, and broader socio-emotional networks. Timely and analytically informed palliative interventions not only alleviate the emotional burden experienced by terminally ill children and their family caregivers due to prolonged caregiving but also enhance the quality of life in the child's final stages. Currently, it is particularly important to note that an overemphasis on the healing function of physical spaces may risk relegating humanistic care to the margins once again. Therefore, when accompanying children through their end-of-life journey, it is essential to fully respect their need to express memories, maintain autonomy, and preserve dignity. They should be gently "seen" and compassionately accompanied until the very end, thereby facilitating a meaningful farewell that embodies a form of spiritual ecology.

Keywords: Pediatric palliative care; Personalized care; Quality of life

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1. Introduction

With the advancement of medical technology, a paradigm shift from curative treatment to palliative care has gradually taken place. While the lives of many critically ill children have been prolonged, for those with incurable diseases and their families, the question of how to face the end of life with dignity has become a serious challenge. Under the traditional disease-centered medical model, excessive treatment at the end of life not only exacerbates the physical and psychological suffering of the child but also places a heavy emotional and financial burden on the family. In this context, pediatric palliative care has emerged, marking a transition from a "disease-focused" curative approach to a "person- and family-centered" model of holistic care. The goal is no longer merely to prolong life, but to enhance the quality of the child's remaining days, allowing them to pass away free from pain

and with dignity, while supporting the family through the grieving process.

2. Literature review

Research on palliative care has long been a growing focus in academia. The concept of palliative care can be traced back to late 19th-century Europe, particularly the United Kingdom. In 1967, St. Christopher's Hospice, founded by Cicely Saunders in the UK, marked the beginning of the modern palliative care movement ^[1]. The modern concept of palliative care, shaped in the 20th century, emphasizes the right of choice, respecting children's decisions and providing comprehensive care addressing physical, psychological, spiritual, and emotional needs. Initially developed for children with advanced cancer, palliative care later extended to all children experiencing severe pain and suffering ^[2]. Since the 1960s, palliative care has rapidly expanded in Western countries and gradually spread worldwide. Different countries and regions have developed distinct models. For instance, Germany and Japan have established relatively mature systems supported by health insurance funds. In the U.S., Elisabeth Kübler-Ross further popularized the idea through her influential book *On Death and Dying* ^[3]. In China, palliative care emerged in the 1980s but has developed relatively slowly, influenced by traditional cultural values and the general level of public awareness ^[4]. Over the past decades, Chinese palliative care services have mainly focused on adults and the elderly, while pediatric palliative care has received insufficient attention ^[5]. Meanwhile, academic discussions in China have often centered on physical settings, such as inadequate qualifications of medical facilities and communities for palliative care, with insufficient attention to children's subjectivity at the end of life ^[6]. Internationally, however, pediatric palliative care has been widely discussed, with consensus around interdisciplinary collaboration and respect for children's agency and decision-making. For instance, the American Academy of Pediatrics (AAP) emphasized in its 2019 guidelines the importance of children's active participation and multidisciplinary teamwork ^[7]. Scholars have also highlighted the role of children's spirituality and emotions in shaping their perception of death, an essential part of their agency in palliative contexts ^[8]. International standards further underscore the importance of addressing children's developmental and social needs, alongside their families' quality of life ^[9]. Current research has also expanded into issues such as the timing of interventions, family-centered models, and more ^[10,11]. In this process, children, as individuals with volition, purpose, and self-awareness, can actively engage in information exchange with the external world ^[12]. Palliative care brings comfort by affirming life. Its goal is to support dignity and quality of life for the individual, regardless of the setting ^[13]. In South Africa, palliative care is needed by an average of 1 in 60 people, with the demand among child patients being even higher ^[14]. According to research by the international scholar Julia, approximately 21.6 million children and their families worldwide currently require palliative care services. This figure underscores the significant scale of pediatric palliative care needs and highlights the urgent attention required for its development ^[15].

At the international level, there is a substantial body of visualized research on pediatric palliative care, which has already incorporated attention to tiered care models within palliative services. Focusing on the domestic context, pediatric palliative care in China remains in its initial stages of development, facing multiple structural challenges that are primarily manifested as three major disconnects.

Firstly, a disconnect in service provision. Service resources are highly scarce, and the content of care is singular. Second, a disconnect in medical paradigms. The mainstream medical culture in China remains deeply rooted in the traditional paradigm of "prolonging life at all costs". For terminally ill children, excessive medical interventions are common. This not only fails to improve the quality of life at the end-of-life stage but may instead increase suffering and lead to a waste of medical resources. The decision to transition from a "curative"

to a “palliative” approach, lacking support from socio-cultural and ethical frameworks, often places heavy moral pressure on both healthcare professionals and families. Third, a disconnect in cultural ethics. This is the most distinctive local challenge. Domestic literature frequently discusses the profound impact of the “taboo surrounding death” and the culture of “filial piety” on the promotion of palliative care. On one hand, adult society generally avoids discussing death with children, leading to the inadvertent denial of children’s right to information and participation. On the other hand, the culture of “filial piety” drives families to spare no effort to prolong their child’s life, making the decision to transition to palliative care exceptionally difficult. In particular, Western-style “spiritual care”, such as chaplaincy services is difficult to directly transplant into a Chinese society lacking a strong religious tradition. How to construct a localized spiritual support system based on ethical and moral foundations is an area requiring further in-depth research in the future.

3. Case data

3.1. General materials

The patient is a 9-year-old girl in the fourth grade of elementary school. She has been undergoing continuous treatment for recurrent metastatic mixed germ cell tumor of the pineal gland, which was later managed by the hematology department. She has now been transferred to the palliative care unit but still requires necessary pain management. Upon admission, she had been experiencing a persistent fever for nearly half a month, with poor response to antipyretic measures. She also presents with body aches, difficulty breathing requiring hyperbaric oxygen assistance, and has undergone two emergency resuscitations recently. Her overall condition is weak, and she remains drowsy most of the time. The patient is the only child of divorced parents, and her mother has been the primary caregiver during her illness. Her Activities of Daily Living (ADL) score is 41, which primarily assesses an individual’s independence in basic daily activities such as eating, dressing, and toileting. A lower score indicates a higher degree of dependence on others for care.

3.2. Key issues and needs assessment

In this case, the management of the child’s condition and symptoms are of paramount importance. Due to the complexity of her condition following tumor recurrence and metastasis, she experiences significant pain and respiratory distress. Throughout this process, the medical team’s primary focus is on enhancing palliative symptom control. Secondly, the child has psychosocial needs. During periods of consciousness, she has expressed to her mother a wish to have video recordings of her hospital treatment preserved, wanting to leave behind her own unique story. Finally, it is necessary to provide grief support for the child’s family (particularly the mother) and connect them with appropriate funeral resources.

3.3. Intervention and support process

Firstly, professional medical care and symptom control form the cornerstone of palliative care, primarily led by the medical team. The goal is not only to alleviate the child’s physical pain through standardized procedures and medication but also encompasses crucial “implicit care”. This includes establishing a solid doctor-patient trust relationship, providing emotional comfort during pain episodes, and addressing negative emotions arising from treatment discomfort, ensuring the child receives dual (soothing/support) both physically and psychologically.

Secondly, personalized comprehensive support services are provided. When the condition is stable, medical social workers collaborate with the team to offer diversified professional support to the child and their family. The

services mainly cover two areas: Non-pharmacological adjuvant therapies: To reduce weakness and pain caused by chemotherapy, social workers actively connect resources, such as arranging professional massage therapists and integrating gentle therapies from the Traditional Chinese Medicine department including applying moxibustion patches and auricular acupressure seeds. An inflatable leg massage device is also used to enhance comfort non-pharmacologically and address potential pressure injuries from prolonged bed rest; Social resource linkage such as assistance is provided to the family in applying for social charity aid to alleviate the mother's financial pressure. This included successfully securing assistance funds for children with critical illnesses like leukemia and initiating online fundraising campaigns such as "Waterdrop Fundraising".

Thirdly, the focus of daily care prioritizes both safety and comfort, particularly regarding hygiene. "Repositioning" and "bathing" are key aspects directly impacting the child's quality of life and dignity. These must adhere to the principles of safety first and individualization. The decision to bathe the child requires strict assessment by the medical team. For children deemed physically able, environmental temperature, water temperature, and duration must be strictly controlled. For the child in this case with a pineal gland tumor, who was weak, had multiple tubes, and a high infection risk, sponge baths or localized cleaning were adopted to avoid physical exhaustion and infection. Post-bathing skin care also received extra attention to prevent complications.

Given that the child in this case expressed a strong desire for emotional expression when conscious, the medical social worker employed the "Photovoice" method to create a "time capsule storybook" for the family, documenting the child's treatment journey in the hospital. This enhanced emotional interaction and shared life experiences among family members. Medically, pain was managed with opioid medications per medical orders, complemented by non-pharmacological interventions like aromatherapy and horticultural therapy. These measures effectively alleviated the child's physical suffering, enhanced her comfort and sense of dignity at the end of life, and ultimately contributed to a peaceful and dignified passing, further enriching the understanding of safeguarding children's right to life. The practice also revealed the child's unmet need for religious services at the end of life.

Currently, within China's system, it is challenging for medical social workers to coordinate and provide such support systematically. In contrast, palliative care systems in Western countries often integrate religious services such as chaplaincy care as routine component. Through themes like spiritual solace and exploring life's meaning, they effectively alleviate the fear of death for both the child and family, enhancing spiritual comfort. In mainstream Chinese culture, rooted in ethical morals and influenced by death taboos and filial piety culture, families often tend to prioritize life-prolonging treatments. Religious support is often regarded as a private matter, making it difficult to integrate systematically into the service framework. This difference suggests the need to explore spiritual care pathways more suited to the local cultural context within China (**Figure 1**).

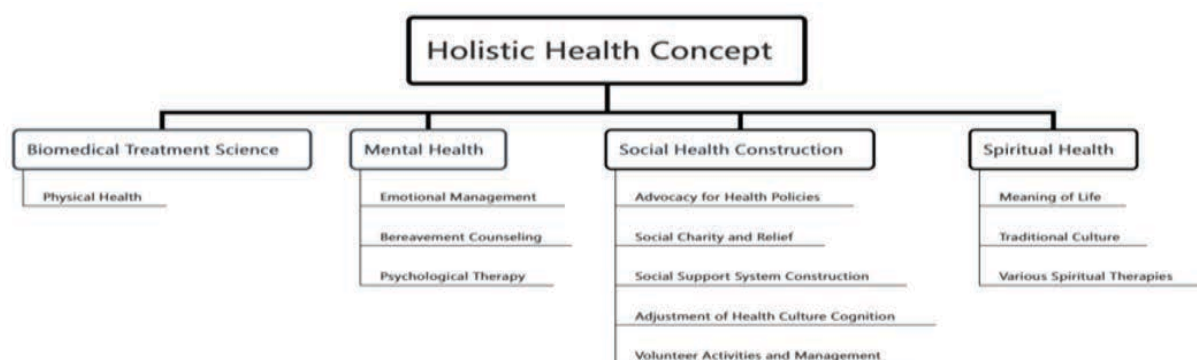


Figure 1. The holistic view of health.

4. Reflections on social work interventions in pediatric palliative care

4.1. A multidisciplinary collaborative model for pediatric palliative care

In China, palliative care services currently primarily target the elderly end-of-life population, while practices in the pediatric field are still in the exploratory stage. Compared with the elderly, the end-of-life situation of a child inflicts a more intense emotional impact on the family, who often endure deeper suffering and greater psychological stress that is harder to adjust to. Against this backdrop, constructing an interdisciplinary professional service system is particularly crucial, as its quality directly affects the quality of life and dignity in death for both the child and their family during the end-of-life stage.

After children enter the palliative care phase, they often continue to endure physical and mental suffering due to the disease itself and the side effects of previous treatments, necessitating comfort-oriented comprehensive medical interventions. Simultaneously, the families of these children commonly face multiple challenges, including financial pressure, caregiving burden, and spiritual grief. Therefore, it is imperative to establish a multi-professional collaborative mechanism involving medical social workers, physicians, psychological counselors, family therapists, and physiotherapists, all working as equal partners. Through a systematic and integrated service model, this team can collectively address the holistic needs of both the child and the family.

4.2. The shaping effect of modern life education on the public's view of death

In traditional Chinese society, constrained by the overall quality of life, there was a prevalent tendency to “prioritize lifespan length over life quality”, which largely hindered the promotion of paid palliative care services. However, with the rapid socio-economic development over the past four decades, public attention to life quality has significantly increased, and the practical need for life education has become increasingly prominent. Against this backdrop, developing localized life education based on China's moral and cultural traditions can help guide the public toward forming a more positive and healthy understanding of death and values of life. This is not only of profound significance for the quality of individual end-of-life care but also serves as an important pathway for promoting social civilization progress and the enhancement of life quality.

4.3. The constraining effect of missing service standards on palliative care professionalization

In countries with more mature palliative care systems, such as the United Kingdom and the United States, service quality is safeguarded by highly detailed, proceduralized, and legalized standard frameworks. These standards not only clarify the scope of responsibilities and collaboration mechanisms for various professionals but are also supported by legislative measures. In contrast, palliative care in China is still in its early stages of development. The number of service institutions remains limited, relevant regulations lag, and there is a lack of unified norms regarding service content and procedures. Public understanding often remains at the level of humanitarian care, with limited recognition of its role as a professional service capable of enhancing quality of life, integrating multidisciplinary resources, and systematically addressing end-of-life issues. Therefore, accelerating the establishment of palliative care service standards and policy frameworks tailored to national conditions is crucial for promoting the professional development of this field.

5. Comprehensive reflections on the medical social worker's intervention process in pediatric palliative care

5.1. The localization ethical dilemmas in pediatric palliative care

The ethical core of palliative care is to ensure that children at the end of life receive holistic care, physically, psychologically, socially, spiritually and able to die with dignity. However, these professional ideal faces severe practical challenges within the Chinese context.

Firstly, professional service capacity is weak. The scale of development and resource support for medical social workers remain insufficient, resulting in heavy reliance on government-funded programs or out-of-pocket payments by families, which limits accessibility. Secondly, a more fundamental conflict arises from differences in medical paradigms. The mainstream healthcare system still adheres to a traditional model focused on “cure”, often resorting to excessive pharmacological and instrumental interventions for terminally ill children. This not only diminishes their quality of life at the end-of-life stage but also leads to a waste of medical resources.

Yet, the decision to abandon “curative” efforts in favor of “palliative” care, lacking support from traditional ethics, often places caregivers under significant moral pressure, forming a core obstacle to the wider adoption of palliative care.

5.2. The particularities of the child as a subject and the ensuing challenges

The Children, as service recipients, possess a high degree of uniqueness, necessitating adherence to their cognitive developmental patterns. Physiologically, children's expression of pain and emotion differs significantly from that of adults, with younger children particularly requiring parental assistance in developing individualized care plans. Psychologically, their immature cognitive capacities make it difficult for them to comprehend the abstract concept of death, often leading to fear. According to Piaget's theory of cognitive development, a child's understanding of death is concrete. Therefore, discussions about death must employ language and methods appropriate to their age and cognitive level, focusing on alleviating fear rather than imparting abstract concepts.

This raises a critical ethical issue: to what extent should children have the right to know about their own condition and to participate in decisions regarding their treatment? In practice, this right is often exercised entirely by guardians. Furthermore, influenced by the cultural “taboo of death”, adults generally avoid discussing death with children. Consequently, the fundamental principle that “the child is an independent individual with unique needs” is difficult to genuinely implement within current pediatric palliative care services.

5.3. Barriers to transitioning from isolated care to integrated services

The ideal model of palliative care should be a multi-disciplinary, integrated service system encompassing medical, psychological, social, legal, and even spiritual support. Developed countries have achieved this through institutionalized team-building. In contrast, the service content in China remains relatively singular, primarily focusing on psychological comfort and daily living care, with systemic barriers hindering multi-sectoral collaboration.

A typical case is the absence of spiritual care. The family involved in this study had a need for religious services, which was difficult to meet under the current system. In the West, services such as chaplaincy are standard components, effectively providing solace. Chinese society, however, is rooted in an ethical and moral cultural foundation, where approaches to end-of-life issues are deeply influenced by “filial piety culture”. This culture favors prolonging life at all costs, resulting in religious or spiritual support being regarded as a private

matter, difficult to integrate into the public service system. This reflects a structural shortcoming in the localization process of the holistic care concept.

5.4. Integrating inverted care with intelligent humanity

“Reverse Hospice Care” refers to the phenomenon where terminally ill children express gratitude and well-wishes to their caregivers. This emotional feedback can sometimes create an illusion of “improved condition” for the caregivers. It is crucial to recognize that this constitutes a positive emotional response from the child, reflecting their capacity for empathy and connection towards the caregivers’ efforts, rather than indicating an actual turnaround in their medical prognosis. Building on this understanding, future service systems should not only maintain routine pain management and grief counseling but also strengthen focus on fundamental care aspects such as nutritional support and bowel care.

A more forward-looking pathway lies in the deep integration of technology and humanistic care. While artificial intelligence (AI) has demonstrated value in adult palliative care including symptom prediction, its application in pediatrics faces unique ethical threshold challenges, such as the legitimacy of surrogate decision-making and the risks associated with emotional substitution. Future research, grounded in the holistic health perspective and complex adaptive systems theory, could explore the development of intelligent palliative intervention systems tailored to children’s developmental characteristics. This approach aims to address the “precision dilemma” and “humanistic crisis” currently faced by pediatric end-of-life care, potentially paving the way for paradigm innovation in China’s child-focused hospice services.

6. Conclusion

Pediatric palliative care represents a crucial shift from curative-focused treatment to holistic, dignity-centered support for children with life-limiting illnesses and their families. This case study highlights the urgent need in China to develop a culturally sensitive, multi-disciplinary service model that integrates medical, psychosocial, and spiritual support while respecting the child’s autonomy and emotional needs. Moving forward, it is essential to establish standardized practices, enhance professional training, and foster public awareness to ensure that every child can experience a peaceful and meaningful end-of-life journey.

Disclosure statement

The authors declare no conflict of interest.

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Exploring the Importance of Health Education during Pregnancy Based on the Health Belief Model

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Abstract: Pregnancy health education is of great significance for the health of both mothers and infants, and the Health Belief Model (HBM) provides a key theoretical framework for it. The HBM consists of six constructs: perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy. It can facilitate the transformation from “knowing” to “believing” and then to “acting” for pregnant women. Pregnancy health education based on the HBM can improve maternal and infant health outcomes, enhance specific health knowledge and safe behaviors, and promote the establishment of healthy lifestyles. Its intervention implementation involves assessment, planning, implementation, and re-assessment processes, and the educational content needs to be constructed according to the characteristics of the early, middle, and late stages of pregnancy. However, the application of the HBM faces challenges such as cultural adaptability, digital integration, and the lack of long-term effect evaluation. In the future, targeted optimization is needed to improve the pregnancy health education system and ensure maternal and infant health.

Keywords: Health education; Pregnancy; Health Belief Model (HBM)

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1. Introduction

Pregnancy is a special period in a woman's life, not only accompanied by significant physical and psychological changes, but also directly related to the long-term health of both the mother and the baby. Pregnancy health education aims to help pregnant women master necessary health care knowledge, establish a healthy lifestyle, and prevent complications and comorbidities during pregnancy through systematic information dissemination and behavioral guidance, thereby ensuring the safety of both the mother and the baby and improving the quality of life. However, merely imparting knowledge is not sufficient to guarantee behavioral change. The Health Belief Model, as one of the most widely applied theoretical models in the field of health behaviors, provides us with a profound theoretical perspective and practical framework for understanding and intervening in pregnant women's health-related behaviors^[1,2]. This article will take the Health Belief Model (HBM) as the core theoretical basis, deeply exploring the intrinsic importance, implementation strategies, empirical effects, and future development directions of prenatal health education, aiming to provide theoretical basis and practical insights for optimizing prenatal

health services.

2. Analysis of the theoretical framework of the HBM

The Health Belief Model is a theory derived from social psychology, aiming to explain and predict why individuals do or do not engage in health-related behaviors ^[3,4]. This model posits that an individual's decision regarding health behaviors is primarily driven by their internal beliefs and attitudes ^[5]. Understanding the core constructs of HBM is the foundation for exploring its application in health education during pregnancy.

2.1. The core construct of HBM

The Health Belief Model mainly consists of six core constructs, which work together to influence an individual's health decision-making process.

2.1.1. Perceived susceptibility

This refers to the individual's subjective assessment of their own likelihood of contracting a certain disease or facing a certain health risk ^[6]. In the context of pregnancy, this manifests as whether the pregnant woman believes that she and her fetus are prone to adverse pregnancy outcomes (such as gestational diabetes, premature birth, birth defects).

2.1.2. Perceived severity

This refers to an individual's perception of the severity of potential consequences associated with contracting a certain disease or facing health risks, including medical consequences (such as death, disability) and social consequences (such as family relationships, work ability). For example, the awareness level of pregnant women regarding the severe consequences that hypertension during pregnancy may bring, such as eclampsia and intrauterine growth retardation of the fetus.

2.1.3. Perceived benefits

This refers to an individual's belief that engaging in a certain health behavior (such as maintaining a balanced diet, undergoing regular prenatal check-ups) can effectively reduce risks or bring positive outcomes. For instance, a pregnant woman believes that taking folic acid supplements can effectively prevent neural tube defects, which is an example of perceived benefits.

2.1.4. Perceived barriers

This refers to the difficulties, costs, or negative impacts that individuals may encounter when adopting healthy behaviors, including physical, psychological, economic, and time-related obstacles. For instance, pregnant women might struggle to maintain a healthy diet due to "severe morning sickness", or fail to get sufficient rest due to "busy work schedules".

2.1.5. Action cues

These refer to the internal and external factors that prompt individuals to take action. Internal cues include physical discomfort symptoms, while external cues include doctors' advice, family reminders, media publicity, or health

education materials.

2.1.6. Self-efficacy

It refers to an individual's belief in their ability to successfully carry out a certain health behavior. For instance, does a pregnant woman have the confidence to control her weight during pregnancy by adjusting her diet and exercising?

2.2. The mechanism of HBM

According to HBM, when a pregnant woman perceives that she and her fetus are facing a real and serious health threat (high perceived susceptibility and severity), and believes that the benefits of a certain health behavior (such as attending a prenatal class) outweigh the obstacles (high perceived benefits and low perceived obstacles), she is more likely to take action when triggered by appropriate action cues (such as community posters, doctor recommendations). Self-efficacy plays a crucial regulatory role in this process. Pregnant women with high self-efficacy are more inclined to adhere to health behaviors even in the face of obstacles. Therefore, if prenatal health education is designed around these six constructs, it can more effectively tap into the internal motivation of pregnant women, thereby achieving the transformation from "knowledge" to "belief" and then to "action". Studies have shown that using HBM for health intervention of pregnant women effectively improves their knowledge, beliefs, and compliance with disease prevention ^[7].

3. Empirical research on pregnancy health education based on HBM and its outcomes

Applying the Health Belief Model to prenatal health education is not just a theoretical concept. In recent years, numerous empirical studies have provided strong evidence for its effectiveness. These studies show that intervention measures based on the HBM can significantly improve maternal and infant health outcomes, enhance the health literacy and self-management ability of pregnant women.

3.1. It significantly improves the comprehensive health outcomes of both mothers and infants

A study aimed at improving maternal and infant health outcomes through in-depth prenatal education and analyzing the Health Belief Model found that pregnant women who received systematic prenatal education performed better in multiple indicators ^[8]. This educational program was based on the HBM framework and not only conveyed knowledge but also focused on shaping the pregnant women's health beliefs. The specific outcomes of the research report include effectively improving the weight management during pregnancy for pregnant women, reducing the level of stress during pregnancy, and directly correlating to better neonatal health indicators, such as higher birth weight, higher Apgar scores, and higher success rates of early breastfeeding. Studies have shown that providing nursing services to pregnant women under the guidance of health beliefs can enhance their understanding of pregnancy and childbirth, thereby reducing the rate of cesarean sections and is worthy of clinical adoption ^[9]. This fully demonstrates that interventions targeting the construct of the HBM can produce quantifiable and positive clinical health outcomes.

3.2. It effectively enhances specific health knowledge and safe behaviors

In the field of specific risk prevention, HBM also demonstrates strong application value. A health education study targeting mothers of premature infants, based on HBM, aimed to promote safe sleep practices related to SIDS^[10]. The study found that after one month of intervention, the mothers who received education showed significant improvements in relevant knowledge, scores of the health belief model items, and reports of safe sleep practices. This indicates that by emphasizing risks (perceived severity), providing solutions (perceived benefits), and building the mothers' confidence (self-efficacy), HBM can effectively transform knowledge into key behaviors that protect the safety of newborns' lives. A study showed that health education can effectively alleviate the anxiety and depression of pregnant women with gestational diabetes, improve glucose and lipid metabolism, enhance their mastery of disease-related knowledge, improve compliance, and ensure the safety of mothers and infants^[11].

3.3. It promotes the establishment and maintenance of a healthy lifestyle

The lifestyle during pregnancy, including nutrition and physical activities, is of vital importance for both the mother and the baby's health. An empirical study evaluated the impact of an education intervention based on HBM on pregnant women's physical activity and nutritional behaviors^[12]. The results showed that the physical activity levels and nutritional status of the pregnant women in the intervention group were significantly improved. More importantly, from the conceptual level of HBM, after the intervention, the pregnant women's perceived susceptibility, perceived severity, perceived benefits, and self-efficacy all significantly increased, while the perceived barriers significantly decreased. Another study, a randomized controlled trial of HBM-based nutrition education conducted among pregnant women, also reported similar positive results. The intervention significantly enhanced the pregnant women's nutritional knowledge and dietary practices^[1]. These studies clearly reveal the mechanism of HBM as an intervention "mediator": health education, by changing the internal beliefs of pregnant women, ultimately leads to the improvement of external health behaviors.

In conclusion, empirical evidence consistently indicates that prenatal health education based on the health belief model is not merely a one-way dissemination of information, but rather an effective intervention strategy that can profoundly influence the cognition, beliefs, and behaviors of pregnant women. Its significance lies in its ability to systematically and specifically address the psychological factors that hinder healthy behaviors, thereby fundamentally improving the quality and effectiveness of self-care during pregnancy.

4. Design and implementation of health education intervention for pregnant women based on HBM

A successful HBM-based health education program for pregnant women requires systematic design and meticulous implementation procedures. This encompasses assessing the initial beliefs of pregnant women, understanding the specific needs at different stages of pregnancy, and formulating personalized intervention strategies accordingly.

4.1. The general process of intervention implementation

Interventions based on HBM typically follow a dynamic cyclic process, consisting of four stages: assessment, planning, implementation, and re-assessment^[13].

4.1.1. Evaluation phase

Before the intervention begins, through questionnaires, interviews, or focus groups, assess the levels of each construct of the BM framework among the target pregnant population regarding specific health issues (such as prenatal nutrition), and understand their existing knowledge, beliefs, obstacles, and confidence.

4.1.2. Planning stage

Based on the assessment results, design targeted intervention contents and forms. For instance, if it is found that pregnant women generally have high perceptual barriers (such as not knowing how to prepare healthy meals), then practical demonstrations or recipe sharing sessions should be included in the education.

4.1.3. Implementation phase

A variety of educational methods are employed, such as health lectures, group discussions, video materials, one-on-one counseling, role model sharing, and skills training, to convey the intervention content to pregnant women.

4.1.4. Re-evaluation phase

After the intervention is completed, the same tools used before the intervention are employed again to measure and assess the changes in each component of the HBM and related health behaviors, in order to verify the effectiveness of the intervention ^[14].

4.2. Comprehensive construction of educational content during different stages of pregnancy

Although existing studies have provided relatively few clear HBM intervention plans divided into early, middle and late pregnancy stages, we can construct a theoretical educational content framework based on the physiological characteristics and health care priorities of different pregnancy stages, combined with the HBM construct. It should be emphasized that this is a model derived from the existing scattered information and the HBM theory, and more empirical research is needed for verification.

4.2.1. Early pregnancy (1-12 weeks): The focus in establishing basic knowledge and eliminating early risks

- (1) Enhancing perception of susceptibility/severity
By explaining the incidence and severe consequences of early miscarriage, fetal neural tube defects, etc., pregnant women will realize the necessity of early health care.
- (2) Highlighting the benefits of perception
Emphasizing the decisive role of folic acid supplementation in preventing deformities, as well as the advantages of quitting smoking and drinking for fetal development.
- (3) Reduce perception barriers
Provide dietary advice to cope with early pregnancy symptoms (such as nausea and vomiting), helping pregnant women maintain basic nutrition even when feeling unwell.
- (4) Enhancing self-efficacy
Providing pregnant women with guidance on how to correctly take supplements, and helping them build confidence that they are “capable of providing the best start for their baby”.

4.2.2. Second trimester (13-27 weeks): The focus in preventing complications and monitoring fetal growth

- (1) Enhancing perception of susceptibility/severity
Introduce the risk factors, screening methods, and long-term harm to both mother and baby of common complications such as gestational diabetes and gestational hypertension.
- (2) Enhancing perception of susceptibility/severity
Introduce gestational diabetes, gestational hypertension, etc. These conditions often highlight perceived benefits: Explain the advantages of reasonable weight control, moderate exercise, and regular prenatal check-ups in preventing these diseases and monitoring fetal health.
- (3) Reduce perception barriers
Offer simple and feasible pregnancy exercise plans (such as prenatal yoga), healthy snack options, and guidance on how to interpret prenatal examination reports, thereby reducing the confusion and difficulty in implementation for pregnant women.
- (4) Set up action clues
Encourage pregnant women to use the app to record their weight and fetal movements, and the hospital will send reminders via text messages about the due dates for prenatal check-ups ^[15].
- (5) Enhancing self-efficacy
Teaching pregnant women, the method of self-monitoring fetal movements, enabling them to acquire a skill for actively monitoring the health of their babies and enhancing their sense of control.

4.2.3. Late pregnancy (from week 28 until delivery): The focus in preparing for childbirth and welcoming the new baby

- (1) Enhance perception of susceptibility/severity
Explain the signs and risks of premature birth, as well as the prevalence and severity of postpartum depression, to enhance the alertness of pregnant women.
- (2) Highlighting the perceived benefits
Teaching non-pharmacological pain relief techniques such as Lamaze breathing exercises, explaining the short-term and long-term benefits of breastfeeding for both mothers and infants, and enhancing pregnant women's positive expectations of natural childbirth and breastfeeding.
- (3) Reduce perception barriers
Conduct psychological counseling for pregnant women regarding their fear of labor pain, provide a template for the "Birth Plan" to help them communicate effectively with their families and doctors, and reduce anxiety caused by uncertainty.
- (4) Enhancing self-efficacy
Conduct simulation exercises for childbirth and practical operations for newborn care (such as bathing and changing diapers), allowing prospective parents to build confidence through practice.

5. Challenges and future directions of applying HBM in pregnancy health education

Although HBM has demonstrated great potential in prenatal health education, it still faces some challenges in its application and research, which also points out the direction for future development.

5.1. Challenges and countermeasures of cultural adaptability

The Health Belief Model was developed within the context of American culture, and its conceptual explanations and weights may vary across different cultures. For instance, in some cultures that emphasize collectivism and family opinions, family support or social norms might have a greater influence on pregnant women's behavioral decisions than the perceived benefits by individuals. Therefore, when applying the HBM to different countries and regions, cultural adaptability adjustments must be made to ensure that the educational content and intervention strategies are in line with the local cultural values, beliefs, and social norms ^[16,17]. Future research should focus more on cross-cultural comparisons, developing and validating culturally adjusted HBM assessment tools and intervention programs.

5.2. The opportunities and current situation of digital integration

With the rise of mobile health (mHealth) and telemedicine (Telehealth), prenatal health education has ushered in new digital opportunities. Digital platforms can enhance the effectiveness of health behavior modification (HBM) interventions in a highly promising way. Personalized push notifications can serve as a powerful "action cue", sending reminders and knowledge based on the gestational weeks and individual health data. The interactive functions (such as online Q&A, virtual communities) can provide social support and help reduce "perceived barriers". Data tracking and feedback (such as weight and blood sugar curves) can visually demonstrate the "benefits" of behaviors and enhance "self-efficacy" ^[18].

Previous studies have begun to explore the combination of telemedicine and HBM to promote pregnant women's exercise behaviors, and it has been found that HBM is an appropriate theoretical framework for education in this model ^[19]. However, the current research evidence shows that studies that combine HBM, mobile applications, and comprehensive prenatal health education, and conduct rigorous randomized controlled trials (RCTs) to verify their quantitative effects are still very scarce. This constitutes an important research gap, and future research should focus on developing and evaluating digital prenatal health education tools that integrate the HBM theory to verify their effectiveness and cost-effectiveness in the real world.

5.3. The absence of long-term effect assessment

Most current studies on HBM-based pregnancy education focus on short-term effect evaluations, such as changes in behaviors and health indicators during pregnancy or shortly after childbirth. However, many of the goals of pregnancy health education, such as establishing healthy family lifestyles, preventing long-term diseases in children, and promoting long-term mental health of mothers, take much longer to manifest. Search results indicate that there is an extreme lack of longitudinal studies that conduct follow-ups on HBM-based pregnancy education programs over a long period (e.g., two years or longer after childbirth). Although one study conducted a two-year follow-up on infant injury prevention education, it was not a comprehensive pregnancy education based on HBM ^[20]. Therefore, future research designs should consider longer observation periods to comprehensively assess the profound impact of HBM-based pregnancy health education on the long-term health and well-being of mothers and infants.

Pregnancy health education based on the HBM has been substantiated by a solid theoretical foundation and an increasing number of empirical research results. It goes beyond the traditional transmission of knowledge, systematically influencing pregnant women's perceived susceptibility, severity, benefits, obstacles, cues for action, and self-efficacy, thereby fundamentally stimulating their intrinsic motivation to adopt and maintain healthy

behaviors. Practice has proven that this model can effectively improve the immediate and short-term health outcomes of both mothers and infants, including optimizing weight management, preventing complications, enhancing the health level of newborns, and promoting key safety behaviors.

However, in order to fully realize its potential, future practice and research must address three major challenges. Firstly, enhance the research on cultural adaptability to make intervention measures more in line with the cultural backgrounds of different groups. Secondly, embrace digital transformation and explore innovative models of integrating mobile health technologies with the HBM theory through high-quality randomized controlled trials. Thirdly, conduct long-term longitudinal studies to assess the lasting impact of prenatal health education on the health of mothers and infants. Through continuous efforts in these directions, we can continuously improve and optimize the prenatal health education system, laying a more solid foundation for the healthy future of every mother and newborn.

6. Conclusion

In conclusion, the Health Belief Model provides a robust and effective theoretical framework for pregnancy health education, facilitating the transformation of knowledge into sustained healthy behaviors. By systematically addressing perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy, HBM-based interventions significantly improve maternal and infant health outcomes, enhance specific health knowledge, and promote healthy lifestyles. However, challenges such as cultural adaptation, digital integration, and the lack of long-term evaluation remain. Future efforts should focus on culturally tailored strategies, technology-enabled education, and longitudinal studies to optimize the prenatal health education system and better safeguard the health of mothers and infants.

Disclosure statement

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Epidemiological Characteristics of a Varicella Outbreak in a Primary School and Analysis of Vaccine Protection Efficacy

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Abstract: *Objective:* To analyze the epidemiological characteristics of a varicella outbreak in X Primary School in 2024, evaluate the protective efficacy of varicella vaccine, summarize the characteristics of varicella outbreaks, and provide references for the prevention and control of infectious diseases in schools and emergency response. *Methods:* Symptoms of all ill students were analyzed to clarify the epidemiological characteristics, and the Cox regression model was used to analyze the protective efficacy of varicella vaccine. *Results:* The varicella epidemic lasted for one month, involving 3 classes in 2 grades. A total of 16 varicella cases were identified in the school, with an attack rate of 1.78%. The vaccination status of 142 students was analyzed for vaccine protective efficacy. Comparison with unvaccinated students showed that the protective efficacy of 1 dose of varicella vaccine was not significant, while the protective efficacy of 2 doses of varicella vaccine was 82.10%. *Conclusion:* Vaccination with 2 doses of varicella vaccine provides the best protective effect. Timely isolation of ill students after the outbreak can effectively control large-scale varicella outbreaks.

Keywords: Primary school students; Varicella; Epidemiological characteristics; Vaccine protective efficacy

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1. Introduction

Varicella is a respiratory infectious disease caused by varicella-zoster virus infection. It is highly contagious, mostly occurring in children, and spreads through close contact and aerosols. It is prone to inducing large-scale epidemics, and severe cases can lead to pneumonia and encephalitis, making it one of the important “killers” threatening children’s health^[1]. Due to its strong infectivity and wide transmission routes, varicella is likely to cause outbreaks and epidemics in primary schools and kindergartens, seriously endangering children’s health. Therefore, the prevention, control and vaccination of varicella are crucial in primary school health work and important measures to protect primary school students from varicella. Taking the varicella outbreak in X Primary School in 2024 as an example, this study conducted an epidemiological investigation to explore the protective efficacy of varicella vaccine, aiming to provide guidance for varicella vaccination and varicella prevention and control in schools^[2].

2. Survey objects

2.1. Objects and methods

Taking the varicella outbreak that occurred in X Primary School from September to November 2024 as an example, this study analyzed the epidemiological characteristics of the varicella outbreak and the protective efficacy of the vaccine, and put forward suggestions for the prevention and control of varicella epidemics in primary schools. From September to November 2024, some students and faculty members of the school developed varicella-like rashes, mainly presenting as papules, herpes or scabs, and were clinically diagnosed as varicella patients. The varicella patients in the school included breakthrough cases, who had received 1 dose of varicella vaccine. Within 7 days, more than 10 varicella cases were confirmed in the school, which met the characteristics of a varicella outbreak.

2.2. Survey methods and content

Referring to the varicella case definition and data from the National Notifiable Infectious Disease Reporting System of China, this study clarified the diagnostic criteria for varicella. Then, combined with data such as the school's morning and noon inspections and registration of absence due to illness, varicella cases in the school were screened. Following the principle of informed consent of patients, staff from the Center for Disease Control and Prevention (CDC) conducted epidemiological investigations through on-site interviews and telephone follow-ups with parents with the cooperation of school teachers. Information such as gender, clinical symptoms, contact history, past varicella history and vaccine vaccination history of students in the classes where varicella cases occurred from September to November 2024 was collected. The varicella vaccine vaccination status of students was verified through the CDC system to gain a more comprehensive understanding of the protective efficacy of the varicella vaccine^[3].

2.3. Statistical analysis

SPSS 27.0 software was used for statistical analysis of the data. Cox regression analysis was adopted to evaluate the protective efficacy of the varicella vaccine, and the hazard ratio (HR) and its 95% confidence interval (95% CI) were calculated. The vaccine effectiveness (VE) of varicella was calculated using the formula: $VE = (1 - HR) \times 100\%$. The chi-square test (χ^2 test) was used for comparison of rates between groups; the test level was set at $\alpha = 0.05$ (two-tailed).

3. Results

3.1. Basic information of the school

X Primary School is a public non-residential primary school with a total of 898 students, including 445 males and 453 females; the school has 61 faculty members and 1 part-time school doctor. Each classroom of the school is equipped with an ultraviolet lamp, and ultraviolet disinfection is carried out for 1 hour every day.

3.2. Epidemiological characteristics of the varicella outbreak

3.2.1. Epidemic overview

The varicella outbreak started on September 22nd. The index case was a 7-year-old male student from Class 3, Grade 2. On September 22nd, he developed red rashes on the head, neck, chest and back with a normal body

temperature. His parents took him to the hospital on the morning of September 24th. After being diagnosed with varicella, he was placed under home isolation. During the medical visit, it was found that the boy had developed cough symptoms and sought medical treatment 3 weeks earlier. The student had only received 1 dose of varicella vaccine. As of November 15th, 2024, a total of 16 varicella cases were confirmed in X Primary School, with an attack rate of 1.78%, and the duration of the varicella outbreak was as long as 34 days.

3.2.2. Clinical characteristics of varicella

This study focused on analyzing the symptoms of 16 confirmed varicella patients in X Primary School and found that they all presented with skin macules or herpes. Among them, 16 patients had herpes on the back, 13 had skin macules or herpes on the head and neck, 13 had herpes on the hands and feet, and 12 had skin macules on the chest ^[4]. In addition, 10 ill students had fever. No complications occurred in any of the cases, and all patients were classified as mild cases ^[5].

3.3. Analysis of varicella vaccine protection efficacy

The varicella outbreak in X Primary School involved 3 classes with a total of 153 students. After excluding 11 students who had previously contracted varicella, the remaining 142 students were included as research subjects. Comprehensive analysis showed that there were significant differences in the age of patients, the number of vaccine doses received, and the duration since vaccination ($p < 0.05$), which was statistically significant. Cox regression analysis was performed with the vaccine protection period as the dependent variable and the number of doses and duration since vaccination as covariates. After adjusting for factors such as age at vaccination and duration since vaccination, the protective effect of 1 dose of varicella vaccine was not obvious. The risk of contracting varicella in the group that received 2 doses of varicella vaccine was significantly lower than that in the unvaccinated group and the group that received 1 dose of varicella vaccine, as shown in **Table 1**.

Table 1. Cox regression analysis of varicella vaccine protection efficacy during the varicella outbreak in x primary school (n = 142)

Variable	Number of subjects	Number of cases	Attack rate (%)	χ^2	p	Wald χ^2	p	HR (95%CI)
Age (years)				17.433	< 0.001			
≤ 7	49	13	26.53					1.000
> 7	93	3	3.23			14.842	< 0.001	0.035
Vaccination Status				8.352	0.015			
Unvaccinated	31	7	22.58					1.000
1 Dose Vaccinated	29	5	17.23			0.031	0.861	1.000
2 Doses Vaccinated	82	4	4.87			4.665	0.031	0.179
Duration Since Vaccination (years)								
≤ 4	55	2	3.62	5.229	0.022			1.000
> 4	87	14	16.08			0.050	0.823	0.807

3.4. Vaccine protection efficacy of emergency vaccination at different time points

This study also focused on classes with more than 2 varicella cases. Taking the occurrence of the first varicella case in the class as the time starting point, emergency vaccination was administered to students without a history of varicella vaccine immunity, and all emergency vaccinations were completed within 3 days, as shown in **Table 2**. Emergency vaccination of varicella vaccine within 3 days for students without a prior history of varicella immunity still achieved a certain protective effect ($p < 0.05$), which was statistically significant.

Table 2. Protective efficacy of varicella vaccine by different emergency vaccination time points (%)

Prior immunity history	Days to emergency vaccination	Secondary cases (Attack Rate, %)	RR (95%CI)	Protection rate (%)
None	> 3	6 (26.08)	1	
	≤ 3	1 (3.13)	0.12 (0.02–0.93)	88.02
Yes	> 3	6 (26.08)	1	
	≤ 3	1 (3.13)	0.12 (0.02–0.93)	88.02

3.5. Prevention and control measures

Upon receiving the confirmation of the first varicella case, X Primary School promptly reported it to the Center for Disease Control and Prevention (CDC). CDC staff conducted on-site investigations and disposal at the school and quickly formulated a response plan for the varicella outbreak^[6]. Firstly, the CDC focused on defining varicella case criteria and rapidly conducted case searches across all grades of X Primary School, especially Grades 1 and 2. This facilitated the prompt identification of classes affected by the outbreak and close contacts, enabling early detection of suspected cases and arrangement for home isolation, thereby achieving the prevention and control goals of “early detection, early isolation, and early treatment”^[7]. Secondly, the school arranged for teachers to strengthen morning and noon inspections. Once a student was found absent due to illness, febrile, or presenting with skin macules or herpes, the student was promptly advised to seek medical attention, and parents were notified to closely monitor their child’s body temperature and skin changes. Thirdly, under the guidance of the CDC, the school conducted comprehensive disinfection of classrooms with varicella cases and public areas on campus, including disinfectant spraying, increasing the frequency of ultraviolet lamp disinfection, and urging head teachers to enhance classroom ventilation and students to wash their hands frequently^[8]. Fourthly, after the detection of varicella cases, the school canceled group activities such as morning exercises and club activities to avoid cross-infection among students. For classes with varicella cases, the school required a 21-day suspension starting from the date of isolation of the last case in the class. Students could only return to school after complete recovery and 3 days of herpes scabbing. Fifthly, X Primary School organized head teachers and teachers of all grades to compile varicella prevention and control brochures and record home isolation guidance videos, which were distributed to parents via WeChat groups and official WeChat accounts. This enhanced parents’ and students’ understanding of varicella and encouraged their cooperation with the school’s prevention and control efforts, helping students recover quickly and return to school smoothly^[9].

4. Discussion

4.1. Formulation of an emergency management plan for varicella outbreaks in schools

Varicella has a relatively long incubation period, strong infectivity, and inconspicuous early symptoms, which are easily mistaken by parents for colds or fevers, leading to rapid transmission. X Primary School lacked sensitivity to this varicella outbreak and failed to detect the index case in a timely manner^[10]. Through monitoring and analysis by the CDC, it was inferred that the index case of varicella in X Primary School might have contracted the virus during a hospital visit and continued to attend school unknowingly, resulting in clustered infections within the class and subsequent spread to other classes. Under the guidance of the CDC, X Primary School quickly identified the index case and suspected cases, successfully controlling the varicella epidemic and preventing its spread to other grades and schools. Based on the varicella outbreak in X Primary School, the CDC issued a detailed epidemiological investigation report, concluding that the epidemic was mainly caused by the following factors^[11]. Firstly, the student with the index case continued to attend school after developing varicella-related symptoms, and the parents failed to report this to the school in a timely manner, leading to clustered infections within the class. Secondly, the school did not implement timely control measures after detecting 3 varicella cases, and the prevention and control measures were inadequate, resulting in the spread of varicella to other grades in the school.

Therefore, schools should learn from this experience and establish a sound emergency management plan for varicella outbreaks. They should actively promote knowledge about the basic symptoms and prevention of varicella on campus, require parents to pay attention to their children's physical conditions, and urge parents to seek timely medical treatment and arrange home isolation for their children once suspected varicella symptoms appear, as well as report to the school promptly^[12]. In addition, after identifying varicella cases, schools should arrange for the isolation of relevant classes immediately and disinfect classrooms and public areas across the campus to avoid secondary generation transmission, block varicella transmission routes, and improve the effectiveness of varicella outbreak prevention and control.

4.2. Strengthen varicella vaccination and promotion of prevention and control knowledge

The varicella outbreak in X Primary School was concentrated in Grades 1 and 2. Many students had not been vaccinated against varicella or had only received 1 dose, resulting in insufficient immunity to varicella and making outbreaks more likely. This study found that the protective efficacy of 2 doses of varicella vaccine was significantly higher than that of 1 dose^[13]. Varicella vaccine not only prevents the occurrence of varicella but also reduces the severity of the disease, minimizing damage to children's organs and bodily functions. Therefore, schools should strengthen the promotion of varicella vaccination among lower-grade students. Through short videos, animations, and other forms, they should publicize the benefits of varicella vaccination, raise parents' awareness of its importance, and encourage them to take the initiative to have their children receive 2 doses of varicella vaccine. This will enhance children's immunity to varicella and prevent infection^[14]. In addition, head teachers of lower grades should conduct surveys on varicella vaccination status, promptly understand the vaccination situation of students in their classes, and urge parents to complete the 2-dose varicella vaccination for their children as soon as possible. Improving vaccination coverage will thereby enhance the protective efficacy of the varicella vaccine^[15].

5. Conclusion

In summary, vaccination is the best method for preventing varicella. Receiving 2 doses of varicella vaccine provides the optimal protective effect, which can help schools improve the effectiveness of varicella prevention and control and build a strong defense for students' health. Schools should establish a sound varicella prevention and control as well as emergency management mechanism, strengthen morning and noon inspections, enhance classroom ventilation and disinfection, place hand sanitizer and soap in restrooms, and cultivate students' good hygiene habits of frequent handwashing to reduce the risk of varicella transmission. In addition, schools should actively promote knowledge about varicella vaccination and prevention, urge parents to have their children vaccinated in a timely manner, and encourage parents to report their children's health information promptly. By adhering to the principles of "early prevention, early detection, and early treatment," schools can comprehensively improve their ability to prevent and manage public health emergencies.

Disclosure statement

The author declares no conflict of interest.

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The Impact of Early Initiation of Intensive Lipid-Lowering Therapy on the Efficacy and Inflammatory Factors in Patients with Acute Coronary Syndrome Undergoing Percutaneous Coronary Intervention

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Abstract: *Objective:* To investigate the impact of early initiation of intensive lipid-lowering therapy on the postoperative efficacy and inflammatory factors in patients with acute coronary syndrome (ACS) undergoing percutaneous coronary intervention (PCI). *Methods:* A total of 100 ACS patients undergoing PCI admitted to our hospital were selected as the study subjects. They were randomly divided into a control group (treated with statin combined with ezetimibe, $n = 41$), a study group 1 (initiated with statin combined with PCSK9 inhibitor immediately after surgery, $n = 32$), and a study group 2 (routinely administered oral statin and initiated with combined PCSK9 inhibitor before discharge, $n = 27$). The therapeutic efficacy, inflammatory factor levels, and incidence of adverse events were compared and analyzed among the three groups. *Results:* The therapeutic regimen in study group 1 demonstrated the optimal efficacy and impact on inflammatory factors, followed by study group 2, while the control group showed relatively weaker efficacy, with statistically significant differences ($p < 0.05$). The overall incidence of adverse reactions was 30.00% in the control group, 5.00% in study group 1, and 10.00% in study group 2, with statistically significant differences among the groups ($p < 0.05$), with the lowest incidence observed in study group 1. *Conclusion:* Early intensive lipid-lowering therapy can effectively improve lipid metabolism, suppress inflammatory responses, and reduce cardiovascular events in ACS patients after PCI, suggesting its pleiotropic cardiovascular protective effects.

Keywords: Early; Intensive lipid-lowering; Acute coronary syndrome PCI patients; Efficacy; Inflammatory factors

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1. Introduction

Acute coronary syndrome (ACS) is one of the most critical clinical types of cardiovascular disease, with its

pathological basis being the rupture of atherosclerotic plaques in the coronary arteries, leading to secondary thrombosis and resulting in myocardial ischemia or necrosis. Percutaneous coronary intervention (PCI) can rapidly restore blood flow, but post-operative restenosis, inflammatory responses, and myocardial injury remain key issues affecting prognosis^[1]. Research has shown that dyslipidemia, particularly elevated low-density lipoprotein cholesterol, is the core mechanism underlying the progression of atherosclerosis, while inflammatory responses play a crucial role in plaque instability and post-PCI complications^[2,3]. In recent years, intensive lipid-lowering therapy has been recommended for patients with acute coronary syndrome (ACS) to reduce lipid levels and improve prognosis. However, there is still inconsistency in existing research conclusions regarding the optimal timing and dosage for initiating intensive lipid-lowering therapy early in the perioperative period of PCI, as well as its dynamic effects on inflammatory factors (such as IL-6, TNF- α , and hs-CRP). Some trials have confirmed that early intensive lipid-lowering therapy can reduce inflammatory responses and myocardial reperfusion injury, but there are also views suggesting that its short-term benefits are limited^[4]. Additionally, whether inflammatory factors can serve as predictors of therapeutic efficacy still requires further validation. Therefore, this study aims to investigate the clinical efficacy (such as cardiovascular events and improvement in cardiac function) of early intensive lipid-lowering therapy in ACS patients undergoing PCI, as well as its regulatory effects on inflammatory factors, in order to provide evidence-based guidance for optimizing treatment strategies and improving long-term prognosis in patients.

2. Research subjects and methods

2.1. Research subjects

A total of 100 ACS patients undergoing PCI admitted to our hospital were selected as the research subjects, including 55 male patients and 45 female patients.

2.1.1. Inclusion criteria

Meeting the criteria in the “Guidelines for Rapid Emergency Diagnosis and Treatment of Acute Coronary Syndrome”; Meeting the indications for PCI surgery, with coronary angiography showing at least one coronary artery lesion with a stenosis degree > 70%; Aged 18–79 years, with no gender restrictions; Diagnosed with acute coronary syndrome, including patients with acute ST-segment elevation myocardial infarction and acute non-ST-segment elevation myocardial infarction; Meeting ethical principles and signing informed consent forms.

2.1.2. Exclusion criteria

Patients who have received lipid-lowering therapy in the past 6 months; Patients with other heart diseases, severe heart failure with a left ventricular ejection fraction less than 30%; Patients with creatine kinase levels exceeding five times the normal range or unexplained CK elevation or those who cannot tolerate lipid-lowering therapy; Patients with concomitant malignant tumors, immune system diseases such as rheumatoid connective tissue diseases; And individuals with impaired liver and kidney function [blood urea nitrogen (BUN) \geq 10.71 mmol/L (30 mg/dL) or creatinine (Cr) \geq 176 mmol/L (2.0 mg/dL)], obstructive jaundice, active liver disease, chronic hepatitis, aspartate aminotransferase (AST) or alanine aminotransferase (ALT) levels three times or more higher than the upper limit of normal, or hyperbilirubinemia; those currently taking medications that may interact with the study drug (such as immunosuppressants), as well as drugs that, when used in combination with statins, may increase the risk of rhabdomyolysis; patients allergic to any statin or with contraindications for

ezetimibe use.

2.2. Methods

2.2.1. Experimental grouping

The 100 patients included in the study were divided into three groups: control group (statin combined with ezetimibe therapy, n = 41), study group 1 (immediate postoperative initiation of statin combined with PCSK9 inhibitor, n = 32), and study group 2 (conventional oral statin with initiation of combined PCSK9 inhibitor before hospital discharge, n = 27).

The control group received statin combined with ezetimibe therapy: 20 mg of oral atorvastatin tablets (Lipitor, Lepu Pharmaceutical Technology Co., Ltd.) combined with 10 mg of ezetimibe tablets (Zetia, Merck & Co., Inc.) every night for 6 consecutive months.

Study group 1 received immediate postoperative initiation of statin combined with PCSK9 inhibitor: immediate postoperative initiation of 20 mg of oral atorvastatin tablets (Lipitor, Lepu Pharmaceutical Technology Co., Ltd.) every night combined with subcutaneous injection of evolocumab injection once every 4 weeks, 140 mg per injection, for 6 consecutive months.

Study group 2 received conventional oral statin with initiation of combined PCSK9 inhibitor before hospital discharge: 20 mg of oral atorvastatin tablets (Lipitor, Lepu Pharmaceutical Technology Co., Ltd.) every night, with initiation of subcutaneous injection of evolocumab injection before hospital discharge, once every 2 weeks, 140 mg per injection, for 6 consecutive months.

2.2.2. Analysis of therapeutic efficacy in the three groups

The therapeutic efficacy in the three groups was evaluated before treatment, 1 month after treatment, 3 months after treatment, and 6 months after treatment. All three groups of patients maintained fasting for at least 12 hours, and 3 mL of forearm cubital vein blood was collected for blood biochemical tests. The Sysmex XN1000 blood analyzer was used to measure platelet count, neutrophil count, lymphocyte count, and monocyte count. Additionally, an immunoassay analyzer (COULTER, USA) was employed to measure Brain Natriuretic Peptide (BNP), while a dry-type immunofluorescence method was used to determine Creatine Kinase-MB (CK-MB) levels via a fluorescence immunoassay analyzer.

2.2.3. Analysis of inflammatory markers in the three groups of patients

All three groups of patients maintained fasting for at least 12 hours, and 3 mL of forearm cubital vein blood was collected for blood biochemical tests using the Siemens Atellica device. Changes in Interleukin-6 (IL-6), High-Sensitivity C-Reactive Protein (hs-CRP), and Neutrophil-to-Lymphocyte Ratio (NLR) were recorded before treatment, and at 1 month, 3 months, and 6 months after treatment.

2.2.4. Incidence of adverse events in the three groups of patients

The occurrence of drug-related adverse events (fatigue, muscle pain, skin itching, rash, and abnormal liver function) was recorded in the three groups of patients, and the incidence rates were calculated.

2.3. Statistical analysis

All data in this study were processed using SPSS 20.0 statistical analysis software (IBM, USA). Measurement data

were expressed as “mean \pm standard deviation” ($\bar{x} \pm s$), and comparisons between groups were performed using independent sample *t*-tests. Categorical data were expressed as percentages (%), and comparisons between groups were conducted using χ^2 analysis. A *p*-value < 0.05 was considered statistically significant.

3. Results

3.1. Analysis of therapeutic efficacy in the three groups of patients

Before treatment, there were no significant differences among the three groups in terms of platelet count, neutrophil count, lymphocyte count, monocyte count, BNP, and CK-MB ($p > 0.05$). One month, three months, and six months after treatment, the platelet counts in Study Group 1 and Study Group 2 were significantly lower than those in the control group. Significant differences were also observed in neutrophil count, lymphocyte count, and monocyte count at various time points after treatment ($p < 0.05$). Furthermore, BNP and CK-MB levels significantly decreased in Study Group 1 and Study Group 2. Particularly notable was that six month after treatment, the BNP and CK-MB levels in Study Group 1 were significantly lower than those in the control group, while the degree of improvement in Study Group 2 fell between that of Study Group 1 and the control group. Overall, the therapeutic effects in Study Group 1 and Study Group 2 were significantly superior to those in the control group, with Study Group 1 showing more pronounced improvement. (See **Table 1**)

Table 1. Analysis of therapeutic efficacy in three groups of patients ($\bar{x} \pm s$)

Group	Control group (n = 41)	Study group 1 (n = 32)	Study group 2 (n = 27)	<i>t</i> / χ^2 value	<i>p</i> -value
Before treatment					
Platelet ($\times 10^9/L$)	216.42 \pm 78.41	218.78 \pm 71.39	247.43 \pm 82.88	0.290	0.435
Neutrophil Count ($\times 10^9/L$)	7.48 \pm 2.96	7.84 \pm 2.96	11.05 \pm 1.58	0.465	0.787
Lymphocyte Count ($\times 10^9/L$)	1.83 \pm 0.82	1.60 \pm 0.68	2.79 \pm 0.42	0.396	0.542
Monocyte Count ($\times 10^9/L$)	0.51 \pm 0.27	0.70 \pm 0.19	0.84 \pm 0.08	0.418	0.296
BNP (pg/mL)	802.41 \pm 19.58	746.52 \pm 13.28	1144.35 \pm 19.82	0.554	0.328
CK-MB (ng/mL)	24.37 \pm 1.01	35.27 \pm 0.37	26.85 \pm 3.93	0.895	0.415
1-month post-treatment					
Platelet ($\times 10^9/L$)	223.82 \pm 68.32	235.07 \pm 62.74	224.73 \pm 56.39	10.243	0.013
Neutrophil Count ($\times 10^9/L$)	4.26 \pm 1.12	5.10 \pm 1.94	4.85 \pm 1.31	9.864	0.024
Lymphocyte Count ($\times 10^9/L$)	2.10 \pm 0.65	1.81 \pm 0.70	3.13 \pm 0.67	11.267	0.038
Monocyte Count ($\times 10^9/L$)	0.51 \pm 0.14	0.57 \pm 0.15	0.84 \pm 0.23	9.087	0.042
BNP (pg/mL)	364.40 \pm 12.32	85.48 \pm 2.33	110.24 \pm 10.80	15.647	0.008
CK-MB (ng/mL)	17.83 \pm 1.28	10.55 \pm 1.08	14.23 \pm 1.12	18.769	0.001
3-months post-treatment					
Platelet ($\times 10^9/L$)	226.50 \pm 70.83	228.12 \pm 54.01	220.90 \pm 52.56	6.756	0.036
Neutrophil Count ($\times 10^9/L$)	4.31 \pm 1.06	6.73 \pm 0.65	4.25 \pm 0.16	8.796	0.024
Lymphocyte Count ($\times 10^9/L$)	2.18 \pm 0.58	1.86 \pm 0.76	2.15 \pm 0.78	9.870	0.035
Monocyte Count ($\times 10^9/L$)	0.49 \pm 0.13	0.55 \pm 0.15	0.50 \pm 0.19	9.665	0.027

Table 1 (Continued)

Group	Control group (n = 41)	Study group 1 (n = 32)	Study group 2 (n = 27)	<i>t</i> / χ^2 value	<i>p</i> -value
BNP (pg/mL)	140.25 ± 11.45	75.36 ± 2.15	100.18 ± 9.42	16.842	0.001
CK-MB (ng/mL)	16.95 ± 1.20	9.20 ± 0.95	12.85 ± 1.05	20.154	0.001
6-months post-treatment					
Platelet (×10 ⁹ /L)	302.00 ± 89.09	146.50 ± 13.14	209.00 ± 57.98	6.756	0.043
Neutrophil Count (×10 ⁹ /L)	3.45 ± 0.64	4.97 ± 1.13	4.24 ± 1.45	8.970	0.056
Lymphocyte Count (×10 ⁹ /L)	3.08 ± 0.98	1.77 ± 0.57	2.00 ± 0.98	9.867	0.035
Monocyte Count (×10 ⁹ /L)	0.54 ± 0.04	0.75 ± 0.29	0.76 ± 0.09	8.779	0.046
BNP (pg/mL)	135.40 ± 10.28	68.42 ± 1.98	92.15 ± 8.35	18.963	0.001
CK-MB (ng/mL)	15.80 ± 1.10	8.15 ± 0.85	11.20 ± 0.95	22.417	0.001

3.2. Analysis of inflammatory indicators in three groups of patients

Before treatment, there were no significant differences in IL-6, hs-CRP, and NLR levels among the three groups of patients ($p > 0.05$). After treatment, all indicators significantly improved in Study Group 1 and Study Group 2 and were superior to those in the control group ($p < 0.05$). Specifically, one month after treatment, the levels of IL-6, hs-CRP, and NLR in Study Group 1 were significantly lower than those in the control group and Study Group 2 ($p < 0.05$). As time progressed, the improvement effects in Study Group 1 and Study Group 2 continued to strengthen, with Study Group 1 showing particularly outstanding performance six months after treatment, significantly better than that in the control group and Study Group 2 ($p < 0.05$). The degree of improvement in Study Group 2 fell between that of the control group and Study Group 1 but was still significantly better than that in the control group ($p < 0.05$). Overall, the treatment plans in Study Group 1 and Study Group 2 were both effective in reducing inflammatory indicators, with Study Group 1 showing more significant results. (See **Table 2**)

Table 2. Analysis of inflammatory indicators in three groups of patients ($\bar{x} \pm s$)

Group	Control group (n = 41)	Study group 1 (n = 32)	Study group 2 (n = 27)	<i>t</i> / χ^2 value	<i>p</i> -value
Before treatment					
IL-6 (mg/dL)	3.45 ± 0.12	3.50 ± 0.15	3.48 ± 0.13	0.257	0.783
hs-CRP (mg/L)	33.81 ± 0.19	2.51 ± 1.78	63.13 ± 5.68	0.546	0.779
NLR	4.98 ± 0.35	5.23 ± 0.68	4.86 ± 0.97	0.732	0.584
1-month post-treatment					
IL-6 (mg/dL)	2.87 ± 0.10	2.14 ± 0.08	2.39 ± 0.12	12.454	< 0.001
hs-CRP (mg/L)	1.91 ± 0.42	2.95 ± 0.52	1.96 ± 0.58	9.665	0.012
NLR	1.81 ± 0.20	1.37 ± 0.10	1.56 ± 0.15	10.897	< 0.001
3-months post-treatment					
IL-6 (mg/dL)	2.62 ± 0.08	2.17 ± 0.14	1.34 ± 0.03	18.325	< 0.001
hs-CRP (mg/L)	4.37 ± 0.20	2.54 ± 0.12	3.25 ± 0.15	20.144	< 0.001
NLR	1.72 ± 0.15	1.16 ± 0.08	1.35 ± 0.10	22.566	< 0.001

Table 2 (Continued)

Group	Control group (n = 41)	Study group 1 (n = 32)	Study group 2 (n = 27)	t/ χ^2 value	p-value
6-months post-treatment					
IL-6 (mg/dL)	2.47 ± 0.05	1.81 ± 0.08	2.03 ± 0.04	15.783	< 0.001
hs-CRP (mg/L)	3.57 ± 0.18	2.15 ± 0.10	2.89 ± 0.12	18.909	< 0.001
NLR	1.64 ± 0.10	0.85 ± 0.05	1.18 ± 0.08	21.326	< 0.001

3.3. Incidence of adverse events in three groups of patients

In the control group, adverse reactions occurred in 6 patients (30.00%), including fatigue in 2 patients, muscle soreness in 2 patients, rash in 1 patient, and abnormal liver function in 1 patient. In Study Group 1, only 1 patient (5.00%) experienced fatigue. In Study Group 2, 2 patients (10.00%) experienced fatigue and rash, respectively. Statistical analysis revealed a significant difference in the overall incidence rates among the groups ($\chi^2 = 13.435$, $p < 0.05$), indicating that the incidence of adverse reactions was significantly lower in the study groups compared to the control group (see **Table 3**).

Table 3. Incidence of adverse events in the three groups [n (%)]

Group	Fatigue	Myalgia	Pruritus	Skin rash	Abnormal liver function	Total incidence (%)	χ^2 value	p-value
Control (n = 20)	2	2	0	1	1	6 (30.00)		
Study group 1 (n = 20)	1	0	0	0	0	1 (5.00)	13.435	0.001
Study group 2 (n = 20)	1	0	0	1	0	2 (10.00)		

4. Discussion

Early initiation of intensive lipid-lowering therapy has demonstrated significant clinical benefits in patients with acute coronary syndrome (ACS) undergoing percutaneous coronary intervention (PCI) ^[5,6]. The results of this study indicate that the therapeutic effects in Study Group 1 and Study Group 2 were significantly superior to those in the control group, particularly in improving patient prognosis, with Study Group 1 showing the most pronounced efficacy. This finding aligns with previous research, suggesting that intensive lipid-lowering strategies can rapidly alleviate lipid levels, stabilize plaques, and reduce the occurrence of ischemic events ^[7]. Furthermore, the significant advantage of Study Group 1 may be attributed to its more aggressive lipid-lowering regimen or earlier intervention timing, highlighting the crucial role of early intensive lipid-lowering in the acute management of ACS.

In terms of inflammatory factor regulation, the treatment regimens in Study Group 1 and Study Group 2 effectively reduced serum inflammatory marker levels, with Study Group 1 demonstrating a more pronounced effect. Inflammatory responses in ACS patients are closely associated with plaque instability and adverse cardiovascular events, and intensive lipid-lowering may alleviate inflammation by inhibiting pathways such as nuclear factor-kappa B (NF- κ B) ^[8]. The exceptional performance of Study Group 1 further supports the anti-inflammatory mechanism of intensive lipid-lowering, particularly the synergistic effect

of high-intensity statins combined with other lipid-lowering drugs such as PCSK9 inhibitors. This result underscores the multifaceted benefits of lipid-lowering therapy in ACS patients, not only improving lipid metabolism but also potentially delaying the progression of atherosclerosis through anti-inflammatory pathways, consistent with the findings of Li et al. ^[9].

The safety analysis revealed that the incidence of adverse reactions in the study group was significantly lower than that in the control group, possibly related to standardized dosage adjustments and close monitoring. Although intensified lipid-lowering therapy theoretically carries the potential to increase the risk of abnormal liver enzymes or myopathy, no severe adverse reactions were observed in this study, indicating that early initiation of intensified lipid-lowering therapy demonstrates good tolerability in clinical practice ^[10]. Further exploration of the long-term efficacy and safety of different lipid-lowering regimens is needed in the future to optimize individualized treatment strategies for patients with acute coronary syndrome (ACS).

5. Conclusion

In summary, early initiation of intensified lipid-lowering therapy holds significant clinical value in patients with acute coronary syndrome undergoing percutaneous coronary intervention (PCI), effectively improving prognosis, reducing inflammation levels, and exhibiting good safety.

Disclosure statement

The authors declare no conflict of interest.

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The Impact of Metabolic Syndrome on Coronary Artery Disease in Middle-Aged and Older Women

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Abstract: *Objective:* This study aims to assess the influence of Metabolic Syndrome (MS) on the risk and severity of Coronary Artery Disease (CAD) in middle-aged and elderly women (40–75 years old), to inform evidence-based prevention and management strategies for this population. *Methods:* A retrospective study enrolled 200 middle-aged and elderly female patients (aged 40–75 years) who underwent coronary angiography (CAG) at our hospital between January 2024 and March 2025. Participants were divided into an MS group ($n = 88$) and a non-MS group ($n = 112$) based on meeting MS diagnostic criteria. General clinical data including age, body mass index [BMI], blood pressure, blood glucose, blood lipids, and more were collected for both groups. The severity of coronary artery lesions was quantified using the Gensini score. Differences in the positive rate of coronary artery lesions, the number of diseased vessel segments, and Gensini scores between the two groups were compared. *Results:* Patients in the MS group exhibited a significantly higher prevalence of coronary artery lesions (79.55% vs. 48.21%, $p < 0.001$), a greater proportion of multivessel disease (46.59% vs. 18.75%, $p < 0.05$), and higher Gensini scores (25.72 ± 14.28 vs. 16.35 ± 9.86 , $p < 0.05$) compared to the non-MS group. *Conclusion:* Metabolic syndrome is a significant risk factor for coronary artery disease in middle-aged and elderly women, substantially increasing both the incidence and severity of coronary lesions. Clinical efforts should focus on enhancing screening and comprehensive intervention for metabolic syndrome in this population to reduce the risk of coronary heart disease.

Keywords: Metabolic syndrome; Middle-aged and elderly women; CAD; Gensini score; Risk factors

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1. Introduction

Coronary atherosclerotic heart disease (CHD) ranks among the leading cardiovascular diseases causing death and disability in middle-aged and elderly populations worldwide. Women experience a significant increase in cardiovascular disease risk following menopause due to the loss of estrogen's protective effects^[1]. According to the China Cardiovascular Health and Disease Report 2023, the prevalence of CHD among Chinese women aged 50 and above reaches 12.3%, representing a 3- to 4-fold increase compared to premenopausal women, with poorer prognosis^[2]. Metabolic syndrome (MS) is a cluster of metabolic disorders characterized by central obesity,

hypertension, hyperglycemia, and dyslipidemia. Its core pathophysiological mechanism is insulin resistance, which increases cardiovascular disease risk by damaging vascular endothelium, promoting inflammation, and accelerating atherosclerosis (AS) progression^[3]. Existing research has confirmed the strong association between MS and coronary artery disease in men, hypertensive patients, and diabetic patients. However, studies targeting the specific population of middle-aged and elderly women aged 40–75 remain insufficient. On one hand, these women often have comorbidities such as osteoporosis and osteoarthritis, which may mask MS-related symptoms. On the other hand, postmenopausal hormonal changes may interact synergistically with MS components, exacerbating coronary artery damage^[4]. Furthermore, clinical practice still prioritizes MS screening in men over women, resulting in delayed detection of coronary artery disease in middle-aged and elderly women. This study examined 200 middle-aged and elderly women aged 40–75 who underwent coronary angiography (CAG). By comparing coronary lesion characteristics between metabolic syndrome (MS) and non-MS groups, this study analyzed the impact of MS on the occurrence and severity of coronary lesions in this population. Our aim is to provide data support for early prevention, risk stratification, and clinical intervention strategies for coronary heart disease in middle-aged and elderly women.

2. Materials and methods

2.1. General data

A retrospective study included 200 middle-aged and elderly female patients aged 40–75 years (mean 56.45 ± 7.32 years) who underwent coronary angiography (CAG) at our hospital's Department of Cardiology between January 2024 and March 2025 due to “chest pain, chest tightness” or “suspected coronary heart disease”.

2.1.1. Inclusion criteria

First-time admission of middle-aged and elderly female patients aged 40–75 years with suspected coronary heart disease; Underwent CAG with confirmed coronary artery lesions; Complete clinical data (including demographic characteristics, laboratory tests, imaging records, and more.); No prior primary or secondary prevention interventions for coronary heart disease; No history of coronary intervention or coronary artery bypass grafting.

2.1.2. Exclusion criteria

Active severe infection; severe hepatic impairment (Child-Pugh Class C) or severe renal impairment (estimated glomerular filtration rate $< 30 \text{ mL/min/1.73 m}^2$); diagnosis of any malignant tumor or autoimmune disease; a history of major surgery or significant trauma within the preceding 3 months; or poorly controlled thyroid dysfunction.

2.2. Methods

Diagnosis of metabolic syndrome followed the criteria recommended by the Diabetes Branch of the Chinese Medical Association (2019 edition)^[5].

(1) Overweight and/or obesity

Body mass index (BMI) $\geq 25 \text{ kg/m}^2$

(2) Hyperglycemia

Fasting plasma glucose (FPG) $\geq 6.1 \text{ mmol/L}$ (110 mg/dL), and/or 2-hour postprandial glucose ≥ 7.8

mmol/L (140 mg/dL), and/or diagnosed diabetes mellitus under treatment

(3) Hypertension

Systolic/diastolic blood pressure $\geq 140/90$ mmHg, and/or diagnosed hypertension under treatment

(4) Dyslipidemia

Fasting triglycerides (TG) ≥ 1.7 mmol/L, and/or HDL-cholesterol (HDL-C) < 0.9 mmol/L (males) or < 1.0 mmol/L (females).

Presence of three or all four criteria confirms MS diagnosis. Participants not meeting these criteria were assigned to the non-MS group.

2.3. Observation indicators

2.3.1. General clinical data

Data on patient age, height, weight, waist circumference, and past medical history (including hypertension, diabetes, and hyperlipidemia) as well as medication history (including antihypertensive, antidiabetic, and statin medications) were retrieved from the electronic medical record system.

2.3.2. Laboratory testing

All patients underwent venous blood sampling the morning after admission (fasting ≥ 8 hours) to measure the following parameters:

(1) Fasting plasma glucose (FPG)

(2) Lipid profile

Total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C)

(3) Hepatic and renal function

Alanine aminotransferase (ALT), serum creatinine (Scr), with estimated glomerular filtration rate (eGFR) calculated using the CKD-EPI equation

(4) Thyroid function

2.3.3. Coronary Artery Disease assessment (CAG and Gensini score)

All patients underwent coronary angiography (CAG) performed by experienced interventional cardiologists using the Judkins technique with multi-position imaging. Two independent interventional cardiologists (blinded assessment) evaluated coronary artery lesions based on angiographic findings: Single-vessel disease ($\geq 50\%$ stenosis in one coronary artery), two-vessel disease ($\geq 50\%$ stenosis in two coronary arteries), multivessel disease ($\geq 50\%$ stenosis in three or more coronary arteries). Left main coronary artery disease was classified as two-vessel disease.

The severity of coronary lesions was quantified using the Gensini scoring system, with the following criteria: Scoring based on the degree of coronary stenosis: $\leq 25\%$ stenosis = 1 point; 26–50% stenosis = 2 points; 51–75% stenosis = 4 points; 76–90% stenosis = 8 points; 91–99% stenosis = 16 points; $\geq 100\%$ stenosis = 32 points^[6]. Weighting by coronary territory: Left Main (LM) $\times 5$; Left Anterior Descending (LAD) proximal segment $\times 2.5$, mid-segment $\times 1.5$, distal segment $\times 1$; Left Circumflex (LCX) proximal segment $\times 2.5$, distal segment $\times 1$; Right Coronary Artery (RCA) proximal segment $\times 1.5$, mid-segment $\times 1$, distal segment $\times 1$; collateral circulation vessels $\times 1$; Total Gensini score = sum of stenosis severity scores \times corresponding weight scores. Higher scores indicate more severe coronary artery disease.

2.4. Statistical methods

Data analysis was performed using SPSS 27.0 statistical software. For continuous variables meeting normal distribution, results were expressed as mean \pm standard deviation ($\bar{x} \pm s$), with intergroup comparisons conducted using independent samples *t*-tests. Non-normally distributed continuous variables were presented as median with interquartile range [M (Q1, Q3)], and the Mann-Whitney U test was used for between-group comparisons. Categorical data were expressed as counts and percentages [n (%)], and group differences were assessed using the Chi-square or Fisher's exact test, as appropriate. A two-sided *p*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of general clinical characteristics between groups

There was no statistically significant difference in age between the two groups ($p > 0.05$). The MS group exhibited significantly higher BMI, waist circumference, SBP, DBP, FPG, TG, LDL-C, and prevalence rates of hypertension, diabetes, and hyperlipidemia compared to the non-MS group, while HDL-C was significantly lower in the MS group ($p < 0.05$). See **Table 1** for details.

Table 1. Comparison of general clinical data between the two patient groups

Indicator	MS group (n = 86)	Non-MS group (n = 94)	<i>t</i> / χ^2	<i>p</i>
Age (years)	62.87 \pm 7.54	62.03 \pm 7.11	0.89	0.436
BMI (kg/m ²)	28.63 \pm 3.15	24.02 \pm 2.87	10.52	< 0.05
Waist Circumference (cm)	88.56 \pm 6.32	76.24 \pm 5.89	14.03	< 0.05
SBP (mmHg)	145.27 \pm 12.36	128.45 \pm 10.78	9.86	< 0.05
DBP (mmHg)	88.45 \pm 9.62	80.13 \pm 8.54	6.89	< 0.05
FPG (mmol/L)	7.89 \pm 1.63	5.32 \pm 0.87	13.52	< 0.05
TC (mmol/L)	5.63 \pm 1.02	5.21 \pm 0.98	2.98	< 0.05
TG (mmol/L)	2.56 \pm 0.98	1.45 \pm 0.62	9.65	< 0.05
LDL-C (mmol/L)	3.62 \pm 0.85	3.15 \pm 0.76	4.12	< 0.05
HDL-C (mmol/L)	1.02 \pm 0.21	1.35 \pm 0.28	9.23	< 0.05
Hypertension [n (%)]	74 (84.09)	45 (40.18)	38.56	< 0.05
Diabetes [n (%)]	58 (65.91)	16 (14.29)	55.82	< 0.05
Hyperlipidemia [n (%)]	70 (79.55)	38 (33.93)	45.28	< 0.05

3.2. Comparison of coronary artery lesions between the two groups

The coronary artery lesion positivity rate in the MS group (79.55%) was significantly higher than that in the non-MS group (48.21%), with a statistically significant difference ($p < 0.05$). Regarding the number of diseased vessels, the proportion of single-vessel disease in the MS group (26.14%) did not differ significantly from that in the non-MS group (29.46%) ($p > 0.05$). However, the proportions of two-vessel disease (27.27%) and multivessel disease (46.59%) were significantly higher than those in the non-MS group (19.64% and 18.75%), with statistically significant differences ($p < 0.05$). The Gensini score in the MS group (25.72 \pm 14.28 points) was

significantly higher than that in the non-MS group (16.35 ± 9.86 points), with statistically significant differences ($p < 0.05$). See **Table 2** for details.

Table 2. Comparison of coronary artery lesions between the two groups

Indicator	Group	MS group (n = 88)	Non-MS group (n = 112)	χ^2/t	p
Positive coronary lesions [n (%)]		70 (79.55)	54 (48.21)	19.02	< 0.05
	Single-vessel disease	23 (26.14)	33 (29.46)	0.28	0.596
Number of Lesions [n (%)]	Two-vessel disease	24 (27.27)	22 (19.64)	2.35	0.125
	Multivessel disease	23 (46.59)	21 (18.75)	13.28	< 0.05
Gensini score (points)	Gensini score (points)	25.72 ± 14.28	16.35 ± 9.86	5.48	< 0.05

4. Discussion

Middle-aged and elderly women (40–75 years old) in the perimenopausal and postmenopausal stages exhibit physiological characteristics that amplify the impact of metabolic syndrome (MS) on coronary artery disease: Estrogen exerts cardiovascular protective effects by activating estrogen receptor alpha (ER α) to promote nitric oxide (NO) synthesis and suppress inflammatory factor expression. Postmenopausal estrogen levels plummet, eliminating this protective effect. This leads to increased vascular endothelial sensitivity to MS components (such as hyperglycemia and hypertension), accelerating atherosclerosis (AS) progression^[7]. Middle-aged and elderly women often exhibit “sarcopenic obesity”, characterized by reduced muscle mass and fat accumulation (especially visceral fat), which further exacerbates insulin resistance (IR) and dyslipidemia. This creates a vicious cycle of “obesity-IR-metabolic abnormalities”, increasing the risk of coronary artery disease^[8]. Middle-aged and elderly women often present with atypical symptoms of coronary heart disease (e.g., chest tightness and fatigue rather than typical chest pain) and frequently have comorbidities like musculoskeletal or respiratory diseases. These conditions can mask MS-related symptoms, leading to delayed screening for MS and coronary lesions and missed opportunities for early intervention^[9].

This study systematically analyzed the impact of MS on coronary artery disease in 200 middle-aged and elderly women aged 40–75 years. Results showed that the MS group exhibited significantly higher rates of positive coronary artery disease, multivessel disease, and Gensini scores compared to the non-MS group, consistent with findings from domestic and international studies^[10]. Based on these results and pathophysiological mechanisms, the influence of MS on coronary artery disease in middle-aged and elderly women is analyzed as follows:

- (1) The core characteristic of MS is the “cluster of metabolic abnormalities”. Its components do not act independently but synergistically exacerbate coronary atherosclerosis through a cascade reaction involving “insulin resistance-inflammatory response-vascular endothelial injury”. Insulin resistance (IR) serves as the core driver. In middle-aged and elderly women, postmenopausal decline in estrogen levels can induce IR by reducing insulin sensitivity. Under IR conditions, insulin’s protective effects on vascular endothelium (e.g., promoting nitric oxide NO release) diminish. Concurrently, it stimulates excessive LDL-C synthesis in the liver and inhibits HDL-C-mediated cholesterol reverse transport, leading to lipid

deposition in coronary intima. Furthermore, IR activates the renin-angiotensin-aldosterone system (RAAS), elevating blood pressure and causing additional damage to the vascular endothelium. In this study, the MS group exhibited significantly elevated FPG and LDL-C levels alongside markedly reduced HDL-C, confirming the metabolic dysregulation associated with IR.

- (2) Central obesity is a prerequisite for diagnosing metabolic syndrome (MS). Adipose tissue (particularly visceral fat) secretes inflammatory mediators such as tumor necrosis factor- α (TNF- α) and interleukin-6 (IL-6). These activate the nuclear factor- κ B (NF- κ B) pathway, promoting inflammatory cell infiltration and foam cell formation within the coronary artery intima. In this study, the MS group exhibited significantly higher BMI and waist circumference than the non-MS group, with a 46.59% prevalence of multivessel disease. This suggests obesity-related inflammation may be a key contributor to multivessel coronary artery disease. Hypertension can disrupt the coronary endothelial barrier through mechanical stress, facilitating lipid entry into the intima. Hyperglycemia, through non-enzymatic glycation, generates advanced glycation end products (AGEs), which activate the AGE receptor (RAGE), exacerbating endothelial cell apoptosis and smooth muscle cell proliferation.

Based on the study's results, the following measures are recommended to prevent and manage metabolic syndrome (MS) and coronary artery disease in middle-aged and older women: For women aged 40 and above, routinely monitor waist circumference, blood pressure, fasting plasma glucose (FPG), and lipid profiles (triglycerides, HDL-C) to identify MS patients early, particularly high-risk individuals with concomitant hypertension or diabetes. Reduce BMI to $< 24 \text{ kg/m}^2$ and waist circumference to $< 80 \text{ cm}$ through dietary control (low-calorie, high-fiber diet) and exercise ($\geq 150 \text{ min}$ of moderate-intensity aerobic activity weekly). Target SBP $< 130 \text{ mmHg}$ and DBP $< 80 \text{ mmHg}$, prioritizing ACEI/ARB agents for their dual antihypertensive and insulin resistance-improving effects; target FPG $< 7.0 \text{ mmol/L}$, using metformin or SGLT2 inhibitors (e.g., dapagliflozin) as needed, with the latter reducing cardiovascular event risk; Target LDL-C $< 2.6 \text{ mmol/L}$ (high-risk individuals $< 1.8 \text{ mmol/L}$), prioritizing statins with ezetimibe combination if necessary; For MS patients, especially those with multiple abnormalities (≥ 3 components), conduct regular coronary risk assessments such as coronary CTA, exercise stress testing to detect coronary lesions early and prevent progression to severe coronary artery disease.

The study's findings are limited by its single-center, retrospective design and relatively small sample size of 200 cases, potentially introducing selection bias; results require validation through multicenter, large-sample prospective studies. Insulin resistance-related indicators including fasting insulin and HOMA-IR were not measured, preventing direct quantification of the association between IR severity and coronary artery lesions. The impact of hormone replacement therapy (HRT) was not considered; some patients may have received HRT, and its effects on MS and coronary artery lesions require further analysis.

5. Conclusion

In summary, metabolic syndrome is a significant risk factor for coronary artery lesions in middle-aged and elderly women aged 40–75 years, substantially increasing the risk and severity of coronary artery lesions. Furthermore, the greater the number of MS components present, the more severe the coronary artery lesions. In clinical practice, screening for MS in middle-aged and elderly women should be strengthened. Early comprehensive intervention targeting MS components (controlling weight, blood pressure, blood glucose, and blood lipids) can reduce the risk of coronary artery disease and improve patient prognosis.

Disclosure statement

The author declares no conflict of interest.

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A Qualitative Study on the Self-Management Experiences and Outpatient Nursing Needs of Intestinal Stoma Patients During the Post-Discharge Transition Period

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Abstract: *Objective:* To explore the self-management experiences and outpatient nursing needs of intestinal stoma patients during the post-discharge transition period, in order to provide a basis for scientific decision-making in patient self-care and improvements in specialized stoma outpatient services. *Methods:* Using purposive sampling, 13 colorectal cancer patients in the post-discharge transition period who had undergone intestinal stoma surgery were selected from a tertiary hospital in Shandong Province between November 2024 and March 2025. Semi-structured interviews were conducted, and data were analyzed using Colaizzi's seven-step method to extract themes. *Results:* Three core themes were identified: challenges in self-management during the transition period, outpatient nursing needs during the transition period, and gaps in doctor-patient information continuity. *Conclusion:* Future efforts should focus on high-risk groups of stoma patients during the transition period by building intelligent and systematic outpatient guidance and support systems to improve their quality of life.

Keywords: Transition period; Enterostomy; Self-management experience; Outpatient care needs; Qualitative research

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1. Introduction

An intestinal stoma is a surgically created “artificial anus” that connects the intestine to the abdominal wall, allowing feces to be expelled and collected in a stoma bag. Globally, approximately 1 million patients live with an intestinal stoma. The surgery significantly improves the survival rate of colorectal cancer patients.

According to GLOBOCAN 2022, colorectal cancer ranks third in incidence and second in mortality globally. While stoma surgery can extend life, it also alters bowel function, bringing physiological, psychological, and social stress that severely affects patients' quality of life ^[1]. National policies advocate for coordinated and continuous

medical care; however, with the promotion of enhanced recovery after surgery (ERAS), hospital stays have become shorter, and patients often lack adequate preoperative nursing knowledge. As a result, the readmission rate within six months post-discharge is as high as 40% ^[2].

The first six months after discharge are critical for patients to adapt to bodily changes and learn self-management skills, significantly influencing their recovery and quality of life. Continuity of care is particularly needed during this period, with outpatient services playing a crucial role. Current research mainly focuses on inpatient and home care, often neglecting the outpatient care needs during the transition phase. This study adopts a qualitative approach to deeply interview intestinal stoma patients, aiming to provide theoretical and practical references for optimizing outpatient continuity of care ^[3].

2. Data and methods

2.1. Study participants

From November 2024 to March 2025, this study adopted purposive sampling to select colorectal cancer patients with intestinal stomas in the post-discharge transition period who were receiving follow-up care at the stoma outpatient clinic of a tertiary hospital in Shandong Province.

2.1.1. Inclusion criteria

Aged 18–70, clear clinical diagnosis, mentally alert, and voluntarily participating.

2.1.2. Exclusion criteria

Patients with serious comorbidities, those primarily cared for by others, or those who withdrew midway. The sample size was determined by the principle of data saturation.

2.2. Research methods

2.2.1. Development of the interview outline

Based on a literature review and the research objectives, the research team initially developed an interview outline. Two patients were interviewed in a pilot phase, and based on their feedback, a supplementary question was added: “What do you think are the reasons for the difficulties encountered in self-management during the post-discharge transition period?” The final interview outline included six main questions, covering topics such as knowledge of stoma care, healthcare provider guidance, consistency between self-management and professional expectations, difficulties in self-management and coping strategies, causes of those difficulties, and outpatient nursing service needs ^[4].

2.2.2. Data collection method

Ethical approval was obtained prior to data collection. A nursing graduate student trained in qualitative research conducted the interviews. Before each interview, the study’s purpose, recording procedures, and privacy protection were explained. After signing the informed consent form, face-to-face interviews were conducted in a private and quiet setting. Each session lasted 15–30 minutes. Interviewers followed the principles of “no interruption, no leading, no judgment” to ensure data authenticity and objectivity.

2.2.3. Data analysis method

Interview recordings were transcribed within 24 hours by two graduate students independently (back-to-back). Ambiguous expressions were verified and corrected, with efforts made to retain original phrasing. Transcripts were uploaded to a computer, labeled, and archived. After repeated comparison of audio and transcripts, NVivo 15.0 software was used to perform thematic analysis based on Colaizzi's seven-step method ^[5].

2.2.4. Quality control

The interviewer had received training in qualitative research and was assisted by the director of the stoma outpatient clinic. Trust was established with participants prior to the interviews, and neutrality was maintained throughout to avoid bias. In case of disagreements during data analysis, the research team held discussions or consulted qualitative research experts to ensure the credibility and consistency of the findings.

3. Results

3.1. General information

A total of 13 patients were interviewed: 7 males and 6 females, aged 25 to 67 years, with an average age of 46.31 ± 12.76 years. The types of stoma included: 3 cases of temporary colostomy, 5 cases of permanent colostomy, 3 cases of temporary ileostomy, and 2 cases of permanent ileostomy. Eight patients experienced complications, including 3 cases of fecal dermatitis, 1 case of parastomal hernia, 1 case of stoma prolapse, 1 case of mucosal granuloma, 1 case of skin-mucosa separation, and 1 case of allergic dermatitis. The study was approved by the ethics committee, and all patients gave informed consent to participate. (See **Table 1** for general participant information)

Table 1. General information of interviewees (n = 13)

ID	Gender	Age	Marital Status	Education Level	Insurance Type	Income (CNY/month)	Occupation	Type of Stoma	Complications
P1	Male	28	Unmarried	College or above	Chronic Disease Insurance	3001–5000	Student	Colostomy (Temporary)	Yes (Fecal dermatitis)
P2	Female	56	Married	Primary school or below	Chronic Disease Insurance	≤ 1000	Unemployed	Colostomy (Permanent)	No
P3	Male	66	Married	Secondary school	Chronic Disease Insurance	≤ 1000	Farmer	Colostomy (Permanent)	Yes (Parastomal hernia)
P4	Female	25	Unmarried	College or above	Employee Insurance	3001–5000	Clerk	Ileostomy (Temporary)	Yes (Mucosal granuloma)
P5	Male	46	Married	Secondary school	Chronic Disease Insurance	5001–10000	Self-employed	Ileostomy (Temporary)	Yes (Prolapse)
P6	Female	52	Married	Secondary school	Chronic Disease Insurance	3001–5000	Clerk	Colostomy (Permanent)	No
P7	Male	46	Married	Secondary school	Chronic Disease Insurance	3001–5000	Self-employed	Colostomy (Temporary)	No
P8	Female	45	Married	College or above	Employee Insurance	5001–10000	Clerk	Colostomy (Permanent)	Yes (Fecal dermatitis)
P9	Male	67	Widowed	Secondary school	Employee Insurance	1001–3000	Retired	Ileostomy (Permanent)	Yes (Fecal dermatitis)

Table 1 (Continued)

ID	Gender	Age	Marital Status	Education Level	Insurance Type	Income (CNY/month)	Occupation	Type of Stoma	Complications
P10	Female	51	Married	Primary school or below	Chronic Disease Insurance	1001–3000	Farmer	Colostomy (Temporary)	No
P11	Male	38	Married	College or above	Chronic Disease Insurance	3001–5000	Self-employed	Ileostomy (Permanent)	Yes (Skin and mucosa separation)
P12	Female	35	Divorced	College or above	Chronic Disease Insurance	3001–5000	Clerk	Ileostomy (Temporary)	Yes (Allergic dermatitis)
P13	Male	47	Married	Secondary school	Chronic Disease Insurance	1001–3000	Farmer	Colostomy (Permanent)	No

3.2. Thematic analysis

This study involved interviews with 13 patients with intestinal stomas during the post-discharge transition period, with each interview averaging 25 minutes. Based on a comprehensive analysis of the interview data, three major themes were identified surrounding the patients' self-management experiences and outpatient nursing needs during the transition period ^[6].

3.2.1. Theme 1: Challenges in self-management during the transition period

(1) Inconsistent knowledge of stoma care

Due to short recovery periods and the heavy workload of medical staff, some patients did not fully grasp stoma-related knowledge and only understood basic bowel function. In contrast, other patients proactively sought information before surgery and achieved better outcomes through self-learning. For instance, patients P2 and P10 had limited understanding, while P13 and P9 were well-prepared preoperatively and demonstrated better post-op care abilities ^[7].

(2) Difficulty in mastering stoma care skills

During hospitalization, stoma care was often handled by family members, so patients only began personal care after discharge. They struggled with tasks like cutting the flange or replacing stoma bags. P4 and P5 reported difficulty cutting the baseplate, P9 worried about improper sizing, and P3 found replacement challenging due to poor visibility of the stoma site.

(3) Psychological adaptation difficulties

Changes in bowel function triggered identity crises and psychological resistance among patients. P4 struggled to accept physical changes, P7 felt daily life was affected by the support rod, P8 expressed strong aversion to the stoma, and P3, lacking trust in others to perform care properly, relied heavily on outpatient services ^[8].

(4) Lack of family and social support

Limited caregiving abilities among family members left patients feeling unsupported during the transition period, resulting in a sense of isolation in their self-management journey.

(5) Lack of competence in managing complications

Due to insufficient in-hospital education, patients lacked the skills to handle complications during the high-risk transition phase, which often led to improper care and potential readmission. P11: "The skin around the stoma turned red and hurt, I panicked and didn't know what to do". P10: "The stoma bag kept

leaking and wouldn't stick properly, it made me so anxious". P1: "After the support rod was removed, the wound wouldn't heal and kept oozing. I didn't know how to change the dressing".

3.2.2. Theme 2: Outpatient nursing needs during the transition period

(1) Need for professional guidance

Most patients expressed a strong desire for standardized care instruction at outpatient clinics, including techniques for stoma bag replacement and managing complications^[9]. T10: "I hope they hold more nursing seminars, with live demonstrations to teach us how to change stoma bags". T6: "Having professionals guide me gives me peace of mind". T1: "The clinic acts as a safety net, it's crucial to have access to help when problems arise".

(2) Need for psychological support

Psychological support was also seen as essential. Patients hoped for emotional comfort and encouragement through peer exchange and counseling. T11: "I hope regular support group meetings are organized so we can share experiences". T4: "People who haven't gone through this don't understand, it's incredibly tough. Without support and encouragement, it's hard to come to terms with such a body change". T8: "I need help not only with daily life but also emotionally". T13: "Joining mutual aid groups for stoma patients really helps, it allows us to encourage each other".

(3) Need for continuity of care

The demand for continuity of care is increasingly prominent. Patients expect services like online consultations, routine checkups, and home visits. T6 suggested establishing a hybrid online-offline communication system after discharge. T9 hoped for mutual aid via group chats. T13 pointed out the need for home services when mobility is limited. T3 mentioned that some patients, due to their dependence on the clinic, lacked the confidence for independent care.

(4) Need for resource accessibility

Access to resources was a shared concern. Patients called for broader availability of stoma care products and improved distribution of healthcare resources. T6: "There should be more diverse care products and better access to nearby medical resources". T12: "I hope the outpatient clinic can stock various brands and models of stoma bags, so we can try them and find the most suitable one".

3.2.3. Theme 3: Gaps in doctor-patient information continuity

The study revealed significant disconnects in information exchange between patients and healthcare providers. Discharge instructions were often brief and lacked hands-on practice, leaving patients confused and unprepared for home care^[10]. While hospitals prioritize efficiency, families value comfort, leading to mismatched expectations. Moreover, patients had limited access to reliable information, often turning to online sources or peer advice instead of timely, authoritative professional guidance, further complicating the care process.

4. Discussion

4.1. Enhancing doctor-patient information continuity and strengthening knowledge and skill training to build confidence

With the implementation of enhanced recovery after surgery (ERAS), hospital stays have become shorter, leaving

patients inadequately prepared for discharge and creating gaps in information continuity ^[11]. This has resulted in uneven understanding of stoma care, poor complication management, and psychological maladaptation. High-risk patients should be identified early and provided with personalized guidance before discharge to improve their self-management abilities and caregiving skills, thereby enhancing confidence. After discharge, regular outpatient follow-up should be conducted, with particular attention to high-risk individuals. Continued skill instruction and health consultations are essential. Ongoing education and psychological support can help patients recognize and handle complications, improve their mental state, and build confidence in adapting to life with a stoma ^[12].

4.2. Addressing patient needs by improving outpatient decision-making systems to support transitional and continuous care

Patients in the transitional period have clear demands for continuity of care, yet current discharge planning practices remain underdeveloped, making it difficult to ensure care continuity and potentially leading to adverse outcomes. A decision support system which combining online and offline services and grounded in nursing theory, should be established to assist patients in making optimal care decisions regarding safety, cost, and other factors. Such systems can reduce patient anxiety, enhance their ability to address care challenges, and improve treatment adherence and care outcomes ^[13]. This approach is vital for improving outpatient care quality and achieving sustained nursing support.

4.3. Leveraging artificial intelligence to optimize outpatient nursing models and expand information access

National policies advocate for using AI and the Internet of Things (IoT) to streamline nursing workflows. Currently, some outpatient clinics suffer from uneven resource distribution and limited product options, affecting patient satisfaction and choice ^[14]. It is necessary to enhance both hardware and software infrastructure and optimize resource allocation to improve the healthcare experience. Stoma clinics should not only provide basic care but also expand services such as online consultations, Q&A support, and follow-up visits ^[15]. Developing an information-sharing platform between hospitals, communities, and families can ensure comprehensive and personalized continuous nursing care that meets diverse patient needs.

5. Conclusion

This study reveals that patients with intestinal stomas face multiple self-management challenges during the post-discharge transition period, including gaps in knowledge and skills, psychological adjustment issues, lack of social support, and difficulty managing complications. Their outpatient nursing needs are urgent. Moving forward, leveraging technologies such as artificial intelligence to improve outpatient care systems, enhance nursing education, and provide psychological support will be key to comprehensively improving patients' quality of life.

Disclosure statement

The authors declare no conflict of interest.

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Trajectory and Influencing Factors of Postoperative Vulnerable Symptom Clusters in Lung Transplant Recipients

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Abstract: The first three months after lung transplantation are the clinical “vulnerable period”. Complications during this period often appear in the form of symptom clusters. The core includes primary graft dysfunction (PGD), infection, inflammatory response and multiple organ dysfunction, and are interconnected to form a complex network. The symptom cluster shows a clear dynamic trajectory: the risk of PGD peaks at 24 hours after surgery, and its evolution trajectory (recovery, delay, deterioration) directly affects long-term graft function; infections show a “double peak distribution”, with bacteria/fungi dominant in the early stage (< 1 month) and viruses/opportunistic infections dominant in the middle stage (1–6 months), and promote each other with PGD. Influencing factors include four dimensions: donor (smoking history, infection), recipient (weakness, immune status), perioperative period (surgical method, support strategy) and postoperative management (balance of immunosuppression). In the future, dynamic prediction models and individualized management paths need to be built to improve patient outcomes.

Keywords: Lung transplantation; Symptom clusters; Postoperative complications; Trajectory

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1. Introduction

Lung transplantation, as the only radical treatment for patients with end-stage lung disease, has seen a continuous increase in its application worldwide in recent years, and the survival rate of patients has also gradually improved ^[1]. However, postoperative complications in the short term remain a key factor affecting prognosis, among which the management of the “vulnerable period” usually refers to the first 3 months after surgery is particularly important. During this period, patients face multiple risks such as primary graft dysfunction (PGD), infection, and acute rejection. These complications often overlap in the form of “symptom clusters”, increasing the complexity of clinical management. For example, PGD is the leading cause of death within 72 hours

after surgery, with an incidence rate as high as 20%, and it often coexists with complications such as infection and renal impairment ^[2]. Meanwhile, infection is the leading cause of death in the first year after lung transplantation, and its risk is closely related to factors such as immunosuppression regimen, donor quality, and surgical procedures ^[3]. Therefore, a deep understanding of the dynamic changes of the vulnerable period symptom clusters and their influencing factors is of great significance for optimizing postoperative management and improving patient prognosis. In recent years, the number of lung transplant cases and centers in China has steadily increased, and the focus of clinical work has shifted from “being able to do it” to “doing it well”, emphasizing the identification and systematic management of perioperative complications ^[4]. Given that the “symptom cluster” has the characteristics of multidimensional parallel and dynamic evolution across physiological, psychological, social and organ functions, it is difficult to grasp its true trajectory based on a single symptom or a single time point. Domestic clinical observations also suggest that postoperative complications occur in clusters, which have an added impact on rehabilitation and survival ^[5]. Multicenter data show that in 2020, about 29 centers across the country performed more than 500 lung transplants, and the perioperative (< 30 days), 1-year and 3-year survival rates were roughly in the range of 48–83% (depending on whether it is a single or double lung), suggesting that early complication control has an “anchoring effect” on long-term outcomes ^[4]. In addition, studies on postoperative “symptom clusters” in solid organ transplant populations (including lung transplants) have shown that symptom clusters involve four dimensions: physiological, psychological, social and organ function. A longitudinal and holistic assessment and intervention framework is needed to characterize their change trajectory ^[6].

2. Definition of vulnerable period and core symptom clusters after lung transplantation

2.1. The timing and clinical significance of the vulnerable period

The time range of the vulnerable period after lung transplantation is not yet unified, but most studies define it as the period within 3 months after surgery, especially the period from 72 hours to 2 weeks after surgery as the “hyperacute period” with the highest risk. The incidence of complications in this stage directly determines the short-term survival rate and long-term prognosis of patients. For example, a French study on high emergency lung transplantation (HELT) showed that the mortality rate 30 days after surgery was as high as 37.5%, and it was significantly related to factors such as preoperative mechanical ventilation and ECMO support ^[7]. In addition, Japanese scholars found that patients with baseline lung graft dysfunction (BLAD) had significantly longer ICU hospital stays and mechanical ventilation time, suggesting that early functional recovery delays may continue to affect the patient’s recovery trajectory ^[8]. In the population receiving emergency/high-priority lung transplants, the perioperative complications (such as bleeding, cardiopulmonary bypass (CPB)/ECMO dependence) and infection burden are significantly increased. Multiple multicenter and single-center studies have shown that although HELT significantly reduces waiting list mortality, the risk of death during hospitalization and in the early stages (30 days–3 months) is higher than that of routinely assigned recipients, suggesting that the risk exposure in the “hyperacute phase” is more concentrated, requiring more refined perioperative management and early complication screening pathways ^[7,9].

The clinical significance of the vulnerable period is not only reflected in the control of short-term complications, but also closely related to long-term graft survival. For example, PGD is one of the most serious complications of the vulnerable period. Studies have shown that survivors of high-risk HELT have a significantly

higher risk of developing chronic lung allograft dysfunction (CLAD) than conventional lung transplant recipients^[2]. Therefore, systematically managing the vulnerable period as a dynamic risk window is a key link in improving the overall efficacy of lung transplantation.

2.2. The composition and interaction of core symptom clusters

Cluster during the vulnerable period after lung transplantation does not exist in isolation, but rather forms a complex interactive network centered on respiratory insufficiency, infection, systemic inflammatory response, and organ dysfunction.

Respiratory failure is mainly manifested as PGD and hypoxemia. PGD is defined based on the oxygenation index ($\text{PaO}_2/\text{FiO}_2$) and chest imaging changes within 72 hours after surgery. Its pathological nature is similar to that of acute respiratory distress syndrome (ARDS), involving alveolar epithelial damage, release of inflammatory factors and pulmonary edema formation^[2]. Studies have shown that about 55% of PGD patients will progress to BLAD, that is, they cannot reach FEV_1 and $\text{FVC} \geq 80\%$ of the predicted value within 3 weeks after surgery, which further increases the risk of death^[10]. Retrospective cohort studies suggest that when “graft failure + circulatory instability” occurs during/after surgery, sequential/bridging support with VAV ECMO can improve the weaning rate and perioperative survival, providing a feasible rescue strategy for severe PGD and respiratory and circulatory combined failure^[11]. Multicenter and methodologically updated studies have further confirmed that BLAD is not an isolated event, but rather a result of the combined effects of PGD grade 3, donor/recipient factors, and perioperative procedures, suggesting that the continuous chain of “PGD severity–lung function recovery trajectory–subsequent CLAD risk” should be assessed simultaneously during the vulnerable period^[12,13].

Infection is another prominent problem during the vulnerable period, including bacterial, viral and fungal infections. A study in Brazil showed that 15.7% of lung transplant recipients developed surgical site infection (SSI), of which organ/cavity infection accounted for 36.8%, and was significantly associated with factors such as prolonged operation time and positive donor bronchoalveolar lavage fluid (BALF)^[14]. In addition, in pediatric lung transplant recipients, prolonged donor ischemia time (≥ 7 hours) and cardiopulmonary bypass time (≥ 340 minutes) are independent risk factors for postoperative infection^[3]. Infection and PGD often promote each other: on the one hand, infection can aggravate lung tissue inflammation and induce or worsen PGD; on the other hand, the immunosuppressed state and mechanical ventilation requirements of PGD patients increase the risk of infection^[15]. The spectrum of infections during the vulnerable period is time- dependent and site-specific: in the first month after surgery, donor-origin or nosocomial opportunistic infections are the main ones, followed by an increase in the burden of viral (such as CMV, influenza/RSV, etc.) and fungal infections, which are closely related to airway anastomosis complications and the intensity of immunosuppression^[16,17]. Respiratory viruses cause significant mortality and readmission risk among lung transplant recipients in China. Early stratified prevention, rapid nucleic acid testing, and management of drug interactions (such as antiviral and immunosuppressant) are important measures to reduce the continuous damage of “infection-PGD-CLAD”^[18]. A domestic case cohort of bacterial lung infections showed that prolonged cold ischemia time, difficulty in airway management, and exposure to drug-resistant bacteria are key modifiable factors, suggesting that perioperative antimicrobial strategies need to be dynamically optimized by combining donor and recipient culture and central epidemiology^[19].

Systemic inflammatory response is a common pathway connecting various symptom clusters. Surgical trauma, ischemia-reperfusion injury, and immune activation lead to the release of a large number of inflammatory factors, which not only directly damage the lung graft but may also cause multiple organ dysfunction. For

example, the incidence of acute kidney injury (AKI) in lung transplant recipients is as high as 84.9%, of which 30.1% are severe AKI, and it is closely related to underlying diseases such as pulmonary hypertension and diabetes ^[20]. At the same time, AKI and PGD share pathological mechanisms such as ischemia-reperfusion and inflammatory response, forming a vicious cycle of the “cardiopulmonary-kidney axis” ^[21].

Recent studies on AKI indicate that perioperative volume management, hemodynamic fluctuations, ECMO use, and neurohumoral axis activation all contribute to impaired renal perfusion. Domestic reviews suggest stratified monitoring using KDIGO classification linked to biomarkers (such as NGAL) to achieve a balance between respiratory mechanics and renal protection ^[20,22]. In addition, the coagulation-inflammation interaction is particularly prominent in PGD/infection comorbidities: under intraoperative and perioperative anticoagulation exposure, a small number of patients develop HIT and significantly increase the risk of venous thrombosis (VTE), requiring early identification and adjustment of anticoagulation pathways by combining 4T scores and PF4 antibody testing; while VTE is not uncommon in lung transplant patients within one year, independent of HIT, and is related to metabolic factors, center procedures and transplantation procedures, as well as increased mortality and resource consumption, and early ultrasound screening and individualized prevention should be included in the pathway ^[23,24].

Coagulation dysfunction is not listed as a core symptom group, its role in the vulnerable period cannot be ignored. Heparin-induced thrombocytopenia (HIT) occurs in approximately 2.1% of patients and can lead to venous thromboembolism in 72% of patients, prolonging hospital stay ^[23]. In addition, patients with PGD often have activated coagulation system, further increasing the risk of bleeding and thrombosis ^[25].

The interactions of these symptom clusters significantly increase the difficulty of clinical management. For example, infection may mask the clinical manifestations of acute rejection, while adjustments to immunosuppressants may exacerbate the risk of infection. Therefore, adopting a multi-objective intervention based on a “symptom cluster” perspective is an inevitable trend in vulnerable period management.

3. The trajectory of symptom cluster changes and their dynamic characteristics

3.1. Temporal distribution and evolution of PGD

The occurrence of PGD is significantly time-dependent, with the risk peaking within 24 hours post-surgery and then gradually decreasing, but it can still persist up to 72 hours post-surgery. A Canadian study showed that 33% of lung transplant recipients developed PGD within 72 hours post-surgery, with prolonged donor cold ischemia time (≥ 6 hours) and decreased expression of ENaC channels in alveolar epithelial cells being important predictive factors ^[26]. In addition, the amount of red blood cells transfused during surgery and the use of inhaled pulmonary vasodilators were also associated with the severity of PGD ^[25]. Recent studies have emphasized that PGD is essentially an acute lung injury caused by ischemia-reperfusion, and the activation of the early inflammation-edema pathway determines the intensity and direction of its evolution within 72 hours ^[27].

The evolution trajectory of PGD can be divided into three types: rapid recovery type ($\text{PaO}_2/\text{FiO}_2$ recovers to above 300 mmHg within 72 hours after surgery), prolonged type (mechanical ventilation is still required after 72 hours), and deterioration type (progresses to ARDS and requires ECMO support). American scholars have found that HLA mismatch (especially DQ site) and donor smoking history are independent risk factors for prolonged PGD, while EVLP (extracorporeal lung perfusion) technology may improve the functional recovery of some high-risk donor lungs ^[28]. PGD is closely related to the occurrence of subsequent BLAD. A single-center study in Japan

showed that 55% of BLAD patients failed to achieve normal lung function within 6 months after surgery, and the reduced donor-recipient predicted vital capacity ratio was the main risk factor ^[8].

Organ source and assessment strategies also affect the time distribution of PGD. Analysis of national databases shows that lungs assessed/ reconditioned by EVLP have comparable overall survival to conventional direct implantation, without increasing the incidence of PGD3. In the selection of high-risk donor lungs, EVLP can serve as a bridging strategy to “delay/reduce early pulmonary edema and inflammatory response”, thereby reducing the proportion of protracted/deteriorating trajectories in T24–T72 ^[29]. From a biological perspective, the destruction of the epithelial-endothelial barrier and the downregulation of ENaC function in donor lungs lead to alveolar fluid clearance disorders, which are considered to be the key nodes that determine the “recovery-protracted-deterioration” bifurcation in T0–T72, suggesting that targeted interventions for channel function and epithelial repair in the perioperative period are worth exploring ^[30]. Chinese reviews and expert experience also point out that establishing a closed-loop pathway of “72-hour continuous assessment - risk phenotype identification-early intervention” (including lung-protective ventilation, goal-oriented volume management, early external support and infection screening when necessary) can be clinically translated into higher withdrawal rates and lower complication burden ^[31].

3.2. Temporal characteristics and etiological changes of infection symptom clusters

The incidence of post-lung transplantation infection shows a “bimodal distribution”: the first peak occurs within 1 month after surgery, mainly bacterial and fungal infections; the second peak occurs from 1 to 6 months after surgery, characterized by viral infections (such as CMV, EBV) and opportunistic infections ^[15]. A multicenter study in Italy showed that the infection rate in lung transplant recipients within 6 months after surgery was as high as 47.8%, with Gram-negative bacteria accounting for the highest proportion, and most of them being multidrug-resistant strains ^[15]. The Italian national surveillance cohort indicated that the cumulative infection rate in lung transplant recipients within 6 months was 47.8%, with the most concentrated events in the first month. Gram-negative bacilli (mainly drug-resistant *Acinetobacter baumannii*, *Aeromonas baumannii* and *Pseudomonas aeruginosa*) dominated the early lineage ^[15]. A review of lung transplantation bacteriology pointed out that the sources of pathogens include donor lungs, existing colonization in recipients and in-hospital exposure, and that drug resistance phenotypes are closely related to central epidemiology, emphasizing that empirical treatment should be matched with local drug sensitivity ^[32].

Bacterial infections, the pathogens from the donor cannot be ignored. Turkish researchers found that recipients with positive bronchial lavage fluid cultures from donors had significantly longer mechanical ventilation time after surgery (median 4 days vs. 1 day) and a 3.39-fold increase in the incidence of postoperative PGD ^[33]. In addition, for every hour the operation time was extended, the risk of SSI increased by 2.34 times, suggesting that intraoperative contamination may be an important source of early infection ^[14]. Multicenter and single-center studies have further shown that positive bronchial/bronchoalveolar lavage fluid (BAL) cultures from donors are associated with an increased risk of early lung infection and PGD in recipients, suggesting the necessity of a three-pronged screening and decolonization strategy involving the donor, recipient, and perioperative period ^[33]. Regarding perioperative surgical complications, recent large single-center cohort studies have linked invasive SSIs (deep/organ cavities) with poor post-transplant outcomes and provided actionable risk stratification (such as operation time, re-exploration, and transfusion volume) and procedural recommendations ^[34].

Among viral infections, CMV is the most common pathogen, especially in recipients with CMV serological

mismatch. The incidence of CMV infection in pediatric lung transplant recipients is 17%, while studies in elderly kidney transplant recipients show that age ≥ 65 years is an independent risk factor for CMV reactivation (OR = 2.48), suggesting that immunosenescence may exacerbate viral replication^[35,36]. In addition, EBV infection is closely associated with the occurrence of post-transplant lymphoproliferative disease (PTLD), with the risk peaking within 1–2 years after surgery^[37]. A multicenter retrospective study of thoracic transplantation in China suggests that differences in CMV serological background and prevention strategies can significantly affect the CMV infection burden after lung/heart-lung transplantation, supporting risk stratification to guide prevention and surveillance^[38]. In the pediatric lung transplant population, individualized strategies based on CMV-specific cellular immunity and more flexible prevention durations can be considered^[39]. Regarding EBV, empirical studies and authoritative reviews of adults and adolescents suggest that EBV D⁺/R⁻ background, early high-burden replication and enhanced immunosuppression jointly determine the time-series high-risk window of PTLD, requiring dynamic nucleic acid monitoring and early immunosuppression intervention^[40].

Fungal infections are most commonly caused by *Candida* and *Aspergillus*, with an incidence of about 25% within one month after surgery^[35]. Due to long-term antibiotic use before surgery, cystic fibrosis (CF) patients have a significantly higher risk of fungal infection than other populations, and often present with invasive infection and extremely high mortality^[41]. Contemporary studies show that invasive aspergillosis (IA) mostly occurs in the first 6 months after surgery, and the risk is significantly increased in the context of “airway anastomosis complications, chronic rejection (BOS/CLAD) and previous fungal colonization”^[42]. A comparison of domestic programs shows that “targeted prevention” does not increase IA events while reducing adverse reactions, but it needs to be combined with time window and dynamic assessment of individual risk factors^[18]. A single-center retrospective study in China reported that the rate of invasive fungal infection within 30 days after surgery was about 13%, which was related to the spectrum of primary diseases and perioperative exposure. This suggests that imaging, GM/BDG and bronchoscopy assessments should be combined in the early peak window, and preventive strategies should be implemented when necessary to avoid forming a vicious cycle of “infection-PGD-function not reaching peak”^[43].

Overall, the early stage (0–1 month) is dominated by bacterial/*Candida* and surgical site/donor-related events, while the middle stage (1–6 months) is dominated by CMV/EBV and opportunistic fungi, forming a “time-pathogen” coupling, superimposed with PGD, immunosuppression intensity and airway anastomosis complications, constituting the core spectrum of infection symptoms during the vulnerable period. Based on this, a comprehensive pathway of “time-specific pathogen spectrum + antimicrobial (true) drug management + dynamic virological monitoring” should be constructed to reduce the risk of recurrence and long-term CLAD.

4. Analysis of influencing factors of symptom clusters

4.1. Donor-related factors

Donor quality is one of the key factors determining the occurrence of vulnerable period symptoms after lung transplantation, and its influence extends throughout the entire process from organ procurement and preservation to reperfusion. The influence of donor age is controversial: traditional views hold that older donors (> 55 years old) increase the risk of PGD, but the latest research shows that donor age is not significantly associated with the incidence of PGD, which may be related to the advancement of donor lung assessment technology^[2]. However, Japanese scholars have found that donor-recipient age mismatch may indirectly lead to BLAD by affecting graft

size matching, and the donor-recipient predicted vital capacity ratio was significantly reduced in the BLAD group^[8].

A donor smoking history is a known risk factor. A study of double lung transplant recipients showed that a donor heavy smoking history (> 20 packs / year) increased the risk of BLAD by 3.07 times, which may be related to alveolar epithelial damage and inflammatory response caused by tobacco toxins^[10]. In addition, a positive BALF culture is closely associated with postoperative infection. A study in Turkey found that the median postoperative mechanical ventilation time was 4 days in donors with positive BALF cultures, which was significantly longer than that in the negative group^[33].

The impact of ischemic time varies depending on surgical technique. A national study in the UK showed that when CPB was used, the risk of death increased by 13% per year for every hour of extended ischemic time, while when CPB was not used, ischemic time had no significant impact on prognosis^[44]. This finding challenges the traditional “cold ischemic time < 6 hours” standard and suggests that surgical strategies may alter the ischemic tolerance of the donor lung.

Donor infection and immune status should not be ignored. A US study showed that after adopting the expanded definition of “high-risk donor” (IRD) in 2013, the proportion of non-standard infection risk donors increased from 8% to 22%, but the survival rate of recipients was not significantly different from that of standard donors^[45]. This suggests that under strict monitoring, some high-risk donors can still be used safely. In addition, donor CMV serological positivity may increase the risk of recipient CMV reactivation, especially in the absence of prophylactic treatment^[36].

4.2. Receptor-related factors

The recipient-side risk exposure spans from preoperative to early postoperative period and has an “amplifying” effect on the formation of vulnerable period symptom clusters (PGD, infection, AKI, etc.). First, frailty is independently associated with adverse postoperative outcomes. Recent systematic reviews suggest that multidimensional vulnerability assessment of candidates can predict post-transplant hospital stay, complications and readmission risk, and some patients can benefit from a “deterioration-improvement” trajectory 3–6 months postoperatively, suggesting that preoperative vulnerability management should be included in the perioperative pathway^[46]. Second, the intensity of preoperative respiratory/circulatory support reflects the severity of the disease. Although the survival rate of patients bridging transplantation with ECMO has improved year by year, the complications, resource consumption and infection burden are higher, and refined stratification is needed in candidate selection and perioperative management^[47]. In terms of immunology, HLA mismatch (especially HLA-DQ and epitope mismatch) is associated with early complications and the formation of novo donor-specific antibodies (dnDSA), increasing the risk of rejection and CLAD, suggesting that more refined compatibility assessment should be conducted in conjunction with epitope analysis^[48]. Overall, the recipient side should coordinate intervention from four dimensions: “vulnerability—support strength—immuno-compatibility—inflammatory load” to reduce the cumulative effect of vulnerable period symptoms.

4.3. Surgical and perioperative management factors

Perioperative technical routes directly reshape the pathogenesis of vulnerable period symptom clusters. Regarding extracorporeal support methods, the latest meta-analysis and systematic review show that VA ECMO is superior or non-inferior to CPB in many short-term indicators (ICU hospitalization, tracheotomy, renal failure), but its impact on mortality and bleeding/transfusion is heterogeneous, suggesting that strategies should be developed in

combination with center experience and individual hemodynamics^[49]. The amount of red blood cells transfused during the operation is independently correlated with PGD3 at 72 hours after the operation, and is accompanied by an increase in dialysis demand and hospitalization time. A balance should be achieved between hemostasis and transfusion thresholds^[50]. In addition, prolonged operation, re-exploration and high-intensity extracorporeal support can increase infection and bleeding complications, thereby triggering the linkage of “PGD-infection-renal injury”, and a dynamic balance should be achieved between organ protection and complication prevention^[51].

4.4. Postoperative management and immunosuppression-related factors

The dynamic balance between postoperative immunosuppression and infection/rejection determines the “coupling strength” of vulnerable symptom clusters. The infection burden is high in the first year after lung transplantation, with CMV, drug-resistant bacteria and fungi being the core pathogens. Infection and rejection are mutually causal pathways, and imbalance can amplify the PGD-BLAD-CLAD chain^[52]. The association between CMV replication and CLAD risk has been confirmed in multicenter and single-center studies, and a prevention/preemptive strategy should be implemented by combining serological stratification and PCR dynamic monitoring^[53]. In terms of antifungal treatment, real-world and national data suggest that shifting from “general prevention” to “targeted prevention” can reduce adverse reactions without increasing IA events; drug selection (voriconazole/caspofungin, etc.) needs to be combined with individual risk profile and drug interaction management^[54]. Calcineurin inhibitors remain the cornerstone of maintenance therapy. Tacrolimus trough concentration fluctuations are associated with increased acute rejection burden, and TDM and its interaction should be taken seriously. Compared with cyclosporine, tacrolimus has advantages in reducing acute rejection/CLAD, but diabetes and nephrotoxicity need to be weighed^[55]. Chinese guidelines and reviews have formed a standardized path: emphasizing individualized induction–maintenance regimens, stratified diagnosis and treatment of rejection (cell/antibody mediated), and synergy with infection prevention and rehabilitation nursing to reduce the clustering of complications during vulnerable periods^[56].

The vulnerable period after lung transplantation is a critical stage determining short-term survival and long-term graft function, characterized by the high frequency and complex interaction of multi-system complications. This article reviews the composition, dynamic trajectory, and multidimensional influencing factors of symptom clusters during the vulnerable period in lung transplant recipients. Studies have shown that PGD is the most central pathological event in this stage, forming a “symptom cluster network” together with infection, inflammatory response, and multiple organ dysfunction, exhibiting continuous evolution over time. Donor quality, recipient baseline status, surgical and perioperative management, and postoperative immunity and infection control all shape the pathogenesis of symptom clusters at different levels. In recent years, with the optimization of donor selection, the application of EVLP, and the promotion of individualized perioperative management, the overall incidence of PGD and infection has decreased, but the adverse effects of “symptom clusters” on rehabilitation and long-term survival remain prominent. Future research should focus on three aspects: First, establishing dynamic predictive models for symptom clusters based on longitudinal data to achieve precise monitoring and early intervention; second, constructing a two-way assessment system for donors and recipients to promote individualized immune and infection prevention strategies; and third, strengthening multidisciplinary collaboration and improving postoperative rehabilitation, psychological, and social support interventions to improve both physiological and functional outcomes. In summary, research on vulnerable symptom clusters after lung transplantation is shifting from “complication statistics” to “systemic physiology and holistic management” and its systematization,

dynamism, and precision will become the core direction for improving transplant efficacy in the future.

5. Conclusion

The early post-lung transplant period is characterized by a core symptom cluster, primarily comprising Primary Graft Dysfunction (PGD) and infections. This cluster exhibits a distinct temporal trajectory and is influenced by donor and recipient factors, surgical procedures, and postoperative management. Future efforts should focus on developing predictive models to inform proactive, personalized management strategies aimed at improving patient outcomes.

Disclosure statement

The authors declare no conflict of interest.

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The Application Effect of the Discharge Preparation Plan Based on the ADOPT Nursing Model in Patients with First-Visit Ischemic Stroke

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Abstract: *Objective:* To investigate the application effect of the discharge preparation plan based on the ADOPT nursing model in patients with first-visit ischemic stroke. *Methods:* Eighty patients with first-visit ischemic stroke admitted to our hospital from June 1, 2024 to November 31, 2024 were selected and divided into a control group (June 1, 2024 to August 30, 2024) and an intervention group (September 1, 2024 to November 31, 2024) according to different admission times, with 40 cases in each group. The control group received routine care and discharge guidance, while the intervention group received a discharge preparation plan based on the ADOPT model on the basis of routine care. The discharge readiness [Discharge Readiness Scale (RHDS)] of patients on the day of discharge was compared. Self-efficacy at 3 months after discharge [evaluated using the Chronic Disease Self-Efficacy Scale (SECD6)], activities of daily living [evaluated using the Barthel index (BI)], blood glucose and blood pressure indicators (diastolic blood pressure, systolic blood pressure, FPG, 2 h PG), and readmission rate within 3 months after discharge were also compared between the two groups. *Results:* On the day of discharge, the RHDS-related dimension scores of the intervention group were higher than those of the control group ($t = 17.993, 8.560, 10.243, p < 0.05$); Three months after discharge, the SECD6 score and BI score of the intervention group were higher than those of the control group ($t = 8.910, 10.899$, both $p < 0.05$); Systolic blood pressure, diastolic blood pressure, FPG and 2h PG in the intervention group were lower than those in the control group ($t = 8.868, 4.794, 3.829, 7.121$, all $p < 0.05$); Within 3 months after discharge, the readmission rate of the intervention group was lower than that of the control group ($\chi^2 = 5.165, 2, p < 0.05$). *Conclusion:* The discharge preparation plan based on the ADOPT nursing model, when applied to patients with first-visit ischemic stroke, can not only enhance self-efficacy and discharge preparation, improve activities of daily living, but also optimize blood glucose and blood pressure indicators and reduce the readmission rate, which is worthy of reference.

Keywords: ADOPT nursing; Discharge preparation plan; First visit to ischemic stroke; Readiness for discharge; Readmission rate

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1. Introduction

Ischemic stroke is a neurological deficit syndrome caused by obstruction or narrowing of cerebral arteries, which leads to impaired blood circulation in the brain, resulting in ischemia and hypoxia and softening or necrosis of brain tissue ^[1]. With the deepening reform of China's medical system, medical institutions often shorten the length of hospital stay and increase the bed turnover rate, causing most patients to return home after their conditions stabilize ^[2]. Some strokes, after treatment, are often accompanied by varying degrees of functional impairment, and there are still many unmet rehabilitation needs at the time of discharge. To ensure a better return of patients to their families and society, it is important to develop targeted discharge plans to improve discharge readiness. Therefore, it is necessary to explore a new model of care to meet the needs of patients for discharge preparation. Conventional discharge guidance and discharge planning lack multidisciplinary intervention, and the intervention effect is constrained by time and space factors, resulting in unsatisfactory intervention effects. The ADOPT nursing model is an intervention model consisting of five steps: attitude, definition, open thinking, planning, and implementation, aiming to solve the problem ^[3]. At present, some scholars have applied the ADOPT nursing model to diabetic patients, and the results show that the ADOPT model is satisfactory in improving self-management behavior, quality of life and more ^[4]. The discharge preparation plan is a new type of nursing model that has emerged in recent years. It refers to the plans made by hospitals to help patients and their families with treatment and care after discharge, so that patients receive continuous care after discharge, which is a form of continuous care ^[5]. Previous reports have found that nurse-led discharge planning care applied to stroke patients' discharge preparation can improve discharge readiness and keep the risk of readmission at a low level, which is worthy of clinical reference ^[6]. There are very limited domestic research reports on the application of the ADOPT model to the discharge preparation planning of stroke patients, and its application effect needs further study. In view of this, this study is conducted with the aim of providing a reference basis for the future. The relevant reports are as follows.

2. Data and methods

2.1. General information

Eighty patients with first-diagnosed ischemic stroke admitted to the neurology Department of our hospital from June 1, 2024 to November 31, 2024 were selected and divided into a control group (June 1, 2024 to August 30, 2024) and an intervention group (September 1, 2024 to November 31, 2024) according to different admission times, with 40 cases in each group.

(1) Control group

22 males, 18 females; Age: 45–77 years, average (60.73 ± 5.38) years

(2) Educational attainment

17 cases in junior high school and below, 23 cases in senior high school and above

(3) Intervention group

23 males, 17 females; Age ranged from 46 to 78 years, with an average of (61.24 ± 5.53) years

(4) Educational attainment

19 cases were junior high school or below, and 21 cases were senior high school or above. There was no statistical significance between the two groups of data ($p > 0.05$). This study was reviewed by the hospital ethics committee before it was conducted.

2.1.1. Inclusion criteria

- (1) Diagnosed with ischemic stroke ^[7]
- (2) First diagnosis and admission
- (3) The condition is stable after active treatment
- (4) Normal cognitive and communication abilities
- (5) Informed consent has been signed

2.1.2. Exclusion criteria

- (1) Comorbidity of vital organ function
- (2) In the middle or advanced stage of a malignant tumor
- (3) Large cerebral infarction or other serious complications
- (4) Previous history of mental illness
- (5) Not returning home after discharge and being transferred to another institution
- (6) Not cooperating with the follow-up or dropping out halfway

2.2. Methods

Both groups were treated with uniform and standardized medication both inside and outside the hospital. Patients in the control group received routine care in the neurology ward and routine discharge guidance as follows:

- (1) Admission and health education
Responsible nurses introduced the ward environment, hospital management system, etc. to patients; By sending Wechat videos or distributing health education brochures, patients were informed of the disease pathogenesis, risk factors, treatment plans and complications, and were given medication care, dietary guidance and staged rehabilitation training.
- (2) Patient monitoring
Regularly monitor the patient's vital signs and inform the doctor of any abnormalities.
- (3) Neurological assessment
Regularly assess the patient's neurological condition, such as consciousness, language, motor function, etc. If there are any abnormalities, promptly advise the attending physician to dynamically adjust the medication plan
- (4) Postural care
Inform the patient that they can lie still for a long time to prevent pressure injury or muscle atrophy, and regularly turn the patient over, pat their back, change their position, etc.
- (5) Discharge guidance
Before discharge, the responsible nurse conducts a comprehensive assessment of the patient's physical condition and provides discharge guidance to the patient and their family, including post-discharge medication, diet, rehabilitation training and life guidance. At the same time, prepare discharge materials and items for the patient, instruct the patient to come to the hospital for regular check-ups, add the patient's family or the patient's Wechat, and conduct regular follow-ups through phone calls or Wechat voice messages once a week. The follow-ups mainly ask the patient whether they follow the doctor's instructions for medication and rehabilitation training outside the hospital, and provide technical guidance to patients who do not perform well in the above situations outside the hospital when necessary.

The intervention group implemented a discharge preparation plan based on the ADOPT model on the basis of routine care. The steps were as follows: Form an ADOPT team consisting of one attending physician, one head nurse, one nutritionist, one psychological counselor, one rehabilitation therapist, and five specialist nurses in the department. The head nurse trained the group members on the definition of the ADOPT model, its development at home and abroad, the process, and stroke rehabilitation care, etc. After the patient's condition is stable, the team members comprehensively assess the patient's physical condition, develop personalized care plans, and implement the discharge preparation plan under the ADOPT model.

As follows:

(1) Attitude (A)

Specialist nurses have face-to-face conversations with patients, assess their attitudes towards the disease, care and rehabilitation training, build a good trust relationship through open-ended questions, encourage patients to speak out actively, provide targeted guidance based on patient feedback, emphasize the importance of care and rehabilitation training, and invite previous successful rehabilitation cases to share their experiences and insights; Establish wechat groups for patients, push electronic illustrated handbooks or videos related to disease knowledge, and invite group members such as attending physicians, nutritionists, psychological counselors, and rehabilitation therapists to answer questions in the groups in a timely and targeted manner based on their own research fields. For example, psychological counselors encourage family members to give more companionship and care to patients, create a good atmosphere, provide psychological counseling to patients, and relieve patients' negative emotions. To reduce psychological burden, help patients build confidence in recovery and motivate them, nutritionists should assess the nutritional risk of patients and provide them with scientific dietary guidance.

(2) Definition (D)

The rehabilitation therapist helps the patient identify the problems and obstacles they are facing in the current rehabilitation process, ask questions, and determine the problems that the patient urgently wants to understand or solve. Understand the patient's mental state, living habits, etc. Guide the patient to correct wrong perceptions and ideas, encourage the patient to cooperate actively and improve compliance.

(3) Open mind (O)

Specialist nurses encourage patients to have an open mind, express their inner thoughts, find solutions based on defined problems and obstacles, and set phased goals.

(4) Plan (P)

Based on the problem and goal, the group members, under the coordination of the head nurse, work together with the patient to develop the corresponding plan. During the development process, the patient is at the center, and the patient's sense of participation is increased. Encourage family members to offer support while group members provide advice and assistance from a professional perspective.

(5) Implementation (try it out, T)

Group members regularly evaluate the patient's care and rehabilitation training and provide timely feedback. To achieve rehabilitation goals, encourage the patient, for unachieved rehabilitation goals, analyze the reasons together with the patient, find solutions, and make appropriate adjustments to the care or rehabilitation plan, such as helping the patient create a beneficial home environment. Provide rehabilitation knowledge and skills training to family members and encourage them to urge patients to follow the plan and cooperate with rehabilitation treatment. For patients with poor compliance, family

members should supervise to improve the implementation rate of the plan.
The intervention lasted for 3 months for both groups of patients.

2.3. Observation indicators

- (1) Readiness for Discharge On the day of discharge, the Readiness for Discharge Scale (RHDS) was used for assessment^[8]. The scale, translated into Chinese by Lin et al., consists of three aspects: personal status, adaptability, and anticipatory support, involving 3, 5, and 4 items respectively, with a full score of 120. The scores obtained were positively correlated with readiness for discharge.
- (2) Self-efficacy was evaluated on the day of discharge and 3 months after discharge using the Chronic Disease Self-Efficacy Scale (SECD6)^[9]. The scale covers two dimensions, symptom management and disease commonality management, and consists of six items, each on a 1–10 scale, with a maximum score of 60. The score was positively correlated with self-efficacy.
- (3) Activities of daily living were assessed using the Barthel Index (BI) on the day of discharge and 3 months after discharge^[10]. The scale involves 10 items such as walking on flat ground and dressing, with a maximum score of 100. The higher the score, the higher the ability to live.
- (4) Blood glucose and blood pressure indicators Systolic and diastolic blood pressure were measured on the day of discharge and 3 months after discharge. Fasting plasma glucose (FPG) and 2-hour postprandial plasma glucose (2 h PG) indicators were also measured in both groups. Blood pressure indicators were measured three times consecutively, and blood glucose indicators were measured three times consecutively. The results were taken as the average of the three measurements.
- (5) Readmission rate by querying the electronic medical record system within 3 months after discharge, the unplanned readmission of the two groups of patients was counted.

2.4. Statistical methods

Statistical analysis was performed using SPSS 28.0 software. Measurement data were described using mean + standard deviation ($\bar{x} \pm s$) and *t*-test; Count data were described using [number of cases (percentage)] and chi-square test; A difference was indicated as $p < 0.05$.

3. Results

3.1. Discharge preparation

On the day of discharge, the RDS-related dimension scores of the intervention group were higher than those of the control group ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of RHDS-related dimension scores between the two groups ($\bar{x} \pm s$, points)

Group	n	Personal status	Adaptability	Anticipatory support
Control group	40	18.23 ± 1.41	30.76 ± 2.53	27.35 ± 2.37
Intervention group	40	24.34 ± 1.62	35.68 ± 2.61	33.58 ± 3.03
<i>t</i>		17.993	8.560	10.243
<i>p</i>		< 0.001	< 0.001	< 0.001

3.2. Self-efficacy

Three months after discharge, the SECD6 score of the intervention group was higher than that of the control group ($p < 0.05$). See **Table 2**.

Table 2. Comparison of SECD6 scores and BI scores between the two groups ($\bar{x} \pm s$, points)

Group	n	SECD6 score		BI score	
		On the day of discharge	Three months after discharge	Day of discharge	Three months after discharge
Control group	40	26.37 \pm 2.78*	31.46 \pm 3.13	61.25 \pm 3.27*	75.68 \pm 3.64
Intervention group	40	25.84 \pm 2.71*	37.95 \pm 3.38	60.86 \pm 3.12*	84.37 \pm 3.49
<i>t</i>		0.863	8.910	0.546	10.899
<i>p</i>		0.391	< 0.001	0.587	< 0.001

Note: * $p < 0.05$ compared with the day of discharge in this group

3.3. Activities of daily living

Three months after discharge, the BI score of the intervention group was higher than that of the control group ($p < 0.05$). See **Table 2**.

3.4. Blood glucose and blood pressure indicators

Three months after discharge, systolic blood pressure, diastolic blood pressure, FPG, and 2h PG in the intervention group were lower than those in the control group ($p < 0.05$). See **Table 3** and **4**.

Table 3. Comparison of systolic and diastolic blood pressure between the two groups ($\bar{x} \pm s$)

Group	n	Diastolic blood pressure (mmHg)		Systolic blood pressure (mmHg)	
		Day of discharge	Three months after discharge	Day of discharge	Three months after discharge
Control group	40	98.38 \pm 3.83*	92.43 \pm 3.67	147.64 \pm 5.89*	136.75 \pm 5.82
Intervention group	40	98.72 \pm 3.79*	85.28 \pm 3.54	146.87 \pm 5.92*	130.57 \pm 5.71
<i>t</i>		0.399	8.868	0.583	4.794
<i>p</i>		0.691	< 0.001	0.561	< 0.001

Table 4. Comparison of FPG and 2h PG between the two groups ($\bar{x} \pm s$)

Groups	n	FPG (mmol/L)		2h PG (mmol/L)	
		Day of discharge	Three months after discharge	Day of discharge	Three months after discharge
Control group	40	8.26 \pm 1.11*	7.45 \pm 1.06	11.85 \pm 1.23*	10.34 \pm 1.14
Intervention group	40	8.18 \pm 1.17*	6.58 \pm 0.97	11.96 \pm 1.27*	8.46 \pm 1.22
<i>t</i>		0.314	3.829	0.393	7.121
<i>p</i>		0.755	< 0.001	0.695	< 0.001

3.5. Readmission rate

During the treatment period, the readmission rate of the control group was 22.50% (9/40). The readmission rate in the intervention group was 5.00% (2/40). The readmission rate of the intervention group at 5.00% was lower than that of the control group at 22.50% ($\chi^2 = 5.165$; $p < 0.05$).

4. Discussion and conclusion

Stroke is one of the neurological emergencies, with ischemic stroke being the most common in clinical practice, accounting for 60% to 80% of stroke patients^[11]. Due to the high incidence of ischemic stroke, as well as the high rates of disability and mortality, it has a significant impact on the physical health and life safety of patients^[12]. With the continuous development of medical technology, the vast majority of patients can effectively improve their chances of survival, control their condition and meet the discharge criteria after active treatment. However, some patients may still have some health problems and face different degrees of physical dysfunction. In addition, there are many risk factors for stroke patients, and the recurrence risk is relatively high. It is necessary to provide continuous care for patients after they are discharged. It is particularly important to introduce a discharge gown plan.

The ADOPT nursing model, which aims primarily at solving problems and advocates stimulating subjective initiative and encouraging patients to actively participate in self-management, has been applied to the care of various chronic diseases^[13,14]. The results of this study showed that on the day of discharge, the scores of the RHDS-related dimensions in the intervention group were higher than those in the control group; Three months after discharge, the SECD6 score of the intervention group was higher than that of the control group ($p < 0.05$), suggesting that the discharge preparation plan under this model can improve the discharge readiness of stroke patients and enhance their self-efficacy. The reasons for the analysis were: Based on the ADOPT nursing model, with multidisciplinary participation, group members performing their respective duties and cooperating with each other, and integrating medical resources, it can provide patients with sufficient anticipatory support, enable patients to adapt to the role transition, facilitate the active participation of patients, better master rehabilitative knowledge, and voluntarily participate in rehabilitation, thereby improving self-efficacy and discharge preparation; At the same time, patients' active participation in planning can enhance their awareness of the disease, and in combination with multidisciplinary collaboration to address existing problems specifically, it is beneficial to improve self-care ability and help patients prepare for discharge; In addition, establishing a good nurse-patient relationship, through various means such as patient communication groups and psychological counseling intervention, can reduce the psychological burden of patients, relieve their emotions, help establish a correct concept of the disease, face the disease positively, and help improve cooperation ability and self-efficacy. The results of this study show that three months after discharge, the levels of related blood glucose and blood pressure indicators in the intervention group were lower than those in the control group, but the BI score was higher than that in the control group ($p < 0.05$), indicating that the discharge preparation plan under this nursing model can enhance the daily living activities of patients and effectively control the blood pressure and blood glucose levels of patients. The reason for this is that most stroke patients are discharged with hemiplegia, aphasia, swallowing and other functional disorders, which affect their ability to perform daily activities^[15].

The ADOPT care model, by setting care goals and plans, can enhance patients' awareness of the disease, help them realize the potential risks of the disease, and deeply understand the importance of blood sugar control,

diet and exercise for prognosis, encourage patients to actively think about the significance of self-management, consciously follow medical advice and implement plans, thereby facilitating the improvement of daily activities, Effective control of blood pressure and blood sugar levels. The results of this study finally showed that within 3 months after discharge, the readmission rate of the intervention group was lower than that of the control group ($p < 0.05$), indicating that the discharge preparation plan based on the ADOPT nursing model can reduce the readmission rate of stroke patients. The reasons for the analysis might be: During the nursing process, by combining multiple teams of nutritionists, psychological counselors, rehabilitation therapists, etc. for physical assessment, patients can have a clear understanding of their own conditions, better face the disease and possible risks, be able to face the disease more positively, and voluntarily achieve rehabilitation goals, which is conducive to reducing readmission rates, and patients' participation in formulating discharge plans, It can help patients better understand and be familiar with the relevant rehabilitation skills and knowledge, and assist them in home functional rehabilitation training. In this intervention program, by leveraging the supervisory role of family members, it can prompt patients to correct bad behavior, strictly follow the rehabilitation plan, and at the same time enhance disease education and skills training, enabling patients and family members to master some treatment methods, more effectively identify signs of recurrence, better deal with emergencies, and reduce unnecessary readmissions.

In summary, the discharge preparation program based on the ADOPT nursing model, when applied to patients with first-visit ischemic stroke, can not only improve patients' discharge readiness and self-efficacy and activities of daily living, but also effectively control patients' blood sugar and blood pressure levels and reduce the readmission rate within 3 months after discharge, which is worthy of reference.

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A Study on the Preferences of Undergraduate Nursing Students for Clinical Teaching: Based on Discrete Selection Experiments

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Abstract: *Objective:* To investigate the preference characteristics and relative importance of each core factor in the teaching program for undergraduate nursing students during clinical practice, and to provide empirical support for the creation of a student-centered, formalized clinical teaching system that meets the actual needs of nursing students. *Methods:* The quantitative research method of discrete choice experiment was adopted, and the questionnaire was designed based on the random utility theory. Through a systematic literature review, semi-structured interviews, and two rounds of Delphi expert consultations, six core attributes of the instructor, namely educational qualifications, teaching methods, frequency of individualized guidance, operational practice opportunities, feedback timeliness, and instructor title, and their corresponding levels were determined. The study period was from January 2024 to January 2025, and 158 undergraduate nursing students who chose to intern at Deyang People's Hospital were selected as the research subjects. A survey tool with 12 choice sets was created using Ngene software, and then statistical analysis was performed on the obtained data using the conditional Logit model to measure the impact of each attribute on the choice behavior of nursing students. *Results:* The results showed that the conditional Logit model fitted well (likelihood ratio chi-square = 85.32, $p < 0.001$). The analysis results indicated that the most important teaching attributes for undergraduate nursing students were, in order: the academic qualifications of the teaching instructor (master vs. Junior college, $\beta = 0.42$, $p < 0.01$), individualized guidance frequency (daily vs. Weekly, $\beta = 0.38$, $p < 0.01$), operational practice opportunities (more vs. less, $\beta = 0.31$, $p < 0.05$), and the timeliness of feedback (timely versus delayed, $\beta = 0.29$, $p < 0.05$). The influence of the title of the instructor was not statistically significant ($p > 0.05$). *Conclusion:* Undergraduate nursing students show a clear and systematic preference structure for clinical teaching, with a high expectation of frequent personalized guidance from highly educated teachers, as well as sufficient operational opportunities and timely teaching feedback.

Keywords: Undergraduate nursing students; Clinical teaching; Preference; Discrete selection experiments; Nursing education

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1. Introduction

Clinical practice is an important part of nursing education and is tasked with transforming theoretical knowledge of nursing into practical skills. Undergraduate nursing students are a critical period for skill formation, as well as for the construction of professional identity and the cultivation of professional values. With the development of the nursing profession in China, the total number of nurses has exceeded 5 million. The National Nursing Development Plan (2021–2025) also proposes to improve the quality of nursing training, with a focus on improving the quality of nursing training^[1]. However, there is still a disconnection between theory and practice in nursing education. Nursing students often have fewer practical opportunities, inconsistent teaching quality, and frustrated learning initiative during clinical internships, all of which affect the cultivation of core competencies of nursing students.

In the process of clinical teaching, the qualifications of the teaching staff, the teaching methods and the guidance strategies play a decisive role. Traditional studies have mostly focused on teaching models from the perspective of teachers, with little consideration given to the real needs and preferences of nursing students^[2]. Understanding the characteristics of clinical teaching preferences of nursing students can construct student-centered teaching models. The discrete choice experiment method originated in economics and has been widely applied in the medical and health field in recent years. Simulating real decision-making scenarios to quantify individual preferences can reveal the relative importance of each attribute in decision-making.

In the field of nursing education, discrete choice experiments have been used in studies such as nurses' job choices and patients' medical decisions, but their application to the clinical teaching preferences of undergraduate nursing students is relatively rare. Undergraduate nursing students are at a critical stage of their career development, and their teaching preferences have unique phased characteristics^[3]. Exploring the preference structure of undergraduate nursing students for clinical teaching can provide empirical evidence for institutions to formulate scientific and reasonable teaching programs, thereby improving the quality of clinical teaching and the satisfaction of nursing students. A discrete selection experiment was used to quantitatively analyze the preferences of undergraduate nursing students for various attributes of clinical teaching, thereby providing a basis for improving the teaching model.

2. Data and methods

2.1. General information

A cross-sectional survey design was adopted, with undergraduate nursing students doing internships at Deyang People's Hospital from January 2024 to January 2025 as the research subjects. A convenient sampling method was used to recruit 165 eligible nursing students. Finally, 158 valid questionnaires were obtained, with an effective recovery rate of 95.8%.

The sample size was calculated using the thumb rule for discrete selection experiments. Based on the number of attribute levels obtained from the pre-experiment ($c = 3$), the number of selection sets for each version of the questionnaire ($t = 12$), and the number of options for each selection set ($a = 2$), at least 63 samples are required for each version of the questionnaire. Given that two types of questionnaires were used for allocation in this study, a 20% invalid questionnaire ratio was reserved, the final minimum sample size was determined to be 158 people.

There were 12 males (7.6%) and 146 females (92.4%) in the study, and the gender ratio was in line with the actual distribution of the nursing profession. The age ranged from 19 to 23 years, with an average age of (21.4 ± 1.2 years). All nursing students are from full-time undergraduate nursing institutions, including partner institutions

such as Southwest Medical University, Chengdu University of Traditional Chinese Medicine, and North Sichuan Medical College. All the nursing students in the internship arrangement have completed more than eight months of clinical rotations, including major clinical departments such as internal medicine, surgery, obstetrics and gynecology, and pediatrics.

2.2. Methods

This study used discrete choice experiments, a quantitative research method, to explore the preference structure of nursing students by simulating clinical teaching scenarios. The main steps of the research method are as follows:

Through systematic literature review, semi-structured interviews, and two rounds of Delphi expert consultations, six core teaching attributes and the levels of each attribute were determined.

Generate the selection set using efficient fractional factor design. Experiment with Ngene1.2 software to ensure that the selection set is orthogonal and balanced. A total of 12 selection sets were obtained and randomly divided into two questionnaires, each containing 6 selection sets. Each selection set had two mentoring options and one “no choice” to simulate a real decision-making environment and prevent bias caused by forced selection.

When the questionnaire was implemented, uniformly trained investigators explained the purpose of the study and the filling requirements to the nursing students. Before the formal start, sample questions are provided to ensure that participants understand the selection task. It takes about 15 to 20 minutes to complete the questionnaire, and all questionnaires are filled out and collected on the spot.

2.3. Observation indicators

The primary indicator of this study was the degree of preference of nursing students for various aspects of clinical teaching, quantified by the regression coefficients (β values) of each attribute in the conditional Logit model. A positive regression coefficient indicates a positive direction of preference, meaning the larger the coefficient, the stronger the preference. At the same time, calculate the relative importance of each attribute, that is, the proportion of that attribute in the decision-making of nursing students.

Secondary observation indicators include demographic characteristics of nursing students, such as gender, age, and school, to analyze differences in preferences among different groups. Quality indicators of questionnaire completion, such as completion time and option consistency, were also recorded to ensure the reliability of the data.

2.4. Statistical processing

Data entry was performed using EpiData 3.1, and conditional Logit model analysis was conducted using Stata 17.0. A difference was considered statistically significant when $p < 0.05$ ^[4].

3. Results

3.1. Basic characteristics of the research subjects

A total of 158 undergraduate nursing students were included in this study, and their basic information is shown in **Table 1**. The majority of the students were female, with an average age of 21.4 ± 1.2 years, ranging from 19 to 23 years. In terms of the distribution of institutions, Southwest Medical University had the largest number of students, accounting for 39.2%, followed by Chengdu University of Traditional Chinese Medicine, accounting for 30.4%, and then North Sichuan Medical College, accounting for 24.1%. All the nursing students completed a clinical rotation of no less than eight months.

Table 1. Distribution of basic characteristics of the study subjects (n = 158)

Characteristics	Classification	Number of people (n)	Composition ratio (%)
Gender	male	12	7.6
	female	146	92.4
Age (years)	≤ 20	45	28.5
	21–22	78	49.4
	≥ 23	35	22.1
Institution of Study	Southwest Medical University	62	39.2
	Chengdu University of Traditional Chinese Medicine	48	30.4
	North Sichuan Medical College	38	24.1
	Other institutions	10	6.3

3.2. Analysis of clinical teaching preferences for undergraduate nursing students

The results of the preference analysis based on the conditional Logit model are presented in **Table 2**. The regression coefficients of the other five attributes, except for the title of the instructor, were statistically significant ($p < 0.05$), indicating that these factors had a significant impact on the choice preferences of undergraduate nursing students.

Table 2. Results of the conditional Logit model analysis of clinical teaching preferences for undergraduate nursing students

Attributes	Level	β value	SE	p-value	Attributes
Teaching qualifications	Associate degree (see)	-	-	-	Teaching qualifications
	Undergraduate	0.18	0.09	0.08	
	Master's	0.42	0.11	< 0.01	
Teaching methods	On-the-job learning (see)	-	-	-	Teaching methods
	Group teaching	0.11	0.08	0.21	
	One-on-one	0.25	0.13	0.06	
Personalized guidance frequency	Once a week (reference)	-	-	-	Personalized guidance frequency
	2–3 times a week	0.22	0.10	< 0.05	
	Every day	0.38	0.09	< 0.01	
Hands-on practice opportunities	Less (for reference)	-	-	-	Hands-on practice opportunities
	General	0.15	0.07	0.09	
	more	0.31	0.12	< 0.05	
Feedback timeliness	Delay (see)	-	-	-	Feedback timeliness
	General	0.13	0.08	0.15	
	Timely	0.29	0.10	< 0.05	
Teaching teacher title	Nurse (reference)	-	-	-	Teaching teacher title
	Nurse	0.09	0.06	0.32	
	Head Nurse	0.20	0.11	0.07	

Note: Model likelihood chi-square = 85.32, $p < 0.001$

From the regression coefficients of each attribute, the educational attainment of the instructor had the greatest impact on the preference of nursing students ($\beta = 0.42, p < 0.01$), and nursing students were significantly more inclined to choose the frequency of individualized guidance by instructors with a master's degree ($\beta = 0.38, p < 0.01$), operational practice opportunities ($\beta = 0.31$). The second and third most important factors, $p < 0.05$, are that nursing students hope to receive personalized guidance every day and have more practical operation opportunities.

Feedback timeliness ($\beta = 0.29, p < 0.05$) also showed a significant impact, as nursing students hoped that their instructors could provide feedback in a timely manner. In terms of teaching methods, nursing students showed a tendency to prefer one-on-one teaching, but the significance level was at the critical value ($\beta = 0.25, p = 0.06$).

4. Discussion

This study uses discrete selection experiments to reveal the preference characteristics of undergraduate nursing students for clinical teaching, providing data support for the improvement of clinical teaching. It can be seen from the findings that nursing students have preferences for the academic qualifications of their instructors, individualized guidance, practical opportunities, and timely feedback, which can provide specific directions for the development of teaching work ^[5].

The academic qualifications of the instructors ($\beta = 0.42, p < 0.01$) are the attributes that nursing students value most. Nursing students' preference for instructors with a master's degree or higher reflects their desire for high-level theoretical knowledge guidance and research capabilities. Highly educated teachers can provide nursing students with a more systematic knowledge system and a cutting-edge academic perspective, helping them develop the concept of evidence-based nursing. This result is the same as the conclusion of the Master of Professional degree in nursing research, indicating that medical institutions should take academic qualifications into account when selecting teaching staff and create a variety of teaching teams.

The frequency of individualized instruction ($\beta = 0.38, p < 0.01$) was the second favorite of nursing students. Nursing students clearly prefer daily guidance to 2–3 times a week or once a week, indicating that the frequency of personalized guidance is very important for learning outcomes ^[6]. Due to the high pressure of clinical work, it is difficult for teaching staff to provide sufficient personalized guidance. It is recommended that medical institutions reasonably adjust the workload of teachers to ensure the implementation of personalized guidance.

The operational practice opportunities ($\beta = 0.31, p < 0.05$) reflect the demand of nursing students for more operational practice opportunities, which is contrary to the current phenomenon of “seeing more and doing less” in most medical institutions. More operations are the most frequently chosen option by nursing students, twice as many as general operations, indicating that operational practice for nursing students should be increased through simulation training, phased authorization, etc.

Feedback timeliness ($\beta = 0.29, p < 0.05$) is the fourth factor, that is, the degree of importance nursing students attach to timely feedback. Timely feedback can correct mistakes, consolidate skills, and boost confidence in learning. Research has found that nursing students value the timeliness of feedback more than the frequency of feedback. It is recommended that instructors provide feedback promptly to improve the quality of teaching.

5. Conclusion

The practical significance of this study lies in pointing out the direction for the reform of clinical teaching, which

should establish teaching teams mainly composed of highly educated teachers and supplemented by teachers of all levels; Standardized individualized guidance plans should be developed to ensure the frequency and quality of guidance; A complete practical training system should be established to ensure the operation time of nursing students; An effective feedback mechanism should be established to achieve mutual learning between teaching and learning. The quality of clinical teaching has improved, and the professional identity and career confidence of nursing students have been enhanced.

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Observation on the Application of Case-based Three-dimensional Teaching Method Guided by Evidence-Based Thought in the Teaching of Intern Nurses in the Rehabilitation Department

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Abstract: *Objective:* To explore the effect of implementing the case-based three-dimensional teaching method guided by evidence-based thinking in the teaching of trainee nurses in the rehabilitation department. *Method:* Eighty nursing practice nurses who were conducting clinical practice learning in the Rehabilitation Department of Deyang People's Hospital from June 2024 to May 2025 were selected as the research subjects. By using the controlled grouping method, the practice nurses from June 2024 to November 2024 were taken as the control group ($n = 40$). The period from December 2024 to May 2025 was taken as the experimental group ($n = 40$ students), the control group was taught by traditional teaching methods, and the experimental group was taught by evidence-based nursing combined with case teaching method. The clinical thinking ability, autonomous learning ability, exit assessment scores and teaching satisfaction of the two groups of intern nurses at the time of leaving the department were compared. *Results:* At the time of leaving the department, the scores of each dimension and the total score of clinical thinking ability of the intern nurses in the experimental group were higher than those in the control group ($t = 9.268, 6.354, 6.199, 9.694$, all $p < 0.05$). At the time of leaving the department the scores of each dimension and the total score of the autonomous learning ability of the intern nurses in the experimental group were higher than those in the control group ($t = 6.998, 7.333, 5.503, 5.977, 22.244$) all $p < 0.05$). At the time of leaving the department the theoretical assessment scores and operational assessment scores of the experimental group were both higher than those of the control group ($t = 14.546, 11.676$, all $p < 0.05$). At the time of graduation, the teaching satisfaction of the experimental group was higher than that of the control group ($\chi^2 = 7.314$, $p < 0.05$). *Conclusion:* The adoption of the case-based three-dimensional teaching. Rehabilitation method guided by the evidence-based ideology during the teaching process can effectively improve the clinical thinking ability, autonomous learning ability, departmental assessment results and teaching satisfaction of the intern nurses in the rehabilitation department, which is worthy of reference.

Keywords: Nursing intern; Evidence-based thinking; Case-based multidimensional teaching method; Clinical thinking ability; Self-learning ability

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1. Introduction

Rehabilitation, as an essential part of the modern medical system, has unique and complex nursing work. Rehabilitation care requires nurses to be proficient in basic nursing skills, as well as to have a keen ability to observe the patient's condition, a professional level of rehabilitation training guidance, and the ability to provide psychological support to patients throughout their long-term rehabilitation process ^[1]. The internship stage is a crucial transitional period for nursing students to transition to the role of clinical nurses, and the quality of internship nurse training is directly related to the overall level and professional quality of the future nursing team ^[2]. However, the traditional nursing teaching model currently adopted by rehabilitation departments is indoctrination-style one-way education, which is prone to causing nurses to feel tired during clinical practice and have low learning enthusiasm, which is not conducive to the cultivation of new types of nursing talents. Therefore, it is particularly important to explore innovative teaching methods ^[3]. Evidence-based thinking, as an emerging concept, combines research conclusions with clinical experience to provide a scientific basis for nursing practice ^[4]. The case teaching method, with its unique advantages, can stimulate students' interest and initiative in learning and improve learning efficiency through the discussion and analysis of real cases ^[5]. Based on this, this study will delve into the application effect of the case-based stereoscopic teaching method guided by evidence-based thinking in the teaching of rehabilitation practice nurses.

2. Data and methods

2.1. General information

Eighty nursing practice nurses who conducted clinical practice learning in the rehabilitation Department of Deyang People's Hospital from June 2024 to May 2025 were selected as the research subjects. The control group method was adopted, with intern nurses from June 2024 to November 2024 as the control group (n = 40) and those from December 2024 to May 2025 as the experimental group (n = 40). There was no statistically significant difference in the general data between the two groups ($p > 0.05$), and a comparative analysis could be conducted. See **Table 1**.

Table 1. Comparison of general data between two groups [$\bar{x} \pm s$ or n(%)]

Group	n	Age (years)	Gender		Education	
			Male	Female	Specialist	Bachelor's degree and above
Experimental group	40	20.37 \pm 2.49	6 (15.00)	34 (85.00)	16 (40.00)	24 (60.00)
Control group	40	19.93 \pm 2.18	5 (12.50)	35 (87.50)	18 (45.00)	22 (55.00)
t/χ^2		0.841		0.105		0.205
p		0.403		0.745		0.651

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

- (1) Completion of all on-campus courses before internship
- (2) With informed consent and voluntary participation

2.2.2. Exclusion criteria

- (1) Those who are unable to complete the rehabilitation internship for various reasons
- (2) Unable to continue participating in the investigator for any reason during the trial period

2.3. Methods

The control group was taught using the traditional teaching method as follows: Based on the internship syllabus and the requirements of the hospital nursing department, the knowledge objectives of the trainee nurses were defined and the rehabilitation department internship teaching plan was formulated. After entering the department, the trainee nurses were guided one-on-one by clinical instructors and demonstrated the operation. Each week, teaching instructors and teaching group leaders give concentrated theoretical and practical lessons. Teaching ward rounds and small lectures are conducted in the fourth week. Theoretical and operational assessments will be conducted before the end of the internship.

The experimental group adopted the case-based three-dimensional teaching method guided by evidence-based thinking. The specific steps are as follows.

2.3.1. Teaching preparation

(1) Forming a teaching team

The teaching team was composed of the teaching instructors hired by the hospital, and the team members had clear divisions of labor. Among them, there was one head nurse of the rehabilitation department, who was mainly responsible for inspecting and supervising the teaching process to ensure the quality and standardization of teaching activities; 1 Head of teaching, responsible for the arrangement and implementation of the entire teaching plan, controlling the progress and direction of teaching; Four clinical instructors will be responsible for providing one-on-one teaching guidance to trainee nurses on the clinical front line. All instructors have received systematic training in evidence-based nursing knowledge and case-based teaching methods before taking up their posts, and have a solid theoretical foundation and rich practical experience.

(2) Student preparation

To facilitate teaching management and information exchange, teaching group leaders have established Wechat communication groups, including all trainee nurses, to facilitate the timely release of teaching notifications and learning materials. Divide the trainee nurses into four groups, each with one group leader, who is responsible for assisting the teacher in organizing group activities and coordinating group affairs. After entering the department, the trainee nurses will receive additional training on evidence-based nursing knowledge in addition to the regular department orientation.

(3) Preparation of teaching content

The teaching team, based on the internship teaching syllabus, extensively consulted a large number of literature materials on evidence-based nursing teaching and case teaching. Based on this, combined with the clinical practice of the rehabilitation department, the teaching plan was carefully formulated through the joint discussion of the teaching team. The main content of the teaching focuses on the key points of care for common diseases in the rehabilitation department, such as spinal cord injury, stroke, cervical spondylosis, etc., and provides corresponding typical cases for each disease.

2.3.2. Teaching implementation

(1) Case preview

The instructor selects the corresponding typical cases from the teaching case library based on the weekly

teaching theme and sends the cases and related theoretical learning materials to the trainee nurse Wechat group one week in advance. The teacher required the trainee nurses to read the cases carefully, study the learning materials carefully, and preview the relevant learning content in advance.

(2) Clinical practice and problem-based learning

The trainee nurse follows the clinical one-to-one teaching teacher into the ward and examines the case patients by the bedside. By communicating with patients, asking about their medical history, conducting physical examinations, and checking the results of auxiliary examinations, the trainee nurse initially understands the patient's condition and acquires first-hand information about the patient. During this process, the instructor instructs the trainee nurse to ask questions about evidence-based nursing and, guided by the questions, leads them to collect information. Intern nurses need to sift through evidence, professional literature, journals, books, etc., to select important literature and information. Based on the patient's characteristics and actual condition, and in combination with the collected evidence, the trainee nurse formulates the corresponding care plan and evaluates its effectiveness and feasibility. Group members summarize the data to ensure completeness and accuracy of the information.

(3) Classroom teaching and group presentation discussion

In the teaching class, the instructor gives a brief explanation of the relevant theoretical knowledge to help the trainee nurse sort out the knowledge framework. After the presentation, the trainee nurses presented the collected case-related materials, nursing plans and reference materials in the form of PPT or Word documents in groups. After the presentation, the teacher organized the trainee nurses to have a discussion, guiding them to inspire each other, think actively, and encourage them to analyze and evaluate the nursing plan from different perspectives. After the discussion, each trainee nurse was asked to express their own feelings and insights and share their learning experiences. Then there will be group reviews through the review process.

(4) Teacher evaluation and summary enhancement

The instructor evaluates the presentation and discussion results of each group. The teacher carefully analyzed the problems and deficiencies in the presentation and discussion of the trainee nurses, provided detailed explanations and demonstrations for the common problems, helped the trainee nurses sort out the relevant knowledge points, summarized the key contents, deepened their impression, and further strengthened the knowledge that needed to be mastered. At the same time, the teacher guided the trainee nurses to reflect on and summarize the application of evidence-based nursing thinking and methods, and encouraged them to apply the knowledge they had learned to their actual work. The group leader, in light of the characteristics of the case and the actual clinical situation, conducted an in-depth analysis and summary of the problems that emerged in the nursing process and practical operation, and further improved the nursing plan.

2.3.3. Post-class practice

Under the guidance of the clinical instructor, the trainee nurse applies the nursing plan refined in class to the corresponding case patient. During the practice, the instructor closely monitored the trainee nurse's operation process and provided timely guidance and correction.

The intervention period for both groups began on the day the trainee nurse entered the department and ended on the day she left the department.

2.4. Observation indicators

2.4.1. Clinical thinking ability

When entering and leaving the department, the clinical thinking ability of the two groups of trainee nurses was evaluated using Song Junyan's clinical thinking evaluation index system for optimization and organization. The evaluation system consists of three dimensions: critical thinking ability, systems thinking ability, and evidence-based thinking ability, with a total of 15 items and a score ranging from 15 to 75 points ^[6]. The higher the score, the stronger the clinical thinking ability of the trainee nurse. The scale has a Cronbach's α coefficient of 0.9.

2.4.2. Self-directed learning ability

The self-directed learning ability of the two groups of trainee nurses was evaluated at the time of admission and graduation using the self-directed learning ability assessment scale for nursing students developed by Zhang Xiyan et al. The scale consists of four first-level indicators and 30 items, namely learning motivation, self-management ability, cooperative ability, pheromone, with a total score of 30 to 150 points ^[7]. The higher the score, the stronger the self-learning ability. The Cronbach's α coefficient is 0.8223.

2.4.3. Exit assessment results

At the time of exit, two groups of trainee nurses were examined in both theoretical and practical parts. The theoretical examination uses a self-compiled unified examination paper on rehabilitation specialty knowledge, with a full score of 100 points. The operational assessment is also set at 100 points, with a focus on simulating typical cases. During the skills assessment, the instructor acts as a standardized patient, and the head nurse is responsible for conducting the operation assessment of the trainee nurse and giving the corresponding score.

2.4.4. Teaching satisfaction

At the end of the department, based on literature review and expert consultation, create a teaching model satisfaction evaluation form, including dimensions such as teaching content, teaching method, teaching process, and teaching effect. The total score of the form is 100 points, with 90 to 100 points corresponding to "very satisfied". The satisfaction score is 75 to 89 points; The average score is 60 to 74; Dissatisfaction corresponds to a score of less than 60. Satisfaction is the sum of the ten-point satisfaction rate and the satisfaction rate.

2.5. Statistical analysis

Data were analyzed using SPSS29.0 statistical software, with normality measures expressed as mean \pm standard deviation ($\bar{x} \pm s$) and t -tests; Count data in n (%), chi-square test; $p < 0.05$ indicates a statistically significant difference.

3. Results

3.1. Comparison of clinical thinking ability between the two groups

At admission, there was no significant difference in the scores of each dimension and total score of clinical thinking ability between the two groups ($p > 0.05$); At the time of discharge, the scores of each dimension and the total score of clinical thinking ability of the trainee nurses in the experimental group were higher than those in the control group ($p < 0.05$), as shown in **Table 2**.

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

Group	n	Critical thinking skills		Systems thinking ability		Evidence-based thinking ability		Total score	
		When entering the department	When leaving the department	Admission	When leaving the department	Admission	When leaving the department	Admission	When leaving the department
Experimental Group	40	10.05 \pm 1.56	14.25 \pm 1.63 ^a	16.53 \pm 2.32	27.64 \pm 3.56 ^a	8.29 \pm 1.08	11.38 \pm 1.35 ^a	34.45 \pm 3.72	52.86 \pm 4.64 ^a
Control Group	40	9.97 \pm 1.71	11.24 \pm 1.25 ^a	16.16 \pm 2.67	22.95 \pm 3.02 ^a	8.15 \pm 1.34	9.57 \pm 1.26 ^a	35.19 \pm 3.56	43.52 \pm 3.95 ^a
<i>t</i>		0.215	9.268	0.662	6.354	0.514	6.199	0.897	9.694
<i>p</i>		0.828	< 0.001	0.510	< 0.001	0.608	< 0.001	0.373	< 0.001

Note: Compared^a with the time of admission to the department of this group, $p < 0.05$.

3.2 Comparison of autonomous learning ability between the two groups

At the time of admission, there was no significant difference ($p > 0.05$) in the scores of each dimension of autonomous learning ability and the total score between the two groups; When leaving the department, the scores of each dimension and the total score of the autonomous learning ability of the trainee nurses in the experimental group were higher than those in the control group ($p < 0.05$), as shown in **Table 3**.

Table 3. Comparison of clinical thinking ability between the two groups ($\bar{x} \pm s$, points)

Group	n	Learning motivation		Self-management ability		Cooperative ability		Information literacy		Total score	
Experimental group	40	10.18 \pm 2.72	21.61 \pm 4.35 ^a	17.31 \pm 2.15	31.37 \pm 3.62 ^a	19.76 \pm 3.39	30.52 \pm 5.04 ^a	31.54 \pm 3.62	44.51 \pm 4.85 ^a	77.58 \pm 4.38	126.75 \pm 6.86 ^a
Control group	40	10.25 \pm 2.83	15.46 \pm 3.46 ^a	17.14 \pm 2.32	25.54 \pm 3.49 ^a	19.01 \pm 3.24	24.75 \pm 4.31 ^a	31.31 \pm 3.27	38.49 \pm 4.13 ^a	76.92 \pm 4.06	96.58 \pm 5.15 ^a
<i>t</i>		0.113	6.998	0.340	7.333	1.012	5.503	0.298	5.977	0.699	22.244
<i>p</i>		0.910	< 0.001	0.735	< 0.001	0.315	< 0.001	0.766	< 0.001	0.487	< 0.001

Note: $p < 0.05$ compared^a with the admission of this group

3.3. Comparison of exit assessment results between the two groups

At the time of graduation, the theoretical assessment scores and operational assessment scores of the experimental group were both higher than those of the control group ($p < 0.05$), as shown in **Table 4**.

Table 4. Comparison of exit assessment scores between the two groups ($\bar{x} \pm s$, points)

Group	n	Theoretical assessment score	Operational assessment results
Experimental group	40	91.36 \pm 3.17	90.38 \pm 4.05
Control group	40	81.29 \pm 3.02	80.14 \pm 3.79
<i>t</i>		14.546	11.676
<i>p</i>		< 0.001	< 0.001

3.4. Comparison of teaching satisfaction between the two groups

At the end of the course, the teaching satisfaction of the experimental group was higher than that of the control group ($p < 0.05$), as shown in Table 5.

Table 5. Comparison of teaching satisfaction between groups [n(%)]

Group	n	Very satisfied	Satisfied	General	Dissatisfied	Teaching satisfaction
Experimental group	40	24 (60.00)	15 (37.50)	1 (2.50)	0 (0.00)	39 (97.50)
Control group	40	14 (35.00)	17 (42.50)	7 (17.50)	2 (5.00)	31 (77.50)
χ^2						7.314
p						0.007

4. Discussion

Rehabilitation nursing work is an essential part of rehabilitation treatment, and its quality is directly related to the rehabilitation outcome and quality of life of patients [8]. For patients in the recovery period, staged rehabilitation nursing intervention is necessary. For critically ill patients, due to their complex conditions, often accompanied by organ dysfunction, they are vulnerable to the risk of nosocomial infection, making effective nursing intervention more difficult [9]. As a new force in the future nursing team, the quality of training for trainee nurses during their internship in the rehabilitation department is of vital importance. However, traditional nursing teaching methods often have problems such as the disconnection between theory and practice and the lack of student initiative, which are difficult to meet the demand for high-quality nursing talents in rehabilitation nursing work [10]. Therefore, it is necessary to discover a more effective way of clinical teaching to address the above problems.

In recent years, the application of the concept of evidence-based medicine in the field of nursing education has gradually attracted attention. Evidence-based thinking emphasizes making scientific and reasonable decisions based on the best evidence, combined with clinical experience and patient needs. When applied to the teaching of trainee nurses in the rehabilitation department, it can guide students to actively explore knowledge and develop their ability to solve practical problems [11]. At the same time, the case-based stereoscopic teaching method, as a comprehensive teaching approach based on actual clinical cases and through multi-dimensional teaching means, can effectively stimulate students' interest in learning and enhance their clinical thinking and practical abilities [12]. The results of this study show that at the time of leaving the department, the scores of each dimension and the total score of clinical thinking ability of the trainee nurses in the experimental group were higher than those in the control group, indicating that the implementation of the case-based stereoscopic teaching method guided by evidence-based thinking in the teaching of trainee nurses in the rehabilitation department helps to improve their clinical thinking ability. The reason lies in: In clinical practice and problem-based learning sessions, trainee nurses obtain first-hand information through communication with patients, examinations, etc., and under the guidance of their instructors, raise questions, collect information, formulate nursing plans and evaluate around evidence-based nursing. This process exercises their ability to identify problems, collect evidence, analyze problems and solve problems, and helps their clinical thinking to be more systematic and scientific; In the stage of classroom teaching, group presentation and discussion, and teacher evaluation and summary improvement, intern nurses further deepen their understanding of knowledge through presentation, discussion, peer evaluation, teacher demonstration and explanation, reflect and summarize the application of evidence-based nursing ideas

and methods, which helps them build a complete clinical thinking framework and enhance their ability to comprehensively apply knowledge to solve practical problems. The research results of Guo Shichang et al. are similar to those of this study, confirming the conclusion of this study^[13].

The results also showed that at the time of leaving the department, the scores of each dimension and the total score of the autonomous learning ability of the trainee nurses in the experimental group were higher than those in the control group, suggesting that the case-based stereoscopic teaching method guided by evidence-based thinking can improve the autonomous learning ability of the trainee nurses in the rehabilitation department. The reason for the analysis was that during the case preview session, the trainee nurses were required to read the cases in advance and study the learning materials, and were asked to actively search for and learn the relevant knowledge to cultivate the awareness and habit of autonomous learning. In the clinical practice and problem-based learning stage, trainee nurses are required to raise questions and collect information around patients' conditions, which helps them actively search professional literature, journals, books, etc., screen important information to solve practical problems, and further exercise their ability of self-study and information retrieval; In the group presentation and discussion, teacher evaluation and summary improvement sessions, the trainee nurses can more clearly recognize their own knowledge deficiencies through presentation, discussion, peer evaluation, teacher explanation and demonstration, thereby stimulating their active learning of more knowledge to make up for the deficiencies and enhancing their motivation for autonomous learning.

The results of this study also revealed that at the time of leaving the department, the theoretical assessment scores and operational assessment scores of the experimental group were both higher than those of the control group, indicating that the implementation of the case-based three-dimensional teaching method guided by evidence-based thinking in the teaching process can help the intern nurses in the rehabilitation department firmly master the relevant nursing knowledge and operational skills. The reason for this is that, in terms of theoretical learning, the evidence-based nursing knowledge training in the teaching preparation stage and the teacher's explanation of theoretical knowledge in the teaching implementation stage help the trainee nurses sort out the knowledge framework and enable them to have a deeper understanding and systematic mastery of theoretical knowledge such as the key points of nursing for common diseases in the rehabilitation department; In terms of operational skills improvement, in the clinical practice and problem-based learning session, trainee nurses follow their instructors on the front line of clinical practice for one-on-one practical operation guidance, which can combine theoretical knowledge with practical operation, accumulate rich practical experience, and improve the proficiency and standardization of operational skills; In addition, in the teacher evaluation and summary improvement session, the teacher provides detailed explanations and demonstrations of the problems that arise during the practice of the trainee nurse, further consolidating their theoretical knowledge and operational skills, which helps the nurse perform better in the assessment and thereby improves the theoretical assessment and operational assessment scores. This is similar to the results from Wang Xuehong et al.'s study^[14]. The results also revealed that at the end of the study, the teaching satisfaction of the experimental group was higher than that of the control group, indicating that the trainee nurses in the rehabilitation department were more satisfied with the effect of the case-based stereoscopic teaching method guided by evidence-based thinking in the teaching process. The reason might be that the teaching model could help the trainee nurses quickly master the relevant knowledge and skills, and during the teaching process, they could communicate more with the instructors, the teaching quality was higher, and the trainee nurses were more receptive, so their nursing satisfaction increased accordingly. This is largely in line with the findings of Chen et al^[15].

5. Conclusion

To sum up, the application of the case-based stereoscopic teaching method guided by evidence-based thinking in the teaching process of trainee nurses in the rehabilitation department can significantly improve their clinical thinking ability, autonomous learning ability, assessment results at the end of the department, and teaching satisfaction. However, this study was a single-center study with a relatively small sample size, lacking sufficient representativeness. A multi-center study with a larger sample size is needed in the future in order to obtain more representative research results.

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