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Effectiveness of an Information-Based Graded Nursing Platform Based on the Donabedian Structure-Process-Outcome Model: A Historical Control Study

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Abstract: *Objective:* To explore the application effect of an information-based graded nursing platform for hospitalized patients, developed based on the Donabedian Structure-Process-Outcome (SPO) Framework. *Methods:* A historical control design was adopted. Hospitalized patients in a tertiary hospital in Shiyan City from January to March 2025 (control group, $n=3,473$) and from October to December 2025 (experimental group, $n=2,586$) were enrolled. The experimental group received the information-based graded nursing platform, while the control group received conventional graded nursing. Indicators related to structure, process, and outcome dimensions were compared between the two groups. *Results:* The total satisfaction score of nurses with information facilities in the experimental group increased significantly from 17.29 ± 2.25 before the intervention to 21.37 ± 2.29 after the intervention ($P < 0.001$). The nursing round implementation rate (88.66% vs. 65.37%) and the nursing grading compliance rate ($96.48\% \pm 3.62\%$ vs. $90.23\% \pm 3.57\%$) were significantly higher in the experimental group than in the control group ($P < 0.01$). The incidence of nursing adverse events (0.1‰ vs. 0.049‰) was significantly lower in the experimental group ($P < 0.01$). Nurses' disease observation abilities (professional ability, critical thinking ability, and professional quality) in the experimental group were significantly improved compared with those before the intervention ($P < 0.05$). *Conclusion:* The information-based graded nursing intervention program, constructed based on the Donabedian Structure-Process-Outcome Model, significantly improves the nursing round implementation rate and nursing grading compliance rate, reduces the incidence of adverse events, and enhances nurses' disease observation abilities. It provides a feasible solution for implementing the "Grading Standards for Nursing (WS/T 431-2023)" in tertiary hospitals.

Keywords: Graded nursing; Nursing quality improvement; Information-based nursing; Structure-Process-Outcome model

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1. Introduction

Graded nursing, which involves implementing differentiated nursing management based on patients' medical conditions and self-care abilities, is a core clinical practice. It is a key strategy for optimizing the allocation of nursing resources, improving nursing service efficiency, and ensuring patient safety^[1-2]. In 2023, the official implementation of the "Grading Standards for Nursing (WS/T 431-2023)" introduced new requirements for dynamic assessment, multidisciplinary collaboration, and quantitative evaluation of self-care ability in graded nursing, serving as an important guideline for the standardized development of graded nursing practice in China^[1,3]. Concurrently, the rapid development of medical information technology provides critical technical support for implementing these new standards, promoting a shift in graded nursing from "experience-based execution" to "standardized and precise" practice^[4].

Current research indicates that tertiary hospitals commonly face challenges in graded nursing practice, including inconsistent implementation of assessment standards, insufficient doctor-nurse collaboration, and weak information system support. These issues lead to a poor match between nursing measures and patient needs, increasing potential safety risks^[5-6]. Moreover, existing studies often focus on a single aspect of grading standards or the effect evaluation of a particular intervention, lacking research grounded in classical theoretical frameworks that align with the new standards^[7-8].

In 1966, the American scholar Donabedian proposed the "Structure-Process- Outcome" three-dimensional quality evaluation model, which has been widely used in healthcare service quality evaluation both domestically and internationally^[9-12]. The core logic of this model, "structure determines process, and process affects outcome," aligns well with the research needs of graded nursing quality improvement^[13-14]. Based on this, the hospital designed and constructed an information-based graded nursing platform guided by the Donabedian model. This platform, grounded in structural optimization, centered on process standardization, and oriented toward outcome improvement, aims to achieve closed-loop management of the entire graded nursing process, from physician order issuance and dynamic assessment to measure execution and quality evaluation.

2. Objects and methods

2.1. Study participants

The hospital has 3,206 operating beds. Using convenience sampling, hospitalized patients from January to March 2025 were selected as the control group ($n=3,473$, total occupied bed days: 298,003 days), receiving conventional graded nursing. Hospitalized patients from October to December 2025 were selected as the experimental group ($n=2,586$, total occupied bed days: 303,323 days), receiving the information-based graded nursing platform. The two groups were comparable in terms of total occupied bed days ($P>0.05$).

2.2. Intervention methods

2.2.1. Control group

The control group followed the hospital's existing graded nursing management system. Nursing grades were determined by the attending physician based on clinical experience upon admission and remained static during hospitalization. Self-care ability assessments were recorded manually on paper. Bedside nursing rounds were documented using paper records. Nursing records used traditional electronic medical record templates. The Nursing Department conducted routine monthly quality checks.

2.2.2. Experimental group

- (1) Research Team: The research team consisted of 10 members, including 2 nursing professors, 2 information engineers, 3 nursing quality management personnel, and 3 master's degree nursing students. The team was responsible for literature retrieval and organization, questionnaire development, organizing expert discussions, distributing questionnaires, data extraction, data organization, and statistical analysis.
- (2) Intervention: In addition to routine nursing care, the intervention strictly adhered to the core requirements of WS/T 431-2023, including “quantitative assessment of self-care ability, dynamic adjustment of nursing grades, and multidisciplinary collaborative decision-making.” The hospital information system (HIS) and mobile nursing information system (MNIS) were interconnected to implement four core interventions:
 - (1) Standardized Assessment and Dynamic Decision-Making: Upon admission, the responsible nurse dynamically assessed self-care ability, and the attending physician dynamically assessed the patient's condition. The HIS automatically captured the results to generate an electronic “Nursing Grading Assessment Summary Form,” and the system automatically matched the appropriate nursing grade.
 - (2) Information-Based Nursing Round Execution and Traceability: Data were collected using PDA barcode recognition and digital positioning technology. Based on preset rules (symbols, fields, time periods, data coverage) in the system backend, personalized rounding tasks were automatically generated according to the assigned nursing grade. Nurses used PDAs to perform and document rounds, with data automatically recorded in the backend. Abnormal patient conditions triggered a “one-key alert” synchronously sent to the physician's workstation for rapid response.
 - (3) Closed-Loop Management for Patient Absence and Discharge: The system clarified the risks, precautions, and contact information for patients of different nursing grades who left the ward temporarily^[15–16]. Nurses marked “temporary leave” in the system for patients planning to leave, which triggered a “three-level alert.” All information regarding the leave, contact attempts, and return to the ward was recorded in a standardized format in the nursing notes, forming a complete clinical evidence chain and strengthening process risk control^[5].
 - (4) Predictive Nursing Training: Using high-fidelity simulators and VR technology, combined with the requirements of WS/T 431-2023 for nurses' disease observation and risk assessment abilities, immersive training and assessments were conducted^[17]. Regular “Nursing Safety Case Workshops” and “Disease Observation Key Points Challenge” skills competitions were held to enhance nurses' clinical judgment and emergency response abilities, providing personnel competency support for the effective implementation of WS/T 431-2023^[18].

2.3. Outcome measures

2.3.1. Structure dimension: Satisfaction with information facilities

A self-developed scale, referencing the Hospital Informationization Survey Form from the National Health Commission Statistical Information Center, was used to survey 56 registered nurses before and after the implementation of the platform^[19]. The scale included five dimensions (hardware operation convenience, system function integrity, interface friendliness, response speed and stability, and support for clinical work), with one item per dimension. Each item was rated on a 5-point Likert scale (1=very dissatisfied to 5=very satisfied), with total scores ranging from 5 to 25. Higher scores indicated greater satisfaction with

information facilities. The Cronbach's α coefficient was 0.87.

2.3.2. Process dimension: Nursing round implementation rate

Nursing round records of patients in both groups were reviewed. The information-based rounding implementation rate was calculated as (number of person-times using information-based rounding / total number of rounding inspections required) $\times$ 100%.

2.3.3. Process dimension: Nursing grading compliance rate

An assessment scale based on WS/T 431-2023 was used, with a total score of 100. The matching degree between the assigned nursing grade and the actual patient needs in both groups was assessed. A score ≥ 80 was considered compliant. The nursing grading compliance rate was calculated as (number of patients with compliant nursing grades during the period / total number of patients surveyed during the period) $\times$ 100%.

2.3.4. Outcome dimension: Incidence of nursing adverse events

Adverse events, including falls, pressure injuries, unplanned extubation, drug extravasation, suicide, and elopement, were collected through the hospital's adverse event reporting system. The incidence rates of various nursing adverse events were calculated according to the formulas in the "Nursing Professional Medical Quality Control Indicators (2020 Edition)."

2.3.5. Outcome dimension: Nurses' disease observation ability

A self-developed scale, based on the "Clinical Nurse Disease Observation Ability Evaluation Scale", was used to assess the disease observation ability of clinical nurses^[20]. The scale included 20 items across three dimensions: professional ability, critical thinking ability, and professional quality. Each item was rated on a 5-point Likert scale (1=very poor to 5=very good), with total scores ranging from 20 to 100. Higher scores indicated better disease observation ability. The Cronbach's α coefficient was 0.89.

2.4. Statistical analysis

SPSS 26.0 software was used. Continuous data were first tested for normality and homogeneity of variance. Data meeting the assumptions were expressed as mean $\pm$ standard deviation (Mean $\pm$ SD), and intergroup comparisons were performed using independent samples t-tests. Categorical data were expressed as frequencies and percentages, and intergroup comparisons were performed using the chi-square (χ^2) test. A P -value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of satisfaction with information facilities

The difference in total satisfaction scores of nurses with information facilities between pre- and post-implementation was statistically significant ($P < 0.01$). Further item analysis showed no significant difference in satisfaction with interface friendliness ($P > 0.01$), as detailed in **Table 1**.

Table 1. Comparison of nurse satisfaction with information facilities

Group	Hardware Operation Convenience	System Function Integrity	Interface Friendliness	Response Speed & Stability	Support for Clinical Work	Total Satisfaction Score
Pre-implementation (n=56)	3.21±0.44	2.27±0.56	2.65±0.75	3.59±0.35	3.06±0.77	17.29±2.25
Post-implementation (n=56)	4.28±0.35	4.33±0.46	2.59±0.48	4.37±0.41	4.32±0.58	21.37±2.29
χ^2	14.242	21.272	-0.504	10.828	9.781	9.510
<i>P</i>	<0.001	<0.001	0.615	<0.001	<0.001	<0.001

3.2. Comparison of nursing round implementation rate

The nursing round implementation rate in the experimental group was significantly higher than that in the control group ($P<0.01$), as shown in **Table 2**.

Table 2. Comparison of nursing round implementation rate

Group	Number of Patients (Grades I, II, III)	Required Rounding Times	Actual Rounding Times	Missed Rounding Times	Implementation Rate(%)
Control	3373	54816	35829	18987	65.37%
Experimental	2518	40504	35912	4592	88.66%
χ^2					6797
<i>P</i>					<0.01

3.3. Comparison of nursing grading compliance rate

The nursing grading compliance rate in the experimental group was significantly higher than that in the control group ($P<0.05$), as shown in **Table 3**.

Table 3. Comparison of nursing grading compliance rate

Group	Number of Hospitalized Patients	Number Compliant with Nursing Grade	Compliance Rate (%)
Control	3473	3210	92.44%
Experimental	2586	2500	96.68%
χ^2			49.31
<i>P</i>			<0.001

3.4. Comparison of nursing adverse event incidence

The incidence of nursing adverse events in the experimental group was significantly lower than that in the control group ($P<0.05$), as shown in **Table 4**.

Table 4. Comparison of nursing adverse event incidence

Group	Number of Hospitalized Patients	Total Patient Bed Days	Total Days of Urinary Catheter Use	Adverse Event Incidence (‰)	
				Falls	Unplanned Extubation
Control	3473	298003	19835	0.020‰	0.1‰
Experimental	2586	303323	20205	0.007‰	0.049‰
<i>u</i>				4.41	7.24
<i>P</i>				<0.01	<0.01

3.5. Comparison of nurses' disease observation ability

Nurses' disease observation abilities in the experimental group were significantly improved after the intervention ($P<0.05$), as shown in **Table 5**.

Table 5. Comparison of nurses' disease observation ability

Group	Professional Ability	Critical Thinking Ability	Professional Quality
Pre-implementation ($n=56$)	16.54±2.11	42.33±2.25	48.62±2.39
Post-implementation ($n=56$)	18.01±1.98	46.22±2.37	52.45±2.28
<i>t</i>	3.802	8.908	8.677
<i>P</i>	<0.001	<0.001	<0.001

4. Discussion

4.1. Content analysis of the information-based graded nursing platform based on the SPO model

4.1.1. Structure dimension

The structure dimension serves as the fundamental guarantee for nursing service implementation, and its completeness directly determines the execution effectiveness of the process dimension^[13]. This study showed that the experimental group addressed shortcomings in both information facilities and personnel competency by deploying mobile nursing terminals (PDAs), integrating HIS and MNIS data, developing an electronic nursing grading assessment summary form, and implementing predictive nursing training using VR/high-fidelity simulators. Results demonstrated a significant increase in nurses' overall satisfaction with information facilities from 17.29±2.25 to 21.37±2.29 ($P<0.001$), with significant improvements in four sub-dimensions: hardware operation convenience, system function integrity, response speed and stability, and support for clinical work. However, no significant difference was found in "interface friendliness" before and after implementation (2.65±0.75 vs. 2.59±0.48, $P=0.615$). This finding suggests that the current system's interface design may still follow traditional HIS interaction logic without ergonomic optimization for nurses' mobile work scenarios. It also reflects that nurses' expectations for interface friendliness increase with system use, reminding future research to prioritize user experience design in nursing information systems, not just functional implementation. Hou et al. also indicated that information facilities and nurses' professional competency are important structural factors influencing graded nursing quality^[5]. However, this study further suggests that the adaptability of structure is more critical than its advancement. The structural improvement in the experimental group did not pursue high-precision technology but precisely targeted the three core

requirements of WS/T 431-2023: electronic assessment tools designed according to the new standards and personnel training focused on the new standard's competency requirements. This high adaptability of the structure to the new standards provides structural support for the localized implementation of WS/T 431-2023 ^[5, 17].

4.1.2. Process dimension

The process dimension, acting as a bridge between structure and outcome, relies on standardized execution to fully leverage structural advantages ^[14]. The results of this study show that all process dimension indicators in the experimental group were significantly higher than those in the control group ($P<0.001$), indicating that the information-based intervention significantly improved process standardization and execution. First, the information system enhances structural standardization and precision by embedding best practices, clinical pathways, and operating specifications into solidified digital workflows, decision support systems, or automated scripts, thereby mandating or guiding practitioners to follow established optimal steps ^[21]. For example, in stroke emergency care, 5G-based mobile stroke units integrate CT image transmission, AI-assisted diagnosis, and electronic medical record synchronization, ensuring seamless and standardized connection between pre-hospital and in-hospital emergency processes, reducing process deviations caused by information gaps or human error, and greatly improving the standardization of emergency procedures ^[22]. In this study, this was specifically manifested in standardized assessment and decision-making: a collaborative model using nurse self-care ability assessment, physician condition assessment, and system-automated grade matching reduced experiential decision-making bias. Second, it promoted closed-loop rounding execution: the system automatically generated personalized rounding tasks according to nursing grade, with PDA confirmation and backend tracking, enabling full supervision and traceability. Third, it enabled proactive risk management: establishing a three-level alert and standardized recording for patient absence or leave, addressing process management gaps.

4.1.3. Outcome dimension

The outcome dimension reflects the ultimate effectiveness of nursing quality improvement. This study showed that the experimental group achieved a 23.29 percentage point increase in the nursing round implementation rate and a 6.25 percentage point increase in the nursing grading compliance rate. Compared with the control group, the incidence of falls decreased by 65.0% and unplanned extubation decreased by 51.0% in the experimental group. Pressure injuries and unplanned extubation of tracheal tubes had zero incidence. Consistent with related research findings, the information system embeds risk alerts, rounding requirements, and grading standards into clinical work, driving nursing management from post-hoc remediation to pre-event prevention and in-process monitoring, effectively reducing the risk of adverse events such as falls, pressure injuries, unplanned extubation, and elopement ^[23–25]. Simultaneously, the intelligent system enables synergistic effects between standardized processes and competency training, reducing human error while strengthening nurses' clinical judgment and emergency response abilities, making nursing services more aligned with patients' actual needs and further improving nursing quality. Therefore, the closed-loop management of "structure-process- outcome" aligns highly with the continuous quality improvement philosophy emphasized by the SPO model ^[13–14].

4.2. Scientific analysis of the information-based graded nursing platform based on the SPO model

In 1969, scholar Donabedian proposed the Structure-Process-Outcome theoretical model for evaluating healthcare system quality. Since then, it has been introduced into the nursing field and widely applied^[9-12]. This study used the Donabedian Structure-Process-Outcome theoretical model as a framework, centered around the core requirements of the “Grading Standards for Nursing (WS/T 431-2023)”, and constructed a preliminary information-based graded nursing intervention plan through literature review, clinical status survey, and expert discussion^[1]. Subsequently, a quasi-experimental research design was adopted, selecting departments from the same hospital as a control, to empirically evaluate the platform’s application effect. Hierarchical regression analysis was used to clarify the transmission pathway of “structure-process-outcome.” Furthermore, this study strictly followed the quality evaluation logic of the SPO model, with indicators covering the three dimensions of structure facilities, process execution, and outcome results^[9]. All dimensional indicators were validated by clinical experts, aligning with the principles of nursing quality management. The quasi-experimental design ensured comparable baseline data, and the data were objectively measurable with reliable sources, effectively controlling for selection and implementation biases. The above design ensures that this study has a scientifically sound theoretical framework, standard-based specifications, and rigorous methodology, conferring high scientific validity.

4.3. Feasibility analysis of the information-based graded nursing platform based on the SPO model

The information-based graded nursing platform constructed in this study demonstrates good clinical feasibility and potential for widespread adoption. Regarding process adaptability, the plan is based on the existing HIS and mobile nursing system, requiring only functional optimization and data interoperability to achieve core functions such as standardized assessment, automatic rounding, and closed-loop recording. It can be seamlessly integrated into daily workflows without significantly increasing the burden on nurses. In terms of resource investment, the focus is on information system upgrades and process optimization, utilizing existing PDA equipment. Training is primarily conducted within the hospital, resulting in low investment costs and high cost-effectiveness, making it suitable for large-scale application in tertiary hospitals. Regarding clinical acceptance, the information tools simplify documentation, enhance reminders, and reduce double-checking, leading to significantly improved nurse satisfaction and strong implementation willingness, thus minimal resistance to adoption. In terms of management sustainability, the closed-loop model of “structure improvement-process control-outcome monitoring” can be directly translated into routine nursing quality control work, facilitating long-term implementation and continuous improvement.

4.4. Limitations

This study has several limitations. First, the single-center, historical control design limits the representativeness of the sample. Second, the observation period was relatively short, and no long-term longitudinal follow-up was conducted, making it impossible to determine the sustainability of the intervention effects. Future research plans include conducting multicenter randomized controlled trials involving 3–5 hospitals at different levels within Hubei Province, performing a 12-month longitudinal follow-up study using structural equation modeling to explore causal pathways, and incorporating artificial

intelligence technology to achieve intelligent prediction of patient risks and personalized recommendations for nursing measures.

5. Conclusion

The information-based graded nursing intervention plan constructed based on the SPO model, through structural improvement and process standardization, significantly increases the nursing round implementation rate and nursing grading compliance rate, reduces the incidence of nursing adverse events, and enhances nurses' disease observation abilities. The "structure-process-outcome" closed-loop system for graded nursing quality constructed in this study achieves the localized and information-based implementation of WS/T 431-2023, serving as an effective solution for quality improvement in graded nursing under the new standards in tertiary hospitals.

Disclosure statement

The authors declare no conflict of interest.

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Exploration of the Multidimensional Effects of a New Sputum Drainage Strategy Using the Trendelenburg Position on Sputum Clearance Function in Children Undergoing Mechanical Ventilation

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Abstract: *Objective:* To investigate the multidimensional improvement effects of a new sputum drainage strategy combining a 30° Trendelenburg position, specialized position-changing pillows, and sedation intervention on sputum clearance function in pediatric patients undergoing mechanical ventilation. *Methods:* From January 2022 to December 2025, 95 children receiving mechanical ventilation were randomly divided into an observation group (48 cases) and a control group (47 cases). The observation group adopted a 30° Trendelenburg position, utilized specialized position-changing pillows, and received appropriate sedation, with drainage performed for approximately 2 hours per shift. The control group employed conventional sputum drainage methods. The effects of the new strategy were evaluated by comparing sputum volume, improvement in pulmonary rates, blood gas analysis indicators, and duration of mechanical ventilation between the two groups. *Results:* Sputum volumes on days 1, 3, and 5 in the observation group were (15.62±3.27) ml, (20.55±4.14) ml, and (22.38±4.55) ml, respectively, significantly higher than those in the control group, which were (10.24±2.82) ml, (15.36±3.52) ml, and (17.65±3.83) ml, respectively (all $P<0.001$). The overall improvement rate of pulmonary rates in the observation group was significantly higher than that in the control group ($\chi^2=7.251$, $P=0.007$). On day 3 post-ventilation, PaO₂ (85.67±6.25 mmHg) and OI (205.33±15.65 mmHg) in the observation group were significantly higher than those in the control group, while PaCO₂ (38.53±3.87 mmHg) was significantly lower (all $P<0.001$). The duration of mechanical ventilation in the observation group was significantly shorter than that in the control group ($t=4.850$, $P<0.001$). *Conclusion:* The new sputum drainage strategy using the Trendelenburg position can significantly enhance sputum clearance efficiency, improve pulmonary ventilation and oxygenation status, and shorten the duration of mechanical ventilation in children through precise positional control and synergistic interventions, demonstrating significant clinical application value.

Keywords: Pediatric mechanical ventilation; Trendelenburg position; Sputum drainage; Sputum clearance function

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1. Introduction

In the Pediatric Intensive Care Unit (PICU), mechanical ventilation is employed to provide life support for children with respiratory failure. Due to factors such as prolonged bed rest and general anesthesia, they are highly susceptible to bronchial obstruction by secretions, leading to pulmonary infections, which can subsequently result in severe atelectasis, pulmonary edema, or even secondary pulmonary embolism. Concurrently, a substantial accumulation of respiratory secretions in the distal ends of small bronchi increases inspiratory resistance and slows down the exhalation flow rate, ultimately contributing to ventilator-associated pneumonia (VAP), which seriously threatens the children's lives and recovery process^[1]. In clinical practice, it has been observed that during the use of invasive ventilators in children, the conventional method of adopting a head-down position (i.e., the head is lower than the feet) is employed to facilitate the drainage of intrathoracic fluids and clear respiratory secretions^[2]. This method is simple and safe; however, it has certain drawbacks, such as difficulty in precisely maintaining the body position angle, a lack of effective auxiliary tools, and insufficient consideration of the child's tolerance^[3-4]. This study aims to propose a new strategy for sputum drainage in the head-down foot-high position and explore its multidimensional effects on sputum evacuation function during mechanical ventilation in children.

2. Materials and methods

2.1. General information

Children admitted to the PICU of our hospital and receiving mechanical ventilation treatment were selected as the study subjects from January 2022 to December 2025. Inclusion criteria: meeting the diagnostic criteria for respiratory failure, requiring mechanical ventilation due to respiratory failure caused by various reasons^[5]; aged between 1 month and 12 years; requiring mechanical ventilation due to respiratory failure caused by various reasons; and an anticipated duration of mechanical ventilation exceeding 48 hours. Exclusion criteria: children with severe cardiovascular diseases; those with increased intracranial pressure or cerebral lesions; and those with spinal developmental abnormalities preventing the adoption of a head-down position. The children were randomly divided into an observation group (48 cases) and a control group (47 cases) using a random number table method. In the observation group, the male-to-female ratio was 26:22, with an age distribution of (5.2 ± 2.1) years; in the control group, the male-to-female ratio was 25:22, with an age distribution of (5.0 ± 2.3) years. The general clinical characteristics, such as gender and age, between the two groups were compared using the χ^2 test ($P > 0.05$), indicating comparability.

2.2. Methods

The control group received conventional sputum drainage methods, including regular turning and back tapping (every 2–3 hours), tracheal intubation or tracheotomy suction with negative pressure aspiration when necessary, and intermittent nasal catheter suction.

The observation group adopted a new strategy for sputum drainage in the head-down foot-high position, as follows: (1) Body Position Setting: A specially designed turning pillow was used to place the child in a head-down foot-high supine position, with the head of the bed adjusted to approximately 30° below the horizontal plane to ensure accuracy and stability. (Generally, this position was maintained for 2 hours daily and could be extended as needed based on the child's tolerance.) (2) Sedation Management: For children with poor tolerance and obvious agitation, an appropriate amount of midazolam sedative was administered,

with the dosage determined based on body weight and clinical manifestations, to ensure the child remained calm in the head-down foot-high position and improve sputum drainage effectiveness. (3) Sputum Drainage Operation: In the head-down foot-high position, chest physiotherapy was performed, including back tapping and vibration sputum evacuation device-assisted drainage. During back tapping, the palm was cupped, and the chest wall was continuously tapped from the lung base upwards and from the outside inwards, with moderate force to avoid inducing coughing (approximately 40–50 times per minute). The vibration sputum evacuation device was selected based on the child's age and specific conditions, with a duration of 10–15 minutes. Vital signs and the child's tolerance were closely monitored, and adjustments were made as needed. If symptoms such as worsening dyspnea or decreased blood pressure occurred, the above measures were immediately terminated, and adjustments were made accordingly.

2.3. Observation indicators

- (1) Sputum Drainage Volume: The total sputum drainage volume was recorded and compared between the two groups on the 1st, 3rd, and 5th days after mechanical ventilation ^[6].
- (2) Improvement in Pulmonary Rales: A dedicated person was responsible for performing pulmonary auscultation on the patients and determining whether the pulmonary wet rales had decreased based on the auscultation results. If they had decreased, a corresponding score was given, categorized as significant improvement (pulmonary rales basically disappeared), partial improvement (pulmonary rales significantly decreased), or no improvement (pulmonary rales unchanged or increased).
- (3) Blood Gas Analysis Indicators: Arterial blood was drawn for blood gas analysis before and on the 3rd day after mechanical ventilation to observe changes in PaO₂, PaCO₂, and OI ^[7].
- (4) Ventilator Use Time: The time from the initiation of mechanical ventilation to weaning was recorded for both groups of children.

2.4. Statistical methods

SPSS 22.0 statistical software was used. Measurement data were expressed as (Mean ± SD) and compared using the *t*-test; count data were expressed as the number of cases (n) and rate (%), and compared between groups using the χ^2 test. A *P*-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of sputum drainage volume

The sputum drainage volume in the observation group was significantly higher than that in the control group on the 1st, 3rd, and 5th days after mechanical ventilation (*P* < 0.05), with specific data shown in **Table 1**.

Table 1. Comparison of sputum drainage volume between the two groups (Mean ± SD, ml)

Group	Number of Cases	Day 1	Day 3	Day 5
Observation Group	48	15.62±3.27	20.55±4.14	22.38±4.55
Control Group	47	10.24±2.82	15.36±3.52	17.65±3.83
<i>t</i> value	-	8.593	6.588	5.486
<i>P</i> value	-	<0.001	<0.001	<0.001

3.2. Comparison of improvement in pulmonary rates

The proportion of children in the observation group showing significant and partial improvement in pulmonary rates was higher than that in the control group ($P < 0.05$). Specific data are presented in **Table 2**.

Table 2. Comparison of improvement in pulmonary rates between the two groups of children (cases, %)

Group	Number of Cases	Significant Improvement	Partial Improvement	No Improvement	Total Effective Rate (%)
Observation Group	48	20 (41.7)	22 (45.8)	6 (12.5)	87.5
Control Group	47	12 (25.5)	18 (38.3)	17 (36.2)	63.8
χ^2 value	-	-	-	-	7.251
P value	-	-	-	-	0.007

3.3. Comparison of blood gas analysis indicators

Before ventilation, there were no significant differences in blood gas analysis indicators such as PaO_2 , PaCO_2 , and OI between the two groups of children ($P > 0.05$). On the 3rd and 5th days after ventilation, the PaO_2 and OI values in the observation group were higher than those in the control group, while the PaCO_2 value was lower than that in the control group ($P < 0.05$). Specific data are shown in **Table 3**.

Table 3. Comparison of blood gas analysis indicators between the two groups of children (Mean $\pm$ SD, mmHg)

Group	PaO_2		PaCO_2		OI	
	Before ventilation	Day 3 after ventilation	Before ventilation	Day 3 after ventilation	Before ventilation	Day 3 after ventilation
Observation group ($n=48$)	62.33 $\pm$ 5.14	85.67 $\pm$ 6.25	45.62 $\pm$ 4.28	38.53 $\pm$ 3.87	150.23 $\pm$ 12.34	205.33 $\pm$ 15.65
Control group ($n=47$)	61.92 $\pm$ 5.38	78.20 $\pm$ 5.89	46.13 $\pm$ 4.56	42.35 $\pm$ 4.14	148.91 $\pm$ 13.14	180.55 $\pm$ 14.27
t value	0.380	5.996	0.562	4.644	0.504	8.067
P value	0.705	<0.001	0.576	<0.001	0.615	<0.001

3.4. Comparison of ventilator usage duration

The ventilator usage duration in the observation group was significantly shorter than that in the control group ($P < 0.001$). Specific data are presented in **Table 4**.

Table 4. Comparison of ventilator usage duration between the two groups of children (Mean $\pm$ SD, days)

Group	Number of Cases	Duration of Ventilator Use (days)
Observation Group	48	7.5 $\pm$ 2.1
Control Group	47	9.8 $\pm$ 2.5
t	-	4.850
p	-	<0.001

4. Discussion

During mechanical ventilation in children, effectively clearing secretions has become one of the clinical focuses [8]. During invasive mechanical ventilation, the presence of an artificial airway and the impact of suctioning can prevent secretions from being promptly expelled to the oral or nasal cavity, leading to local

and systemic infections. This can result in various serious complications, including atelectasis, ventilator-associated pneumonia, aspiration pneumonia, etc., all of which are detrimental to patient recovery and may further progress to hospital-acquired pneumonia, potentially leading to death. Additionally, poor sputum drainage during mechanical ventilation can extend ventilator use by 3 to 5 days and increase the incidence of pulmonary infections by approximately 20% to 30% compared to conventional groups, highlighting the importance of optimizing sputum drainage strategies^[9]. Based on this, this study proposes a new strategy for sputum drainage in the Trendelenburg position and explores its effects from multiple dimensions.

Maintaining airway patency and effectively removing secretions are crucial during mechanical ventilation in children^[10]. Trendelenburg position sputum drainage utilizes gravity to facilitate the downward movement of fluids from dependent areas to promote their expulsion. This method is simple, non-invasive, and easy to perform, but requires precise control of the body position angle to achieve optimal results^[11]. The new strategy for Trendelenburg position sputum drainage proposed in this study is an improvement over existing methods, involving elevating the foot of the bed to a 30° angle and using appropriate specialized positioning pillows for auxiliary support and fixation as needed. This approach better addresses the aforementioned issues, enhances safety, facilitates nursing operations, and improves sputum drainage effectiveness.

The study results showed that the observation group had significantly higher sputum drainage volumes than the control group, indicating that the new strategy enabled children to effectively cough up more sputum. The removal of large amounts of sputum facilitated airway patency, as evidenced by the higher proportion of significant and partial improvements in pulmonary rales in the observation group, further confirming the advantages of the new strategy in improving pulmonary conditions. In terms of blood gas analysis indicators, the observation group exhibited increased PaO₂ and OI values and decreased PaCO₂ values on the 3rd and 5th days after ventilation, suggesting that the new strategy improved oxygenation and gas exchange in children, closely related to better sputum drainage effects^[12]. From the perspective of gravity-driven sputum clearance mechanisms, using a 30° Trendelenburg position for sputum drainage therapy utilizes gravity to move secretions from lower and deep bronchial areas into the upper respiratory tract for expulsion. Compared to conventional turning and percussion, this position creates a continuous and directional driving force, avoiding fluctuations in drainage efficiency caused by unstable body position angles in traditional methods. Additionally, it shortens the duration of ventilator support and reduces the risk of prolonged mechanical ventilation in patients.

However, when implementing the new strategy for Trendelenburg position sputum drainage, several issues require attention. For example, the Trendelenburg position may increase the incidence of gastroesophageal reflux and aspiration, especially in young children with poor lower esophageal sphincter tone. It is essential to monitor for signs of reflux and vomiting and adjust the position accordingly (e.g., slightly elevating the foot of the bed) or take appropriate measures. Prolonged use of the same position can also cause local pressure, leading to skin damage or even pressure ulcers in children. Therefore, skin management should be strengthened, with regular inspections and careful examination of the skin at pressure points.

5. Conclusion

In summary, the new strategy for Trendelenburg position sputum drainage can improve sputum drainage function, increase sputum volume, promote improvement in pulmonary rales, enhance oxygenation, and

shorten ventilator use time in children undergoing mechanical ventilation from multiple dimensions.

Disclosure statement

The authors declare no conflict of interest.

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Suggestions on Training Health Service and Management Professionals from the Perspective of “New Liberal Arts”

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Abstract: This article focuses on the strategic background of “Healthy China 2030,” analyzes the development status, difficulties, and causes of health service and management majors in my country, and proposes future development ideas based on the concept of “New Liberal Arts.” Since its establishment in 2016, the scale of this major has expanded rapidly, but there are systemic problems such as vague strategic positioning, insufficient cross-border capabilities of teachers, and severe homogeneity of courses, resulting in talent training being out of touch with industry needs. In order to break through the dilemma, the article proposes that the “new liberal arts” should be used as a guide to promote the in-depth integration of disciplines, build an interdisciplinary integrated curriculum system, and realize the transformation from knowledge teaching to ability cultivation through outcome-based education (OBE). Ultimately, professional construction requires top-level design, teacher development, and school-enterprise collaboration to cultivate health service talents with cross-border integration capabilities to respond to national strategies and industry needs.

Keywords: Health service and management major; New liberal arts; OBE

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1. Introduction

With the proposal of the “Healthy China 2030” strategy, taking big health as the center, focusing on health management and health promotion, and improving the health level of the entire population and the entire life cycle of the people is the main development direction of China’s health management services ^[1]. It is imperative to cultivate professional health service and management talents that meet social needs in the context of big health.

2. Current status of development of health service and management majors

The Health Service and Management major was added at the end of 2015 and began to enter undergraduate colleges as an independent major. The first batch of five universities was approved to set up the undergraduate major of “Health Service and Management” and was awarded the “Management” degree. The study period was “four years,” and the first enrollment was in 2016 ^[2]. In order to continuously meet the needs of the country’s health service industry for health service and management talents, the Ministry of Education has gradually expanded the scale of professional settings ^[3]. As of May 2025, there have been 138 undergraduate colleges and universities offering health service and management majors across the country.

3. Analysis of the difficulties and causes in the development of health service and management professions

Although the scale of health service and management majors has achieved rapid expansion, its connotation construction lags behind the development of form, and a series of structural dilemmas are restricting the quality of professional training and sustainable development capabilities ^[3]. These dilemmas are not superficial resource or technical issues, but are rooted in deep challenges such as strategic ambiguity, capability gaps, and system imbalances that the profession faces in the process of transforming from traditional disciplinary frameworks to emerging cross-paradigms.

Firstly, at the strategic level, there is a dual problem of “vision suspension” and “demand disconnection” in professional positioning. At present, the response of the Health Services and Management major to macro strategies such as the “New Liberal Arts” is still mostly superficial, and has not been effectively transformed into differentiated training characteristics, which has led to structural deviations between the curriculum system and rapidly changing industry demands ^[3-4]. At the same time, the disconnect between teaching and practice and the shortage of cross-disciplinary faculty further exacerbate the dilemma of talent cultivation ^[5-6]. Ultimately, many universities have fallen into homogeneous competition, and the path of characteristic development is still unclear ^[7]. This leads to path dependence in the construction of the curriculum system, often simply transplanting mature professional course modules such as public service management, business management, or preventive medicine, and combining them in a “patchwork” manner, rather than reconstructing knowledge around the core issue of “health services and management.” As a result, there is a significant deviation between the training program and the actual demand for composite abilities such as data analysis, process optimization, technology integration, and personalized intervention under the rapid development of the health industry. This systemic deviation is the core crux of the urgent need to reform the current professional talent training system. The knowledge structure of graduates presents a “broad and scattered” characteristic, making it difficult to quickly meet the core job requirements of diversified employers such as health management institutions, smart elderly care communities, and commercial health insurance companies, resulting in a mismatch between supply and demand sides.

Secondly, at the organizational and capability level, the teacher structure and teaching system face a prominent “cross-border capability deficit.” Health services and management essentially require teachers to have the ability to “translate knowledge” and “integrate teaching” across medicine, management, information science, and even social science. However, most of the current teachers come from a single disciplinary background or hold concurrent posts, and generally lack systematic practical experience and interdisciplinary research accumulation in real health service scenarios. This dual lack of “composite knowledge” and “cross-

border practical experience” makes it difficult to combine classroom teaching with practice. Research shows that health service and management-related skills courses generally have problems such as a disconnect between teaching content and actual needs and a single teaching method ^[5]. They are unable to effectively carry out in-depth teaching based on real cases and complex problems, and are even less able to guide students in interdisciplinary knowledge practice and application. In addition, the practical teaching system is often a mere formality due to the unstable construction of off-campus internship bases, shallow school-enterprise cooperation, and imperfect practical teaching evaluation mechanisms, resulting in insufficient training of students’ ability to solve practical problems and failure to bridge the “last mile” from theory to practice.

Furthermore, in terms of the overall development model, professional construction shows a significant tendency of “homogeneous competition,” and niche differentiation based on comparative advantages has not yet been formed. Internal surveys of some colleges and universities have clearly pointed out that management majors need to solve the problem of positioning convergence and explore distinctive development paths ^[7]. In the process of rapid expansion, many institutions have failed to deeply examine their own discipline accumulation and regional health industry resources, and carry out misaligned development and characteristic cultivation. Regardless of whether they are schools with a medical background, an engineering background, or a liberal arts background, their training objectives, core curriculum settings, and even practical links are highly similar. This “one-size-fits-all” development model not only results in duplicative investment and inefficient allocation of resources, but also makes it difficult for majors to form unique core competitiveness and cannot accurately meet the needs of specialized talents in subdivided areas of the health service market (such as health technology product management, community chronic disease intervention management, health data governance, etc.), limiting the long-term differentiated development potential and industry influence of majors.

In summary, the current dilemma in professional development is a systemic problem that reveals multiple gaps between macro strategic positioning and micro teaching implementation. To solve these difficulties, it is necessary to go beyond local course additions, deletions, or teacher supplements, and instead reconstruct from the systemic level of professional overall strategic design, cross-border organizational capacity building, and characteristic development path selection. This is precisely the area where the concept of “new liberal arts” can provide key inspiration, that is, how to transform external strategic opportunities into internal sustainable core competencies through deep disciplinary integration and mechanism innovation.

4. Thoughts on the development of the major in health services and management from the perspective of the “New Liberal Arts”

The rise of the “New Liberal Arts” is essentially a systematic response to the limitations of traditional disciplinary classifications in solving complex real-world problems. Its core is not simply to apply technological tools to the fields of humanities and social sciences, but to advocate for a deep knowledge paradigm revolution — by breaking down inherent disciplinary boundaries and promoting the creative integration of heterogeneous knowledge systems, in order to cultivate versatile talents who can cope with future social challenges. For the Health Service and Management major, the “New Liberal Arts” provides a theoretical perspective and action framework that goes beyond the simple superposition of “medicine+management,” pointing towards a professional reconstruction path centered on deep cross-border

integration. This path aims to fundamentally address the strategic disconnect, capability gaps, and system imbalances revealed in the previous chapter.

4.1. From “boundary crossing” to “system reconstruction”: Building a new ecology of integrated curriculum and teaching

The primary task of professional development from the perspective of “new liberal arts” is to achieve a transformation from superficial “multidisciplinary coexistence” to deep “interdisciplinary integration.” This requires that professional construction must actively engage in “boundary work,” that is, intentionally dissolve, bridge, or reconstruct the knowledge boundaries between medical, engineering, humanities, and social sciences disciplines.

4.1.1. Deepening the integration of medicine and engineering: an integrated learning design with problems as the link

The integration of medicine and engineering is not a mechanical combination of medical knowledge and engineering technology knowledge, but rather a knowledge reproduction centered around the core issue of “technical solutions to health problems.” The specific path includes:

Firstly, develop integrated courses: abandon the traditional model of separately offering “Medical Fundamentals” and “Data Science Fundamentals,” and instead design courses such as “Health Data Science and Decision Making.” This course is driven by the data analysis needs in real health management scenarios, and organically connects knowledge modules such as epidemiology, statistics, machine learning, and health policy evaluation to cultivate students’ ability to use computational tools to solve clinical or public health problems.

Secondly, establish a “trading zone” project: draw on the theory of “trading zones” and establish an interdisciplinary project platform. For example, teachers and students from the School of Medicine and the School of Engineering jointly conducted a semester-long project-based learning program on “Intelligent Monitoring and Intervention of Elderly Chronic Diseases in Communities.” In this process, medical students contribute knowledge of pathology and health assessment, engineering students contribute sensors and algorithm models, management students contribute project operations and cost-benefit analysis, and achieve natural integration and innovation of knowledge in the practice of jointly solving complex problems.

4.1.2. The sublimation of “integration of arts and sciences”: The guidance of value rationality on instrumental rationality

The ultimate target of health services is people, which determines that professional education cannot stop at technical and management efficiency, and must deeply integrate the care and critical thinking of humanities and social sciences. The integration of arts and sciences aims to cultivate “complete” health practitioners who possess both scientific literacy and humanistic spirit.

Embedded Ethics and Critical Course Module: In the course of “Application of Health Information Technology,” ethical discussion modules such as data privacy, algorithmic bias, and health equity are introduced; In “Health Project Management,” the analysis of the impact of social determinants on health is strengthened. This makes students realize that technology and management solutions must be considered within social, cultural, and ethical contexts.

Developing communication and exchange skills: By offering courses such as “Health Management

and Service Communication,” students are trained to understand patient stories, provide effective health education, and communicate across professional teams. This transforms humanistic care into actionable professional qualities, ensuring that technical services have a “human warmth.”

4.2. Using OBE as an engine: Driving the systematic transformation of the curriculum system towards “ability output”

The Outcome-Based Education (OBE) concept provides an actionable engineering implementation framework for the integration vision of the “New Liberal Arts.” It requires professional development to shift its focus from “what to teach” (teacher input) to “what students can do” (learning output), in order to align the curriculum system with market demand.

4.2.1. Anchor interdisciplinary core competencies based on the principle of “reverse design”

Firstly, a detailed needs analysis must be conducted to clarify the high-level interdisciplinary abilities that graduates should possess after 5 years, such as the ability to design and evaluate a community health intervention plan that integrates multiple sources of data, and the ability to lead a cross-disciplinary team to implement health promotion projects. These ability statements should be specific, measurable, and directly respond to the cutting-edge needs of the health industry development. Subsequently, these ultimate achievements will be decomposed into a series of phased graduation requirements that can be achieved year by year.

4.2.2. Build a “competency curriculum” mapping matrix to visualize the supporting relationships

According to graduation requirements, systematically restructure all courses to form a clear “course map.” Each course needs to clarify which specific competency indicators it aims to support, and design corresponding teaching activities and evaluation criteria. For example, the course “Health Economics” not only teaches theory, but its homework can be set as “analyzing the cost-effectiveness of a chronic disease management project and proposing optimization strategies based on insurance payments” to support “health resource allocation and financial management capabilities.” This design ensures that every link in the curriculum system makes a clear contribution to the final ability output, eliminating isolation and redundancy between courses.

4.2.3. Implement diversified dynamic evaluation and establish a continuous improvement loop

The evaluation system that matches OBE must be diversified and focused on capabilities. It should comprehensively use evaluation methods such as project reports, case analysis, simulation exercises, internship portfolios, and interdisciplinary portfolios to collect evidence of students’ ability achievement in all aspects. More importantly, these evaluation data should be systematically used to analyze the effectiveness of the curriculum system, forming a continuous quality improvement cycle of “evaluation feedback improvement,” ensuring that professional construction can dynamically adapt to changes in the external environment.

5. Conclusion

In summary, the perspective of “new liberal arts” provides a fundamental idea for the development of health services and management majors to overcome difficulties. It advocates not only the construction of an emerging profession, but also the transformation of a complex professional education paradigm. In terms of goals, it is necessary to shift from cultivating “knowledge repositories” to cultivating “boundary crossers” and “system integrators”; In terms of content, the goal is to shift from providing a “knowledge deck of disciplines” to designing “problem oriented knowledge fusion projects”; From a methodological perspective, shifting from relying on “one-way transmission” to relying on “reverse design and iterative improvement guided by OBE”; Ecologically speaking, the shift from “departments working independently” to building a “collaborative education network with diverse participation from schools, enterprises, and social governance.”

However, the successful implementation of this paradigm cannot be accomplished by a single teaching unit. It strongly relies on universities to carry out top-level design at the strategic management level, breaking down the barriers of disciplinary organization; Innovate incentive systems at the resource allocation level to encourage teachers to engage in interdisciplinary teaching and research; Establish a deeply integrated partnership at the level of school-enterprise cooperation, jointly define competency standards, and provide practical fields. Therefore, the maturity of the health service and management profession will be a key touchstone for whether the organizational resilience, innovation ability, and adaptability of China’s higher education system can truly be improved under the banner of “new liberal arts.” Future research and practice should focus more deeply on how institutional innovation, teacher development, and learning science can evolve in synergy during this transformation process, in order to ultimately achieve a fundamental leap in the quality of talent cultivation.

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Construction and Application of Exercise Intervention Programs during Dialysis for Elderly Maintenance Hemodialysis Patients Based on Multiple Theoretical Models

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Abstract: *Objective:* To construct a dialysis-based exercise intervention program based on the Multi-Theory Model (MTM) and explore its effects on the physical function and long-term exercise behavior of elderly maintenance hemodialysis patients. *Methods:* Using the convenience sampling method, 70 elderly MHD patients from two tertiary hospitals in Hebei Province from September 2025 to February 2026 were selected as the research subjects. They were divided into the control group and the intervention group according to the dialysis duration, with 35 cases in each group. The control group received routine care, while the intervention group implemented the MTM-based exercise intervention on the basis of routine care for 12 weeks. The physical function (SPPB), 6-minute walking distance, lower limb muscle strength, exercise self-efficacy, and exercise compliance of the two groups were compared before the intervention and at 4, 8, and 12 weeks of the intervention. *Results:* After the intervention, the SPPB score, 6-minute walking distance, lower limb muscle strength, exercise self-efficacy, and exercise compliance of the intervention group were all better than those of the control group, and all indicators continued to improve with the extension of the intervention time, and the differences were statistically significant ($P < 0.05$). *Conclusion:* The MTM-based exercise intervention during dialysis can effectively improve the physical function, muscle strength, and exercise endurance of elderly MHD patients, as well as enhance exercise self-efficacy and exercise compliance, which is conducive to promoting the formation of long-term exercise behavior in patients and can provide new intervention ideas for the exercise rehabilitation and long-term behavior management of elderly hemodialysis patients.

Keywords: Multiple theoretical models; Elderly; Maintenance hemodialysis; Physiological functions; Lower limb muscle strength; Exercise endurance

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1. Introduction

Maintenance hemodialysis (MHD) refers to the situation where patients receive continuous and regular hemodialysis treatment for more than 3 months ^[1]. Data from the Chinese National Renal Data System (CNRDS) shows that there are over 1.06 million dialysis patients in China, among whom 91.6% are hemodialysis patients ^[2]. Long-term uremic state and dialysis treatment can lead to complications such as anemia, muscle atrophy, and osteoporosis, which can result in decreased exercise endurance, reduced muscle strength, and impaired daily living activities ^[3]. Long-term lack of physical activity can further accelerate the deterioration of physical function ^[4]. Studies have shown that the exercise capacity of MHD patients is only 50% to 60% of that of healthy individuals ^[5]. Currently, exercise intervention has been proven to be able to improve the physical function and exercise endurance of MHD patients. However, existing studies mostly focus on exercise methods and short-term effect evaluation ^[6-8]. Insufficient attention has been paid to maintaining patients' long-term exercise behavior. Especially for elderly MHD patients, due to long-term disease burden, fatigue state, and concerns about exercise risks, they generally have low exercise compliance and difficulty in long-term persistence ^[9]. Therefore, how to promote the formation of patients' long-term exercise behavior has become an important issue in the field of dialysis rehabilitation. The multi-theory model (MTM) is a health promotion theory centered on behavior change, emphasizing the promotion of the continuous formation of healthy behaviors through "behavior initiation" and "behavior maintenance" ^[10]. It has good application value in the long-term behavior management of chronic diseases. However, the application of MTM-based exercise intervention in elderly MHD patients is still rare. Based on this, this study innovatively applies MTM to the entire process of exercise management in the dialysis of elderly MHD patients, constructing a dialysis-based exercise intervention model integrating exercise training, behavior reinforcement, and continuous support, and exploring its effects on patients' physical function, muscle strength, exercise endurance, exercise self-efficacy, and exercise compliance, in order to provide new theoretical basis and practical references for the long-term exercise rehabilitation management of elderly MHD patients.

2. Construction of the exercise intervention plan for maintenance hemodialysis patients

2.1. Establishment of the research team

The research team consists of 9 members, with the following divisions of labor: 1 mentor (graduate student) is responsible for finalizing the intervention plan; 1 exercise rehabilitation physician is responsible for assessing the patient's physical condition and reviewing the plan content; 2 hemodialysis room physicians jointly review the exercise plan and handle adverse events during dialysis; 2 researchers are responsible for literature review, expert consultation implementation, data collection, plan design, and on-site execution, and assist nurses in completing the exercise intervention; 1 hemodialysis room nurse manager supervises the implementation of the plan; 2 hemodialysis nurses are specifically responsible for the operation implementation of the intervention plan.

2.2. Formulation of the exercise intervention plan for maintenance hemodialysis patients

2.2.1. Drafting the initial plan

According to the "6S" evidence model, systematic searches were conducted in domestic and foreign

databases such as CNKI, China Biomedical Literature Database, VIP, Wanfang Data Knowledge Service Platform, Web of Science, Science Direct, Cochrane, PubMed, Embase, etc. The Chinese search terms were: “hemodialysis,” “renal dialysis,” “maintenance hemodialysis,” “elderly maintenance hemodialysis,” “multiple theory model,” “rehabilitation,” “exercise intervention,” “physical function,” “body function,” “physical function,” etc. The search time range was set from the establishment of each database to June 2025. After screening, a total of 12 relevant articles were included^[11–22]. The research team used the multiple theory model as the theoretical framework, completed the quality evaluation and evidence content extraction of the included literature, and initially drafted the intervention plan.

2.2.2. Expert consultation

A total of 15 experts from tertiary grade A hospitals and universities in Beijing, Tianjin, etc. were selected. Inclusion criteria: (1) Clinical or management position in cardiovascular internal medicine for ≥ 10 years; (2) Bachelor’s degree or above, intermediate or above professional title; among them, 11 were female and 4 were male; age 42 to 62 years, average (52.33 ± 6.77) years; working years 20 to 41 years, average (30.46 ± 6.77) years; professional fields: 4 in nephrology nursing, 5 in hemodialysis nursing, 5 in geriatric nursing, 1 exercise rehabilitationist. All experts gave informed consent and voluntarily participated in this study. The first round of expert consultation was sent out in the form of an email questionnaire in July 2025, and all 15 questionnaires were recovered, with a recovery rate of 100%. Based on the feedback from the experts, the questionnaire was revised, and the second round of expert consultation was initiated in August of the same year, with a total of 15 questionnaires sent out and 13 recovered, a recovery rate of 86.7%. The expert authority coefficients of the two rounds of inquiries were 0.85 and 0.86, respectively, indicating that the expert opinions were highly reliable. The coefficient of variation for each item fluctuated between 0 and 0.14. The Kendall’s coefficient of agreement for the two rounds was 0.224 and 0.305, respectively, suggesting that the consistency of expert ratings in the two rounds reached a statistically significant level, and the consistency in the second round was higher than that in the first round. Based on the experts’ ratings and suggestions, the intervention plan was further optimized, and a final draft version was formed.

2.2.3. Pre-experiment

According to the established inclusion and exclusion criteria, a total of 10 elderly patients undergoing maintenance hemodialysis (including 5 in the control group and 5 in the intervention group) were included. A 4-week pre-experiment was conducted. After the pre-experiment, interviews were conducted with the above patients to obtain their actual experiences and subjective feedback. The interview outline covered the following contents: (1) The specific mastery level of the patients regarding the knowledge and operation methods related to exercise during dialysis, as well as the aspects that they were still not proficient in; (2) Whether they could complete the training according to the current plan and provide specific improvement suggestions or adjustment recommendations for the plan; (3) The family and medical support they felt and their expectations.

Based on the interview results, the plan was optimized, and a final draft version of the exercise intervention plan was formed.

2.2.4. Implementation of the intervention plan

(1) Training and assessment: Before the implementation of the intervention measures, the doctors and

head nurses of the hemodialysis unit conducted a one-week systematic training for the team members. The specific training contents included basic theoretical knowledge, operational procedures, safety monitoring points, questionnaire completion, result index assessment methods, and emergency response strategies. After the training, theoretical and operational assessments were conducted to ensure that all operations met the standards.

- (2) Project implementation: Exercises were arranged to be conducted 30 minutes to 2 hours after each dialysis treatment, but the limbs connected to the catheters did not participate in any exercises. The exercise frequency was three times per week, and the intervention lasted for 12 weeks. After the patients were enrolled, the team members were responsible for explaining relevant exercise knowledge and providing action guidance; the rehabilitation therapist evaluated the patient's physical condition based on the patient's physical function status, and accordingly formulated the exercise mode and gradually increased the duration and intensity of the exercise. The established plan must be strictly followed throughout the implementation process, and corresponding records must be made.

3. Application of the exercise intervention plan for maintenance hemodialysis patients

3.1. Research subjects

Using the convenience sampling method, elderly patients undergoing maintenance hemodialysis in two tertiary grade A hospitals in Hebei Province from September 2025 to February 2026 were selected as research subjects.

3.1.1. Inclusion criteria

- (1) Conforming to the diagnostic criteria for end-stage renal disease stipulated in the "Guidelines for Early Screening, Diagnosis and Prevention of Chronic Kidney Disease," receiving maintenance hemodialysis ≥ 3 times per week, and undergoing dialysis treatment for ≥ 3 months^[23];
- (2) Age ≥ 60 years old;
- (3) Muscle strength ≥ 3 levels, without limb disability;
- (4) Conscious and able to communicate normally;
- (5) Providing informed consent and voluntarily participating in this study.

3.1.2. Exclusion criteria

- (1) Patients with severe complications, such as heart failure, malignant tumors;
- (2) Patients with severe lower limb thrombosis, spinal or joint diseases that prevent movement;
- (3) Severe renal osteopathy;
- (4) Lower limb catheterization.

3.1.3. Withdrawal and dropout criteria

- (1) Patients requiring hospitalization due to disease changes;
- (2) Patients unable to adhere to the exercise plan;
- (3) Patients who died during the study period.

Sample size estimation was based on the formula for comparing two sample means $n1 = n2 = 2[(u + u)$

$\sigma/\delta]$, with a two-sided $\alpha = 0.05$ and $\beta = 0.10$. From the table, $u = 1.96$ and $u = 1.28$. Using the simple physical function score as the main outcome indicator, 10 patients (5 in each group) were selected for a pre-test. Based on the pre-test results, the simple physical function score of the intervention group was (7.80 ± 1.48) points, and that of the control group was (6.40 ± 2.07) points. Based on this, the overall standard deviation $\sigma = 1.7$, and the mean difference $\delta = 1.4$ were estimated. Substituting into the formula, $n_1 = n_2 = 31$. Considering a 10% dropout rate, at least 68 cases were required for both groups. This study actually included 70 cases, with those receiving dialysis on Mondays, Wednesdays, and Fridays set as the control group (35 cases), and those on Tuesdays, Thursdays, and Saturdays set as the intervention group (35 cases). All patients completed the entire study. This study has been approved by the hospital ethics committee (approval number: 2025 Scientific Ethics Review No.466), and all participants have signed informed consent forms.

3.2. Intervention methods

3.2.1. Intervention method for the control group

The control group received routine care.

- (1) The duration of the group health education was set between 20 and 30 minutes. After the patients were enrolled, the responsible nurse would give a group lecture, instructing the patients to perform aerobic and resistance exercises within 30 minutes after dialysis. Each session involved cycling on the bed for 10 to 15 minutes, and the exercise intensity was determined based on the Rating of Perceived Exertion (RPE) at 11 to 13 points ^[24]. The exercises were conducted three times a week. At the same time, the nurse would explain the basic knowledge of end-stage renal disease, hemodialysis, treatment principles, vascular access maintenance, identification of common complications, and nursing methods.
- (2) In terms of dialysis care, before dialysis, the patient's physiological condition would be assessed, precautions would be informed, and preparations would be assisted. During the dialysis process, health education would be strengthened, vascular access protection would be ensured, the machine would be kept running properly, and dialysis adequacy would be guaranteed. After the dialysis, the patient's vital signs, fluid output, weight, and disconnection time would be recorded.
- (3) Dietary care required the patient to follow a high-quality, high-protein, low-potassium, and low-sodium diet plan, and to strictly control weight and fluid intake.
- (4) Routine follow-up was conducted according to the department's standards through regular phone or outpatient follow-up, with the aim of answering patients' questions, but no additional systematic exercise guidance was provided.

3.2.2. Intervention method for the experimental group

The experimental group received the intervention measures of the control group in addition to the intervention plan for maintenance hemodialysis patients based on multiple theoretical models, as detailed in **Table 1**.

Table 1. Exercise intervention scheme for elderly patients on maintenance hemodialysis

Intervention	Intervention time	Intervention content
Participatory conversation	After being enrolled: Discuss for 30 minutes	1. Promotion of health knowledge: Discuss the benefits of the two-way communication exercise for MHD patients, explore the drawbacks of long-term lack of exercise and movement disorders, analyze the current difficulties, and discuss the corresponding solutions. 2. Explain the exercise manual (including knowledge, duration, frequency, and precautions regarding exercise during dialysis).
Behavioral confidence	After being enrolled: Discuss and practice for 30 minutes	1. Expert lectures and nurse skill practice: Explain the movement techniques and key points. 2. Sharing success stories: Share in the group the successful cases where exercise improved physical functions, muscle strength, and quality of life. Regularly share relevant knowledge about blood dialysis exercises and prevention of complications to enhance self-confidence. 3. Understanding and familiarizing with the goals and plans of exercise during dialysis: Follow the principle of “gradual progress,” break down complex exercises into simple steps, and each movement can be repeated 8 to 10 times. The exercises mainly include: (1) warm-up exercises; (2) resistance exercises; (3) intermittent rest; (4) aerobic exercises; (5) stretching exercises;
Change in physical environment	The entire intervention process	1. Fitness equipment: Provide equipment such as resistance bands and bed-mounted exercise bikes, and offer guidance on their use. 2. WeChat Sports: Enable the WeChat Sports function, conduct daily step count statistics, organize WeChat group step challenges, and reward those who perform well.
Emotional transformation	The entire intervention process	1. Proactively inquire about the patient’s fear of exercise (informing the patient that “most patients have similar feelings when they first start exercising, and through gradual exercise, they feel the benefits of exercise and gradually become familiar with the intensity and frequency of exercise; their feelings will gradually improve”); 2. Encourage positive feedback from warm-up through safety demonstrations; Using cognitive restructuring techniques (such as changing “I can’t do it” to “I currently lack strength, but can gradually increase”) to help patients establish positive emotions.
Practice of behavioral change	Set up an exercise plan and goals:	Early stage (1-4 weeks):30 minutes (1) Warm-up exercise (RPE<10, 5min): Except for the arm on the puncture side, all joints should be moved: wrist, elbow, shoulder, knee, hip, deep breathing and relaxation for 5 times; (2) Resistance exercise (RPE11~12,8min): Knee joint flexion and extension resistance exercise: Participants slowly bend and extend the knee joint, keep the foot on the bed, bend the knee about 90 degrees, and then straighten the leg and place it flat on the bed; Supine straight leg lifting resistance exercise: Participants straighten their knee joints, lift their legs off the bed, feel resistance, and then slowly lower them; (3) Intermittent rest (3 minutes): abdominal breathing or relaxation training (4) Aerobic exercise (RPE11~12,8min) on a bed bike: relax the neck, tighten the abdomen, keep the upper body still, and slowly take deep breaths throughout the exercise; Assist patients in placing themselves in a comfortable lying position, with their feet naturally relaxed and ready to be placed on the pedals. Start applying force clockwise, gradually increasing the speed; (5) Stretching exercise (RPE<10,5min): Neck stretching: Move the head closer to the left and right shoulders and feel the muscles on both sides of the neck being stretched; Arm extension: Extend the arm, fix the shoulder joint, and bend and straighten the elbow; Shoulder shrugging rotation: Lift the shoulders up and rotate around the shoulder joint; Chest and upper back extension: The patient lies on the right side and stretches the left upper limb backwards, feeling the chest muscles being stretched and the back muscles being stretched. Switch to the other side; Mid-term (5-8 weeks):35 min (1) Warm-up exercise: Same as above (2) Resistance exercise (RPE12-13,11min): Increase on the basis of 1-4 weeks, supine hip abduction resistance exercise: Participants straighten their knee joints, lift their legs off the bed, and abduct their hip joints by opening them outward until resistance is felt, then restore

		the knee joints to their starting position; (3) Intermittent rest: Same as above (4) Aerobic exercise (RPE12-13,11 min): Bedtime cycling. (5) Stretching exercise: Same as above Late stage (9-12 weeks):40 minutes (1) Warm-up exercise: Same as above
Practice of behavioral change	Set up an exercise plan and goals:	(2) Resistance exercise (RPE13-14,14min): Increase on the basis of mid-term exercise. Hip joint flexion and extension resistance exercise: Participants bend their knees and hip joints, lift their feet off the bed, and bend the hip joint towards the abdomen until resistance is felt, and the knee joint returns to the starting position. (3) Intermittent rest: Same as above (4) Aerobic exercise (RPE12-13, 14 min): Bedtime cycling. (5) Stretching exercise: Same as above
		Notes: 1. Exercise taboos: The arm with a catheter pathway should not participate in resistance and aerobic exercise. 2. Exercise frequency: Three times a week, scheduled on dialysis days. Each exercise consists of at least one set of 20 to 30 repetitions, while maintaining the intensity of the exercise within a subjective perceived fatigue level of 11 to 13 points 3. Safety monitoring: ask about their physical condition before exercising; measure blood pressure, heart rate, and blood sugar for patients with diabetes. During exercise, monitor blood pressure and heart rate every 20 minutes to keep them within the maximum reserve heart rate range of $\leq 70\%$ to 80%, with an RPE score of ≤ 15 points. Also, pay attention to discomfort symptoms such as chest pain and dizziness, and ensure the safety of the puncture site and tubing. After exercise, observe the patient's condition, record blood pressure and heart rate, and any discomfort symptoms. 4. Stop indicators: If any of the following conditions occur, immediately stop the operation: chest, arm, neck, or jaw pain or compression, severe chest tightness, shortness of breath, headache, dizziness, fainting, fatigue, severe arrhythmia, unbearable muscle spasms or joint pain, blood pressure above 220/105mmHg. For patients with hypertension, dialysis catheter detachment, bleeding, or machine failure.
Practice of behavioral change	Set up an exercise plan and goals:	
Change in the social environment	The entire intervention process	1. Medical support: Provide patients with corresponding guidance during the intervention process. After the intervention, a weekly phone follow-up will be conducted in the first month, and a biweekly follow-up will be conducted in the second month. 2. Peer support: Establish mutual aid groups through WeChat groups, allowing patients to communicate and interact with each other, thereby achieving the goal of common learning. 3. Family support: Provide psychological support to boost confidence, allowing family members to participate in suitable activities such as walking and Tai Chi together.

3.3. Evaluation tools

3.3.1. Simple Physical Performance Battery (SPPB)

The Simple Physical Performance Battery (Short Physical Performance Battery, SPPB) is a commonly used tool for assessing overall physical function^[25]. It consists of three parts: balance test, walking speed measurement, and five sit-to-stand tests. In the balance test, the duration of each of the three postures (toes together, half-parallel standing, parallel standing) that the subject maintains is recorded. The walking speed test requires the subject to walk as fast as possible for 4 meters, with two measurements taken, and the shorter time is used as the scoring basis. The five sitting-to-standing tests include the subject crossing their hands in front of their chest and performing five “stand-up — sit-down” movements as quickly as possible, with the time taken recorded. The scoring range for each test is 0 to 4 points, and the total score ranges from 0 to 12 points. The higher the score, the better the physical function. The scores are classified into grades based on the total score: 0 to 6 points indicate poor physical function, to 9 points indicate a medium level, and 10 to 12 points indicate good physical function.

3.3.2. 6-Minute Walk test (6MWT)

The 6-Minute Walk test (6-Minute Walk test, 6MWT) is an objective measurement indicator used to assess the patient's exercise endurance ^[26]. During the test, the subject walks along a 30-meter straight corridor, and the maximum distance they can walk in 6 minutes is recorded. The walking distance is divided into four grades: Grade 1 is less than 300 meters, Grade 2 is between 300 and 374 meters, Grade 3 is between 375 and 449 meters, and Grade 4 is 450 meters or more. A shorter walking distance indicates poor exercise endurance.

3.3.3. Lower limb muscle strength

The Five-times-sit-to-stand test (Five-times-sit-to-stand test, FTSST) is used to assess the lower limb muscle strength of the elderly ^[27]. During the test, the subject sits on a chair about 43 centimeters high without armrests, with hands crossed in front of the chest, back straight, and feet flat on the ground. The subject needs to complete 5 consecutive “stand-up—sit-down” actions as quickly as possible, with each measurement repeated 3 times, and the average value is taken as the final result.

3.3.4. Exercise self-efficacy

Exercise Self-Efficacy Scale (Exercise Self-Efficacy Scale, ESE) is used to assess and measure the confidence level of patients in adhering to exercise ^[28]. This scale was originally developed by Bandura and later translated into Chinese by Tung et al. and adapted for cross-cultural use. The scale contains 18 items and uses the Likert 3-point rating method, with options including “completely confident,” “half confident,” and “completely unconfident.” The total score is calculated by adding the scores of each item, dividing by 18, and then multiplying by 100%. If the score is below 50 points on a 100-point scale, it indicates low self-efficacy; the higher the score, the stronger the patient's confidence in exercise. This scale has been validated in the chronic disease patient population and shows good reliability and validity, with a Cronbach's alpha coefficient of 0.966.

3.3.5. Exercise compliance scale

The exercise compliance questionnaire developed by Li Xue et al. was used for assessment ^[29]. This tool consists of 3 dimensions and a total of 12 items: physical exercise compliance 6 items, exercise monitoring compliance 3 items, and active seeking advice compliance 3 items. The scoring is based on a 4-point rating system (ranging from 1 to 4 points), with corresponding scores for each option as follows: “completely unable to do” is 1 point, “occasionally able to do” is 2 points, “basically able to do” is 3 points, and “completely able to do” is 4 points. The total score of the questionnaire ranges from 12 to 48. The higher the score, the better the patient's exercise compliance. The Cronbach's α coefficient of this scale is 0.87.

3.4. Data collection and quality control methods

In this study, data collection was conducted at four time points: before the intervention began, 4 weeks after the intervention, 8 weeks after the intervention, and 12 weeks after the intervention. All assessments were completed by the research team members within 20 minutes after each hemodialysis treatment of the patients. Before the formal data collection began, all members involved in data collection were uniformly trained, and it was required that the two assessors maintain consistent measurement results for the same research subject at the same time point.

3.5. Statistical methods

Data analysis was completed using SPSS 29.0 software. For continuous variables that followed a normal distribution, they were described by the mean $\pm$ standard deviation ($\bar{x} \pm s$), and the comparison between groups was conducted using the independent-samples *t*-test; for continuous variables that did not follow a normal distribution, they were expressed by the median (interquartile range) [M(P25, P75)], and the comparison between groups was performed using the Mann-Whitney U test. Categorical variables were described by frequency and percentage, and the differences between groups were analyzed using the χ^2 test, Fisher's exact probability method, or rank sum test. For comparisons between groups at different time points, repeated measures analysis of variance or generalized estimating equations were selected based on the characteristics of the data distribution. The significance level of the test was set at $\alpha = 0.05$, and any *P* value less than 0.05 was considered statistically significant.

4. Results

4.1. Comparison of general data between the two groups

The comparison of general data between the two groups is shown in **Table 2**.

Table 2. Baseline comparison of 2 groups before intervention

Variable		Control group (n=35)	Intervention group (n=35)	Statistic	P value
Age (years, $\bar{x} \pm s$)		72.23 $\pm$ 3.200	72.06 $\pm$ 2.700	0.242 ¹⁾	0.809
Gender [Example (Percentage, %)]	Man	20	21	0.059 ²⁾	0.808
	Woman	15	14		
BMI (kg/m ² , $\bar{x} \pm s$)		23.50 $\pm$ 2.890	23.75 $\pm$ 3.759	- 0.309 ¹⁾	0.759
Smoking [Example, (percentage, %)]	Yes	7	9	0.324 ²⁾	0.569
	No	28	26		
Drinking alcohol [Example, (percentage, %)]	Yes	12	6	2.692 ²⁾	0.101
	No	23	29		
Educational attainment [Example (percentage, %)]	Primary school and below	17	17	- 0.285 ³⁾	0.776
	Middle school	11	8		
	High school or vocational school	4	7		
	University or above	3	3		
Living situation [example (percentage, %)]	Living with spouse and children	7	11	2.157 ⁴⁾	0.556
	Living with children	11	11		
	Living with spouse	14	9		
	Living alone	3	4		
Medical payment [example (percentage, %)]	Provincial medical insurance	12	10	0.527 ⁴⁾	0.896
	City medical insurance	22	24		
	Self-payment	1	1		

Variable		Control group (n=35)	Intervention group (n=35)	Statistic	P value
Occupation [example (percentage, %)]	Employed	6	7	0.007 ³⁾	0.995
	Retired	22	20		
	Unemployed	7	8		
Dialysis duration (months, $\bar{X} \pm s$)		38.77±13.975	35.00±16.803	1.021 ¹⁾	0.311
Primary disease [example (percentage, %)]	Kidney disease	16	19	0.886 ⁴⁾	0.959
	diabetes	9	8		
	hypertension	3	3		
	Polycystic kidney	4	3		
Complications [Examples (percentage, %)]	Kidney stones	3	2	1.197 ²⁾	0.274
	≥3types	28	24		
	<3types	7	11		

Note: 1) t value; 2) χ^2 value; 3) Z value; 4) Fisher's exact probability method.

4.2. Comparison of simple physical function scores at different time points between the two groups

Table 3 shows the comparison of simple physical function scores at different time points between the two groups.

Table 3. Comparison of simple physical function scores at different times between the two groups

Group	Sample	Baseline	4 weeks of intervention	8 weeks of intervention	12 weeks of intervention
Control group	35	6.00 (5.00, 7.00)	7.00 (6.00, 8.00)	7.00 (6.00, 9.00)	8.00 (7.00, 9.00)
Intervention group	35	7.00 (6.00, 8.00)	8.00 (7.00, 9.00)	9.00 (8.00, 9.00)	9.00 (9.00, 10.00)
Z value		2.251	2.337	3.770	4.693
P value		0.024	0.019	<0.001	<0.001

Note: Wald $\chi^2_{\text{between groups}}=63.000$, Wald $\chi^2_{\text{time}}=171.614$, Wald $\chi^2_{\text{interaction}}=8.211$, all $P<0.05$.

4.3. Comparison of 6-minute walking test distances between two groups at different times

Table 4 shows the comparison of 6-minute walking test distances between two groups at different times.

Table 4. Comparison of 6-minute walking test results between the two groups at different times

Group	Sample	Baseline	4 weeks of intervention	8 weeks of intervention	12 weeks of intervention
Control group	35	334.23±13.23	334.89±13.14	335.37±13.38	336.66±14.07
Intervention group	35	336.11±12.22	340.63±12.65	344.97±12.69	349.09±12.74
t value		-0.619	-1.862	-3.080	-3.873
P value		0.538	0.067	0.003	<0.001

Note: $F_{\text{time}}=147.726$, $F_{\text{group}}=5.799$, $F_{\text{interaction}}=71.769$, $P_{\text{time}}=<0.001$, $P_{\text{group}}=<0.019$, $P_{\text{interaction}}=<0.001$.

4.4. Comparison of lower limb muscle strength between two groups at different times

Table 5 shows the comparison of 6-minute walking test distances between two groups at different times.

Table 5. Comparison of lower limb muscle strength at different times between the two groups

Group	Sample	Baseline	4 weeks of intervention	8 weeks of intervention	12 weeks of intervention
Control group	35	16.84±1.66	17.08±1.34	17.15±0.60	17.71±0.75
Intervention group	35	17.37±0.92	18.62±0.93	19.78±0.88	20.95±0.98
<i>t</i> value		-1.666	-5.548	-14.566	-15.435
<i>P</i> value		0.102	<0.001	<0.001	<0.001

Note: $F_{\text{time}}=68.726$, $F_{\text{group}}=155.551$, $F_{\text{interaction}}=27.469$, $P_{\text{time}}=<0.001$, $P_{\text{group}}=<0.001$, $P_{\text{interaction}}=<0.001$.

4.5. Comparison of self-efficacy scores for exercise at different times between two groups

Table 6 shows the comparison of self-efficacy scores for exercise at different times between two groups.

Table 6. Comparison of self-efficacy scores for exercise at different times between the two groups

Group	Sample	Baseline	4 weeks of intervention	8 weeks of intervention	12 weeks of intervention
Control group	35	54.76 (50.00, 58.33)	55.63 (52.77, 61.11)	56.82 (52.77, 58.33)	57.93 (52.77, 58.33)
Intervention group	35	58.41 (55.55, 63.88)	62.06 (55.55, 69.44)	66.10 (61.11, 69.44)	70.47 (63.88, 75.00)
<i>Z</i> value		1.104	2.265	5.068	5.822
<i>P</i> value		0.269	0.024	<0.001	<0.001

Note: Wald $\chi^2_{\text{between groups}}=47.490$, Wald $\chi^2_{\text{time}}=32.987$, Wald $\chi^2_{\text{interaction}}=10.966$, all $P<0.05$.

4.6. Comparison of exercise compliance scores between two groups at different times

Table 7 shows the comparison of exercise compliance scores between two groups at different times.

Table 7. Comparison of movement compliance scores at different times between the two groups

Group	Sample	Baseline	4 weeks of intervention	8 weeks of intervention	12 weeks of intervention
Control group	35	24.00 (23.00, 25.00)	25.00 (24.00, 27.00)	26.00 (26.00, 27.00)	27.00 (27.00, 28.00)
Intervention group	35	24.00 (24.00, 26.00)	28.00 (28.00, 29.00)	31.00 (31.00, 32.00)	33.00 (33.00, 34.00)
<i>Z</i> value		0.132	5.257	6.746	6.481
<i>P</i> value		0.895	<0.001	<0.001	<0.001

Note: Wald $\chi^2_{\text{between groups}}=186.513$, Wald $\chi^2_{\text{time}}=401.756$, Wald $\chi^2_{\text{interaction}}=91.330$, all $P<0.05$.

5. Discussion

5.1. Exercise intervention can improve the physical function of elderly maintenance hemodialysis patients

Elderly MHD patients often suffer from complications such as anemia, muscle atrophy, and osteoporosis due to long-term uremia and dialysis treatment, resulting in decreased exercise endurance, muscle weakness, and limitations in daily activities. Long-term lack of physical activity will further accelerate the deterioration of physical function [30–31]. The results of this study show that after 12 weeks of exercise intervention during

dialysis, the SPPB score of the intervention group improved significantly compared to the control group, and the improvement trend became more obvious as the intervention time increased, suggesting that exercise intervention during dialysis can effectively improve the physical function of elderly MHD patients. This result is consistent with that of Jofré-Saldía E et al. ^[32]. Analyzing the reasons, regular exercise training can increase the patient's physical activity level, improve lower limb stability, and enhance daily activity ability. This study adopts an aerobic exercise combined with resistance exercise mode during dialysis, and gradually increases the exercise time and intensity according to the patient's tolerance, which helps the patient gradually establish exercise adaptability and thereby improve overall physical function. Different from previous studies that mainly focused on exercise methods and training intensity, this study innovatively introduces the multi-theoretical model (MTM) into the exercise management of elderly MHD patients during dialysis. It not only focuses on short-term improvement of physical function but also emphasizes the establishment and long-term maintenance of exercise behavior. By integrating behavioral change strategies such as behavior initiation, behavior maintenance, social support, and continuous follow-up into the entire process of exercise during dialysis, this study constructs a comprehensive intervention model combining "functional training + behavior management," breaking through the limitation of traditional exercise intervention in dialysis that only emphasizes the exercise prescription itself. The results suggest that the exercise management model based on multiple theoretical models is more in line with the long-term rehabilitation characteristics and chronic disease management needs of elderly hemodialysis patients. Therefore, this study not only verifies the effectiveness of exercise intervention during dialysis in improving the physical function of elderly MHD patients, but also further explores the application value of behavioral theory in exercise management during dialysis, providing a new theoretical basis and practical references for the long-term rehabilitation care of elderly MHD patients.

5.2. Exercise intervention can improve the muscle strength and exercise endurance of elderly maintenance hemodialysis patients.

Long-term uremia can lead to toxin accumulation, chronic micro-inflammatory response, and protein-energy consumption. At the same time, the patient's daily activity volume decreases, and progressive muscle atrophy and decline in cardiopulmonary function occur, which in turn leads to decreased lower limb muscle strength and shortened 6-minute walking distance, increasing the risk of falls and functional impairment. The results of this study show that after 12 weeks of exercise intervention, the lower limb muscle strength and 6-minute walking distance of the intervention group were significantly improved compared to the control group, and the improvement effect became more significant as the intervention time increased, suggesting that exercise intervention during dialysis can continuously improve the muscle strength and exercise endurance of elderly MHD patients. This result is consistent with that of Bae YH et al. ^[33]. The mechanism may be related to the synergistic effect of aerobic exercise combined with resistance exercise. This study adopts a phased progressive exercise plan and regularly conducts bed cycling training and lower limb resistance training during dialysis. Aerobic exercise can improve cardiopulmonary endurance and oxygen metabolism levels, while resistance exercise helps to enhance lower limb muscle strength, delay muscle function deterioration, and, at the same time, stretching and relaxation training before and after exercise can improve exercise tolerance and reduce the risk of exercise injury. Existing studies have shown that regular aerobic exercise can increase 6-minute walking distance and improve physical function ^[34]. In addition, this study innovatively

adopts individualized and progressive exercise training strategies for elderly MHD patients, adjusting the exercise time and intensity dynamically according to the patient's tolerance, making the exercise plan more in line with the physiological characteristics and rehabilitation needs of elderly patients. This combined model of “dialysis treatment—exercise training—functional recovery” helps improve the safety of patients' exercise and their long-term participation rate. It embodies the concept of precise exercise rehabilitation management for elderly dialysis patients and has good clinical promotion value.

5.3. Exercise intervention can improve the exercise self-efficacy and exercise compliance of elderly maintenance hemodialysis patients.

Due to the long-term disease burden, continuous fatigue, and decreased activity ability of elderly hemodialysis patients, they often have concerns about the safety of exercise and lack the confidence and motivation to continuously participate in exercise, which leads to low exercise compliance^[35]. The results of this study show that the exercise intervention based on multiple theoretical models during dialysis can effectively improve the exercise self-efficacy and exercise compliance of patients, and the improvement effect becomes more obvious with the extension of intervention time. This result is consistent with the research results of Liu Yibing et al.^[36]. The study believes that the mechanism may be related to the dual structure of “behavior initiation” and “behavior maintenance” in the multiple theoretical models. In the behavior initiation stage, through health education, exercise risk cognition intervention, and professional guidance, the patients' understanding of the safety of exercise during dialysis and the health benefits is enhanced, and the confidence in exercise behavior is strengthened; in the behavior maintenance stage, measures such as individualized goal setting, WeChat group interaction, peer support, family support, and continuous follow-up are adopted to strengthen the positive experience of patients' active behavior and promote the long-term maintenance of exercise behavior. The innovation of this study lies in the first time that a multiple theoretical model is systematically applied to the entire process of exercise behavior management during dialysis for elderly MHD patients, integrating the behavior change theory with exercise intervention during dialysis. Different from previous studies that only focus on exercise form or exercise intensity, this study pays more attention to “how to promote patients to persist in exercise for a long time,” and constructs a continuous intervention path of “exercise training + behavior management + continuous support” through social support, behavior reinforcement, and continuous feedback mechanisms. The research results show that this model can form an “exercise improves function—function enhances confidence—confidence promotes persistence” positive cycle, thereby improving patients' exercise initiative and long-term compliance. Therefore, the exercise intervention model based on multiple theoretical models during dialysis not only helps to improve the patients' functional status, but also provides a new theoretical basis and practical reference for the long-term behavior management and continuous rehabilitation care of hemodialysis patients.

6. Summary

This study constructs an exercise intervention plan based on multiple theoretical models and applies it to elderly MHD patients. The results show that this intervention model can effectively improve the patients' physical function, lower limb muscle strength, and exercise endurance, while enhancing exercise self-efficacy and exercise compliance. With the extension of intervention time, the exercise behavior and functional status of the patients show a continuous improvement trend. The innovation of this study lies in integrating

the multiple theoretical model system into the entire process of exercise behavior management during dialysis, not only focusing on exercise training itself, but also emphasizing the establishment and long-term maintenance of exercise behavior. Through strategies such as behavior initiation, behavior maintenance, social support, and continuous follow-up, a comprehensive intervention model combining “exercise training + behavior management + continuous support” is constructed, which helps to promote patients’ long-term exercise persistence and form a continuous healthy behavior cycle. Therefore, the exercise intervention model based on MTM during dialysis is more in line with the characteristics of long-term chronic disease management for elderly MHD patients, and provides new intervention ideas for the long-term exercise behavior management and continuous rehabilitation care of elderly MHD patients.

However, it should be pointed out that the sample size of this study is small, which may limit the statistical test efficacy and the extrapolation ability of the research conclusion to some extent. At the same time, since the intervention only lasted for 12 weeks, the long-term benefits of this intervention are not yet very clear. Further research is recommended to further improve the exercise intervention plan based on multiple theoretical models and to adopt a multi-center, large-sample randomized controlled trial design, so as to better test the potential of the application of this plan.

Disclosure statement

The authors declare no conflict of interest.

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A Study on the Pathways for Artificial Intelligence to Reconstruct the “Health Assessment” Course from the Perspective of Integration of Industry, Education, and Innovation

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Abstract: Driven by the dual imperatives of national vocational education reform and the “Healthy China” strategy, nursing education is undergoing a fundamental transformation from skill transmission to the cultivation of “digital and intelligent literacy” and innovative competence. Focusing on the core module Health Assessment in vocational undergraduate nursing programs, this paper explores innovative pathways for restructuring the curriculum through artificial intelligence (AI) within the theoretical framework of “integration of industry, education, and innovation.” The study analyzes traditional teaching challenges—clinical practice barriers, unitary assessment methods, and disconnection from industry frontiers—and demonstrates the necessity of AI empowerment. It constructs a trichain synergy model (education chain, industry chain, innovation chain) to guide curriculum reform. Four core pathways are elaborated: reshaping objectives and content, innovating methods and resources, reforming evaluation through datadriven approaches, and building collaborative platforms with robust mechanisms. Drawing on international trends, the paper also proposes safeguard measures. The research aims to provide a theoretical reference and practical blueprint for the digital transformation of vocational undergraduate nursing education.

Keywords: Integration of industry; Education and innovation; Artificial intelligence (AI); Health assessment

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1. Introduction

Health assessment serves as a bridge course connecting basic medicine and clinical nursing, and its quality is crucial for fostering clinical thinking skills among nursing students. The integration of big data and artificial intelligence technologies into the healthcare sector has transformed nursing practice from experience-driven to data-driven approaches, and from manual operations to human-machine collaboration ^[1]. The application

of smart hospitals, wearable devices, and AI-assisted decision support systems has imposed new demands for “digital and cognitive literacy” on nursing professionals.

Professional undergraduate education aims to cultivate high-level technical and skilled professionals with “solid foundational knowledge, strong practical skills, and innovative capabilities.” However, current health assessment curricula still adhere to the models of specialized or general undergraduate programs, exhibiting significant deficiencies in content, practical training, and evaluation methods, making them inadequate for meeting the demands of the smart healthcare era ^[2].

“The integration of industry and education, along with school-enterprise collaboration,” constitutes the fundamental approach to vocational education. The concept of “industry-education-innovation integration” incorporates industrial demands, educational instruction, and innovation/entrepreneurship practices into a unified framework, while AI technology offers new solutions to teaching challenges. Incorporating AI into health assessment courses represents not merely an upgrade in teaching methods but also a systematic overhaul of curriculum objectives, content, evaluation systems, and the overall educational ecosystem.

Based on these insights, this study examines the practical realities of vocational undergraduate nursing education and explores pathways for reconstructing AI-enhanced health assessment courses from the perspective of industry-education-innovation integration. It addresses key questions: how AI can overcome traditional limitations, how the industry-education-innovation integration concept guides this restructuring, and how implementation plans and supporting mechanisms should be designed, aiming to provide references for curriculum reform in similar institutions.

2. Challenges and AI-enabling opportunities in traditional health assessment course teaching

The current undergraduate nursing health assessment curriculum faces multiple challenges, which serve as both a practical impetus for curriculum reform and a clear direction for leveraging AI technology.

2.1. Core teaching challenges

Significant barriers exist in clinical practice: The skills required for physical examinations—such as visual inspection, palpation, percussion, auscultation, and olfaction—demand repeated practice; however, patient resources are limited, and the assessment of critical illnesses and infectious diseases involves ethical considerations, leaving students with few opportunities to engage hands-on and resulting in slow acquisition of practical experience. Insufficient representation of dynamism and complexity: Traditional teaching relies heavily on static text cases or standardized patients (SPs), making it difficult to demonstrate the continuous changes in vital signs, disease progression, and the complexity of multi-system interactions ^[3]. Students lack a deep understanding that assessment is a continuous, dynamic, and comprehensive process. Evaluation methods are subjective and one-sided: assessments often depend on instructors’ subjective ratings, lack traceability, and employ no advanced evaluation tools. Although smart monitoring devices have become widely adopted in clinical settings, relevant curriculum coverage remains inadequate, forcing graduates to relearn these technologies when entering the field of smart healthcare. Weak support for personalized learning: Under large-class teaching models, instructors have limited capacity to address individual differences.

2.2. Opportunities and value of AI empowerment

Artificial intelligence technology offers new possibilities for addressing the aforementioned challenges: Overcoming temporal, spatial, and ethical constraints: VR/AR/MR (virtual/augmented/hybrid reality) technologies can create virtual simulation training environments^[4]. Students practice complex clinical cases and protective procedures in virtual wards, compensating for insufficient practical resources. Simulating dynamic and complex scenarios: AI-driven intelligent dynamic case systems can simulate nonlinear changes in disease progression over time and under various interventions, enabling students to assess continuity and decision-making adjustments, thereby fostering dynamic clinical thinking. Achieving precise and intelligent evaluation: Leveraging computer vision technologies, systems can collect operational data and provide objective assessments and improvement recommendations through machine learning analysis. Integrating with smart clinical practices: Advanced electronic health records, wearable device parameters, and medical imaging data can serve as teaching materials. Combined with data analysis tools (e.g., Python, BI tools), these resources guide students in conducting data-driven health risk assessments and adapting to data-driven nursing practice models. Supporting personalized adaptive learning: AI systems can recommend tailored learning pathways and resources based on individual learning behaviors, enabling customized education.

3. The concept of “integration of industry, education, and innovation” and related educational theories

“The integration of industry, education, and innovation” serves as the core concept guiding this curriculum restructuring, combined with a series of modern educational theories to form the logical foundation for reform.

3.1. The connotation of “industry-education-innovation integration” and the “three-chain synergy” model

“Industry-Education-Innovation Integration” represents an advanced development of industry-education collaboration, with its core objective being to break down barriers between employment, education, and innovation while establishing a closed-loop ecosystem that mutually reinforces each other^[5]. In vocational undergraduate nursing education, this is specifically manifested as follows: Employment Chain — Demand-Side Guidance: Starting from the demand for digital literacy and innovation capabilities in fields such as smart healthcare and elderly care, it informs the setting of educational objectives and curriculum content. Education Chain — Supply-Side Reform: Guided by industrial needs, it drives systematic restructuring of curriculum frameworks and assessment standards, integrating cutting-edge technology and innovation cultivation throughout the entire educational process. Innovation Chain-Momentum Transformation and Value Enhancement: It uses technological, practical, and service model innovations as bridges connecting industry and education, facilitates the transformation of new technologies into teaching tools, and encourages both faculty and students to contribute back to industry through technology commercialization.

3.2. Supportive education theory

Outcomes-Based Education (OBE): Emphasizes that teaching should be designed in reverse based on the learning outcomes students are ultimately expected to achieve. In AI-driven curriculum redesign, it is essential to first define the “digital-intelligent” assessment competencies students should possess, thereby

guiding both instruction and evaluation. Situational Learning Theory ^[6]: Posits that learning is a process of interacting with the environment and others within real or simulated contexts. VR/AR simulations create realistic professional scenarios, enabling students to construct knowledge and develop professional identity through assessment tasks. Constructivism highlights learners' active construction of knowledge; inquiry-based learning and data-driven case studies facilitate students' autonomous development of a robust knowledge framework for health assessment.

4. Insights from the current landscape: Applications and implications of AI in nursing education domestically and internationally

4.1. Trends in foreign applications of AI in nursing education

Foreign countries were among the earliest to integrate AI into nursing education, demonstrating the following trends:

The advancement of virtual simulation and high-fidelity modeling: Virtual patients (VPs) and VR-based training have been widely adopted in fields such as health assessment and emergency care, with research demonstrating their positive impact on students' knowledge retention and clinical reasoning skills. AI-driven adaptive learning and intelligent tutoring systems: Some institutions utilize AI algorithms to analyze learning behaviors and develop personalized learning pathways for students. Many nursing schools abroad have integrated data analysis and health information technology into curricula to cultivate students' ability to apply electronic health records in evidence-based practice. The American Association of Colleges of Nursing (AACN) explicitly emphasizes informatics and medical technology competencies as core elements of nursing education ^[7]. Emphasis on ethics, privacy, and humanistic considerations: Issues such as nurse-patient relationships in virtual environments, AI decision biases, and data privacy have been incorporated into ethical curriculum discussions to ensure that technological applications remain aligned with the humanistic principles of nursing.

4.2. Domestic progress and unique explorations

China's AI-driven nursing education is still in its early stages, characterized by policy-driven initiatives and close collaboration between industry and academia.

Development of Virtual Simulation "Golden Courses": The Ministry of Education's initiative for virtual simulation "golden courses" has already seen the implementation of national and provincial-level nursing education projects. Development of teaching products through university-industry collaboration: VR devices, intelligent simulators, and other products developed through such partnerships are being progressively integrated into educational settings. Research focus on outcome evaluation: Most current studies remain focused on verifying the short-term effectiveness of AI tools in specific skill-based instruction; how to embed AI into curriculum frameworks, support competency assessment, and achieve deep integration of industry-education-innovation remains under exploration ^[8].

Insight: When advancing the restructuring of health assessment curricula, it is essential to ground efforts in local realities by transforming industry data into teaching materials and corporate technologies into instructional tools, while simultaneously cultivating students' ability to solve practical clinical problems.

5. Innovative approaches to health assessment courses enhanced by AI

Based on the above analysis, this paper proposes four interconnected core approaches for AI-driven reform of the undergraduate nursing health assessment curriculum, forming a comprehensive systemic reform framework.

5.1. Pathway 1: Goal reengineering and content restructuring — Based on clinical needs and AI capability matrix

The primary task of curriculum restructuring is to define learning outcomes and reorganize instructional content. Goal refinement: Beyond traditional knowledge, skills, and attitude objectives, a new dimension of “Digital Literacy and Innovative Practice” has been introduced^[9]. This includes: (1) Utilizing intelligent assessment tools (e.g., electronic stethoscopes, smart ECG machines, remote monitoring devices) for data collection; (2) Identifying abnormal trends using data analysis software; (3) Conducting standardized high-risk scenario assessments in VR simulations; (4) Making preliminary nursing decisions based on clinical data; (5) Understanding the application limitations and ethical risks of AI. Content reorganization: Departing from the conventional chapter structure organized by bodily systems, a modular framework of “Basic Module + Core Module + Advanced Innovation Module” has been adopted. The Basic Module covers an introduction to health assessment, communication skills, and digital literacy. The Core Module integrates history-taking, physical examination, and AI-assisted interpretation, supplemented with exercises on smart device usage and electronic medical records. The Advanced Innovation Module introduces topics such as anonymized data and wearable devices, encouraging students to develop innovative solutions addressing clinical challenges and collaborate across disciplines.

5.2. Pathway 2: Methodological innovation and resource reengineering — Building a new smart teaching ecosystem integrating virtual and physical elements

Innovation in teaching methods and resources serves as the vehicle for achieving the new objectives.

A blended teaching model integrating online and offline approaches: Pre-class (online): Students acquire foundational knowledge through MOOC/SPOC courses, self-assess using AI-based question banks, obtain personalized preview materials, and watch instructional videos on intelligent medical equipment provided by healthcare institutions^[10]. In-class (offline + virtual): Problem-Based Learning (PBL)/Project-Based Learning (PjBL) is employed. Following concise instructor guidance, students complete case assessment exercises on smart simulators or VR systems, with real-time recording of procedural steps and duration. Post-class (extension and innovation): Advanced training sessions and extended projects are scheduled. Development of smart teaching resources includes: Intelligent dynamic case libraries developed in collaboration with hospitals and enterprises, where cases can evolve differently based on student interpretation; VR/AR training resources focusing on cardiopulmonary-abdominal examinations, neurological assessments, infectious disease prevention, and emergency response scenarios; Clinical big data case packages constructed from anonymized electronic medical records; and integration of real hospital projects as inquiry-based learning tasks.

5.3. Pathway 3: Evaluation reform and data-driven approaches — Towards process-oriented, personalized developmental assessment

Leverage AI technology to transform evaluation systems from outcome-oriented to process-oriented and

developmental. Multimodal data collection: Data are gathered during practical training using sensors, cameras, and operation logs, covering operational behaviors and learning records. AI-assisted automated skill assessment: Computer vision and machine learning enable the development of standardized models for quantitative scoring and detailed feedback on VR operation videos. Personalized feedback and early warning based on learning analytics: The platform integrates data from various stages to generate “ability profiles” and learning dashboards, visually presenting knowledge mastery levels, strengths/weaknesses, and learning patterns. Teachers can provide targeted guidance accordingly, while the system identifies students facing learning difficulties. Value-added assessment and innovation achievement evaluation: Focus on overall competency enhancement throughout the semester, incorporating innovative achievements into assessments with emphasis on information integration and critical thinking skills.

5.4. Pathway 4: Joint platform development and institutional safeguards — Building a sustainable collaborative education community among universities, research institutes, and enterprises

Curriculum restructuring requires a robust collaborative platform and sustainable mechanisms. A joint “AI + Nursing Education” innovation platform should be established, enabling collaboration among educational institutions, partner hospitals, and enterprises to establish joint laboratories. This platform serves four key functions: (1) Technology development and translation: Jointly developing teaching-oriented AI tools and virtual case scenarios; (2) Resource co-construction and sharing: Hospitals provide anonymized data, enterprises contribute technology, and educational institutions facilitate instructional adaptation, forming a dynamic resource repository; (3) Faculty training and exchange: Corporate engineers and clinical experts provide training for educators, while educators participate in enterprise research, achieving mutual empowerment; (4) Student practice and innovation incubation: Serving as a base for student practical training, competitions, and entrepreneurial incubation. Interdisciplinary dual-qualified teaching teams should be established, comprising nursing faculty, clinical nursing experts, and AI/data science professionals or engineers, who engage in regular joint research to foster mutual enhancement. A learner-centered support system must be developed, including technical assistance and mentoring frameworks to help students adapt to new technological tools.

6. Conclusion

From the perspective of integrating industry, education, and innovation, AI empowers health assessment courses in vocational undergraduate programs to meet the demands of smart healthcare and address challenges in traditional teaching. This transformation is not merely a technical addition but a systemic overhaul guided by industrial needs and innovative capabilities, encompassing curriculum objectives, content, teaching methods, and evaluation systems. Through goal redefinition, methodological innovation, evaluation reform, and collaborative platform development within the tri-chain synergy framework, AI technology can serve as a driving force for enhancing teaching quality and students’ core competitiveness. The collaborative efforts among educational institutions, hospitals, and enterprises are poised to open new horizons for vocational nursing education and provide robust talent support for the healthcare sector.

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Application of Refined Nursing in the Prevention of Pressure Injuries in Pediatric Cardiothoracic Surgery

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Abstract: *Objective:* To explore the clinical value of refined nursing intervention in perioperative nursing for children undergoing cardiothoracic surgery, observe its preventive effect on pressure injuries in pediatric patients, and provide evidence-based references for optimizing specialized skin nursing protocols in pediatric cardiothoracic departments. *Methods:* A total of 86 children who underwent elective cardiothoracic surgery in the hospital from January 2022 to December 2025 were enrolled and randomly divided into the control group and the observation group using the random number table method, with 43 cases in each group. The control group received routine perioperative nursing for cardiothoracic surgery, while the observation group was administered whole-process refined nursing interventions on the basis of routine nursing, including preoperative risk stratification and assessment, intraoperative refined decompression protection for body position, multi-dimensional perioperative skin management, postoperative dynamic monitoring, and closed-loop management of nursing quality. The incidence of perioperative pressure injuries, the occurrence of abnormal skin conditions, and family nursing satisfaction were compared between the two groups. *Results:* The incidence of perioperative pressure injuries in the observation group was 2.33%, which was significantly lower than 16.28% in the control group ($P<0.05$). The total incidence of abnormal skin conditions, including skin flushing, moisture-induced injury, and friction damage, in the observation group was 6.98%, remarkably lower than 41.86% in the control group ($P<0.001$). The family nursing satisfaction rate of the observation group was 95.35%, higher than 76.74% in the control group, and all inter-group differences were statistically significant ($P<0.05$). *Conclusion:* Perioperative refined nursing implemented for children undergoing pediatric cardiothoracic surgery can accurately avoid high-risk factors for pressure injuries, effectively reduce the incidence of perioperative skin damage, maintain the integrity of children's skin, improve clinical nursing quality, and family medical satisfaction. Consistent with the development concept of pediatric precision nursing, this intervention has clinical promotion value.

Keywords: Refined nursing; Pediatric cardiothoracic surgery; Surgical nursing; Pressure injury; Skin protection

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1. Introduction

Pediatric cardiothoracic surgery is mainly applied to correct severe congenital pediatric diseases such as congenital heart disease, thoracic deformity, and congenital mediastinal and pulmonary lesions, serving as a core therapeutic approach to improve children's cardiopulmonary function and ensure their normal growth and development. Characterized by complex procedures and long operation duration, this type of surgery requires general anesthesia and cardiopulmonary bypass, which completely restricts patients' spontaneous activities and necessitates prolonged fixed surgical positioning, making pediatric patients a high-risk population for pressure injuries ^[1]. Compared with adults, children have immature physiological skin structures, featuring thin epidermis, high dermal water content, and underdeveloped skin barrier function. In addition, young children have uneven subcutaneous fat distribution, leading to poor compression resistance and shear resistance of local skin tissues. Prolonged local compression easily causes microcirculation disorders, further resulting in skin flushing, congestion, ulceration, and other pressure injuries ^[2]. Furthermore, multiple superimposed risk factors, including intraoperative hypothermia intervention, slowed peripheral circulation and intraoperative exudation induced by cardiopulmonary bypass, as well as long-term postoperative bed rest and insufficient nutrient intake caused by weak cardiopulmonary function, further elevate the risk of pressure injuries. Pressure injuries not only aggravate children's physical pain, induce crying and restlessness, and hinder the recovery of postoperative cardiopulmonary function, but may also trigger complications such as skin infection and unhealed wounds, prolong hospital stay, and increase the financial burden of families and the pressure of clinical nursing work ^[3]. Therefore, strengthening perioperative skin protection and precise prevention and control of pressure injuries in children undergoing cardiothoracic surgery is crucial for improving specialized nursing quality and ensuring smooth postoperative rehabilitation of children.

Current routine perioperative skin nursing in clinical practice is dominated by basic skin cleaning and passive postoperative condition observation, lacking precise preoperative risk assessment, intraoperative refined management, and continuous postoperative dynamic monitoring. It fails to adequately intervene in hidden high-risk factors such as moisture stimulation, positional shear force, and long-term low-pressure compression, resulting in insufficient foresight and relevance of nursing work, and cannot meet the skin protection needs of children with special skin characteristics ^[4]. As an evidence-based modern precision nursing model, refined nursing realizes accurate prevention and control of high-risk nursing risks through whole-process detailed management, stratified risk assessment, individualized intervention, and closed-loop quality control. Based on this, this study applied the refined nursing model to the whole perioperative period of children undergoing pediatric cardiothoracic surgery, constructed an integrated preoperative-intraoperative-postoperative skin protection system, and explored its preventive effect on pressure injuries in children, so as to provide a reference for the construction and clinical promotion of standardized skin nursing protocols for pediatric cardiothoracic specialty.

2. Materials and methods

2.1. General information

A total of 86 children who underwent elective cardiothoracic surgery in the hospital from January 2022 to December 2025 were selected as the research subjects and divided into the control group and the observation group by the random number table method, with 43 cases in each group. In the control group, there were 23

males and 20 females, aged 1–10 years, with an average age of (5.32 ± 2.16) years; surgical types included 25 cases of congenital heart disease correction, 10 cases of thoracic deformity correction, and 8 cases of mediastinal and pulmonary surgery; the operation duration ranged from 1.5 to 4.5 h, with an average of (2.86 ± 0.75) h. In the observation group, there were 24 males and 19 females, aged 1–11 years with an average age of (5.47 ± 2.09) years; surgical types included 24 cases of congenital heart disease correction, 11 cases of thoracic deformity correction, and 8 cases of mediastinal and pulmonary surgery; the operation duration ranged from 1.6 to 4.6 h, with an average of (2.92 ± 0.71) h. Baseline data including age, gender, surgical type, and operation duration were comparable between the two groups, with no statistically significant differences ($P>0.05$).

2.1.1. Inclusion criteria

- (1) Children aged 1–11 years who met the indications for elective pediatric cardiothoracic surgery and underwent surgical treatment for the first time;
- (2) Children with intact preoperative skin without damage, eczema, dermatitis, or a history of previous pressure injuries;
- (3) Children with stable vital signs and no severe hepatorenal dysfunction or coagulation disorders;
- (4) Families of the children were informed of the study content, volunteered to participate, and signed informed consent.

2.1.2. Exclusion criteria

- (1) Children with preoperative skin infection, skin damage, or chronic skin diseases;
- (2) Children with severe malnutrition, immune deficiency, or limb skeletal deformities;
- (3) Children with intraoperative sudden massive hemorrhage, critical conditions requiring emergency rescue, and interrupted surgical procedures;
- (4) Children with incomplete clinical data who were unable to cooperate with nursing interventions and follow-up.

2.2. Nursing methods

2.2.1. Control group

Routine perioperative nursing for pediatric cardiothoracic surgery was implemented. Preoperatively, routine skin cleaning, preoperative health education, and basic physical condition assessment were completed. Intraoperatively, standard surgical body position was assisted by physicians, with routine cotton surgical pads laid to maintain clean and dry surgical skin. Postoperatively, basic skin nursing was carried out, including regular turning over of children, keeping bed units clean and dry, routine skin condition observation, and timely symptomatic treatment for abnormal skin conditions such as flushing and damage. Meanwhile, basic dietary guidance and postoperative rehabilitation nursing were provided ^[5].

2.2.2. Observation group

On the basis of routine nursing, whole-process refined perioperative nursing interventions were implemented. Combined with the physiological skin characteristics of children and high-risk factors of cardiothoracic surgery, a closed-loop nursing system of preoperative risk stratification, intraoperative precise protection, postoperative dynamic monitoring, and whole-process quality control improvement was

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constructed, with specific intervention measures as follows.

Preoperative refined risk assessment and pre-intervention. One day before surgery, the pediatric-specific Braden Q pressure injury risk assessment scale was used for special assessment of children. Multiple indicators, including children's age, weight, skin elasticity, nutritional status, limb mobility, estimated operation duration, intraoperative cardiopulmonary bypass, and hypothermia intervention, were comprehensively evaluated to accurately stratify low, medium, and high risk levels, establish individualized nursing files, and formulate targeted protection protocols. Special emphasis and enhanced targeted protection were placed on high-risk children with young age, low body weight, and estimated operation duration longer than 2 hours. Preoperative full-body skin cleaning was performed thoroughly, focusing on skin folds such as neck, armpits, lumbosacral region, and heels to remove sweat, stains, and residual sundries and avoid local compression and stimulation by foreign matter. Meanwhile, clinical nutritionists collaborated to evaluate children's nutritional status. For children with mild malnutrition and poor skin elasticity, families were guided to supplement high-quality protein and vitamins preoperatively to improve the tolerance of skin tissues. Special health education was conducted for families to elaborate on high-risk factors, key protection points, and cooperation matters of pressure injuries in pediatric cardiothoracic surgery, so as to improve family nursing cooperation.

Intraoperative refined body position management and decompression protection. Surgical body positions were individually and finely adjusted according to children's body shape, skeletal development, and specific surgical procedures to avoid long-term compression of bony prominences and shear force-induced skin damage. For children undergoing supine surgery, flexible medical decompression foam dressings were pasted on stressed parts, including the occiput, scapula, lumbosacral region, and heels, to replace traditional cotton cushions, and silica gel decompression positional pads were adopted to evenly disperse body pressure. For children undergoing congenital heart disease and thoracic deformity surgery, the shank elevation method was applied to suspend the heels completely, thoroughly eliminate compression on terminal parts, and reduce the risk of heel pressure injuries. Surgical bed sheets were fully flattened before surgery to avoid skin compression by folds and sundries; intraoperative negative pressure suction operations were standardized to prevent skin traction and friction caused by pipelines. In view of the slowed peripheral circulation induced by intraoperative cardiopulmonary bypass and hypothermia, limb warmth was maintained without affecting surgical operations to ensure normal skin blood perfusion. Intraoperative disinfectant, blood, and exudate were wiped away promptly to keep the skin dry throughout the operation and prevent damage to the skin barrier caused by moisture stimulation.

Postoperative refined dynamic skin monitoring and special nursing. Immediately after children returned to the ward postoperatively, comprehensive full-body skin assessment was performed, focusing on intraoperative key stressed parts. The skin color, integrity, swelling, and congestion were recorded in detail to improve the postoperative skin monitoring files. Special skin assessment was conducted every 1 hour within 6 hours after surgery and every 2 hours within 24 hours after surgery to accurately identify early occult skin damage and timely intervene in initial abnormal symptoms such as skin flushing and local congestion. Individualized turning plans were formulated based on children's postoperative cardiopulmonary function recovery. Turning movements were gentle without dragging or pulling limbs to minimize skin shear force and friction damage. Bed units were kept flat, dry, and debris-free throughout the nursing period, and damp clothes and bed linens were replaced in a timely manner. For children with postoperative bed rest and

ventilator-assisted ventilation, fixed pipelines and electrode patches were loosened regularly to avoid long-term local skin compression. In addition, individualized postoperative nutritional support was strengthened, and dietary protocols were formulated according to children's age, weight, and condition to enhance body resistance and skin tissue repair capacity.

Refined nursing quality control and continuous improvement. A special quality control group for pressure injuries in the department was established to organize regular professional training on pediatric skin protection and refined operations for nursing staff, so as to strengthen their ability to identify high-risk factors and master specialized nursing skills. The implementation of nursing measures, including skin risk assessment, decompression protection, and dynamic monitoring, was inspected daily. Skin abnormality data were summarized weekly to systematically analyze high-risk causes, and intervention procedures were optimized for weak links in nursing. A closed-loop nursing management model of risk assessment-precise intervention-dynamic monitoring-problem improvement was formed to continuously improve the quality of perioperative skin protection ^[1].

2.3. Observation indicators

- (1) Incidence of pressure injuries: The occurrence of pressure injuries in children during the perioperative period (from preoperative to 72 hours postoperatively) was statistically analyzed. The injury grade was determined in accordance with the international pressure injury grading standard, and the total incidence was calculated.
- (2) Occurrence of abnormal skin conditions: The number of cases and total incidence of various abnormal skin conditions, including skin flushing, moisture-induced injury, and friction damage, were compared between the two groups.
- (3) Nursing satisfaction: A self-made family nursing satisfaction scale of the hospital was adopted for investigation, with a total score of 100 points. Scores of 90–100 points were defined as very satisfied, 70–89 points as satisfied, and <70 points as dissatisfied. Nursing satisfaction rate = (number of very satisfied cases + number of satisfied cases)/total number of cases × 100%.

2.4. Statistical methods

SPSS 26.0 statistical software was used for data analysis. Measurement data were expressed as mean ± standard deviation (Mean ± SD), and *t*-test was used for inter-group comparison; count data were expressed as cases (percentage) [n(%)], and χ^2 test was used for inter-group comparison. The test level α was set as 0.05, and $P < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of perioperative pressure injury incidence between the two groups

Only 1 case of stage I pressure injury occurred in the observation group, with an incidence of 2.33%; 7 cases of stage I–II pressure injuries occurred in the control group, with an incidence of 16.28%. The incidence of pressure injuries in the observation group was significantly lower than that in the control group, and the difference was statistically significant ($\chi^2=4.965$, $P=0.026$).

3.2. Comparison of abnormal skin conditions between the two groups

The incidence of each abnormal skin condition, including skin flushing, moisture-induced injury, and friction damage, in the observation group was significantly lower than that in the control group, and the total incidence of abnormal skin conditions was remarkably lower, with a highly statistically significant inter-group difference ($P<0.001$) (Table 1).

Table 1. Comparison of perioperative abnormal skin conditions between the two groups [n(%)]

Group	Number of cases	Skin flushing	Moisture-induced injury	Friction damage	Total abnormal incidence
Observation group	43	2(4.65)	1(2.33)	0(0.00)	3(6.98)
Control group	43	8(18.60)	6(13.95)	4(9.30)	18(41.86)
χ^2 value	-	4.074	3.888	4.195	14.692
P value	-	0.044	0.048	0.041	<0.001

3.3. Comparison of family nursing satisfaction between the two groups

The family nursing satisfaction rate of the observation group was 95.35%, which was significantly higher than 76.74% in the control group, and the inter-group difference was statistically significant ($P<0.05$) (Table 2).

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

Group	Number of cases	Very satisfied	Satisfied	Dissatisfied	Satisfaction rate
Observation group	43	32(74.42)	9(20.93)	2(4.65)	41(95.35)
Control group	43	21(48.84)	12(27.91)	10(23.26)	33(76.74)
χ^2 value	-	-	-	-	6.198
P value	-	-	-	-	0.013

4. Discussion

Children undergoing cardiothoracic surgery belong to an extremely high-risk group for pressure injuries. The superposition of multiple risk factors, including the anatomical and physiological particularities of children's skin, prolonged intraoperative immobilization, intraoperative hypothermia and cardiopulmonary bypass intervention, and long-term postoperative bed rest, leads to a significantly higher risk of skin damage than children undergoing general surgery^[6]. Pressure injuries not only cause physical pain, crying, and restlessness in children and affect postoperative cardiopulmonary function recovery and feeding status, but may also induce complications such as skin infection and unhealed wounds, prolong hospital stay, and increase family medical burden and clinical nursing pressure, serving as a vital adverse factor affecting the rehabilitation effect of pediatric cardiothoracic surgery^[7]. Therefore, constructing a scientific and standardized refined perioperative skin protection system is the core measure to reduce the incidence of pressure injuries and improve the quality of pediatric cardiothoracic specialized nursing.

The conventional perioperative skin nursing model in clinical practice is extensive, dominated by passive postoperative observation and symptomatic treatment. It lacks precise preoperative risk screening, detailed intraoperative protection and continuous postoperative monitoring, and fails to effectively intervene in hidden high-risk factors such as positional shear force, long-term local low-pressure compression and moisture stimulation. The nursing model is deficient in foresight and pertinence, cannot meet the skin

protection needs of delicate children's skin, and has limited clinical preventive effects ^[8]. Adhering to the modern evidence-based nursing concept, the refined nursing model adopted in this study breaks the passivity and one-sidedness of traditional nursing, constructs an integrated whole-process closed-loop protection system covering the preoperative, intraoperative, and postoperative periods, and realizes accurate prevention and control of pressure injury risks ^[9].

Preoperative individualized risk stratification was performed via the dedicated Braden Q scale to accurately identify high-risk children, and targeted skin pre-intervention, nutritional intervention, and health education were carried out to avoid inducing factors of pressure injuries from the source and lay a foundation for perioperative skin protection. Intraoperatively, the extensive traditional body position placement method was abandoned, and individualized body position arrangement was conducted based on children's body shape and surgical procedures. Specialized decompression dressings and silica gel positional pads were applied to effectively disperse pressure on bony prominences. Meanwhile, intraoperative adverse stimuli such as moisture, friction, and low temperature were strictly controlled to minimize intraoperative skin damage ^[10]. Postoperatively, high-frequency dynamic skin monitoring was implemented to capture early occult skin damage in a timely manner. Combined with individualized turning nursing, pipeline skin protection, and nutritional support, the progression of skin damage was blocked to fully protect the integrity of children's skin. In addition, the special quality control and continuous improvement mechanism standardized nursing operation procedures, made up for the loopholes in routine nursing, and ensured the effective implementation of nursing measures.

The results of this study showed that the observation group had a significantly lower incidence of pressure injuries and total abnormal skin conditions, and remarkably higher family nursing satisfaction than the control group, confirming that refined nursing can effectively avoid high-risk factors for perioperative skin damage in pediatric cardiothoracic surgery and greatly reduce the incidence of pressure injuries and various abnormal skin conditions. The underlying reason is that refined nursing focuses on clinical nursing details, implements targeted interventions for exclusive high-risk factors of pediatric cardiothoracic surgery, and balances individuation and comprehensiveness, which effectively compensates for the shortcomings of routine nursing. It can not only accurately protect children's delicate skin and reduce physical damage, but also improve families' medical experience through detailed and high-quality whole-process nursing services, conforming to the development concept of modern pediatric precision nursing and humanistic nursing.

Meanwhile, this study has certain limitations. It is a single-center and small-sample clinical study with a follow-up period limited to 72 hours postoperatively, failing to observe the long-term skin recovery status of children. Future studies can carry out multi-center, large-sample controlled trials with prolonged follow-up periods, further optimize the refined nursing intervention process, and refine individualized protection protocols for children of different age groups and different surgical types, so as to provide more comprehensive evidence-based support for clinical standardized promotion.

5. Conclusion

The application of refined nursing intervention in the perioperative nursing of children undergoing pediatric cardiothoracic surgery can effectively identify and avoid high-risk factors for pressure injuries, significantly reduce the incidence of perioperative pressure injuries and various abnormal skin conditions, fully maintain the integrity of children's skin, and reduce the occurrence of postoperative complications. Meanwhile, it

can effectively optimize the quality of nursing services, improve family nursing satisfaction, and enhance doctor-patient relationships. With significant intervention effects and strong practicality, this nursing model conforms to the refinement development trend of specialized nursing and is worthy of clinical promotion and application in pediatric cardiothoracic departments.

Disclosure statement

The author declares no conflict of interest.

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Application Research of Online and Offline Blended Teaching in Continuing Medical Education of Basic Medicine

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Abstract: *Objective:* In view of the practical pain points of in-hospital continuing medical education, this study aimed to explore the application value of online and offline blended teaching in basic medical training for medical staff, so as to solve the practical problems of low participation enthusiasm of trainees, difficulty in understanding abstract theories, and poor connection between theoretical learning and clinical practice in traditional centralized teaching. It provides implementable practical evidence for medical institutions to optimize the reform path of basic medical continuing education. *Methods:* A total of 40 on-the-job standardized training physicians and newly recruited clinical medical staff in our hospital were enrolled and divided into two groups via a parallel control design, with 20 cases in each group. The control group adopted the traditional in-hospital training mode of centralized offline lectures combined with on-site practical demonstration. Based on the in-hospital teaching conditions, the observation group constructed an integrated blended training system of *pre-class online preview, in-class offline intensive teaching and practical operation, and after-class online review and expansion* adapted to the disciplinary characteristics of basic medicine. After the training cycle, unified assessments and questionnaire surveys were conducted to compare the differences in theoretical and practical scores, autonomous learning ability, and training satisfaction between the two groups. *Results:* The observation group achieved significantly higher scores in theoretical assessment, clinical practical operation, and comprehensive evaluation, as well as higher scores in autonomous learning initiative, in-depth knowledge understanding, clinical critical thinking ability, and scientific research literacy. The overall training satisfaction was also remarkably improved, and all inter-group differences were statistically significant ($P < 0.05$). *Conclusion:* The targeted blended teaching model can effectively compensate for the shortcomings of traditional in-hospital basic medical continuing education, substantially improve medical staff's theoretical mastery and standardization of clinical operation, and cultivate trainees' autonomous learning ability and clinical thinking capacity. Complying with the training requirements of lifelong learning and progressive ability improvement in continuing medical education, this model is suitable for regular promotion and application in medical institutions.

Keywords: Blended teaching; Basic medicine; Continuing medical education; Teaching reform; Standardized clinical training

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1. Introduction

Basic medicine covers core disciplines including human anatomy, physiology, pathology, biochemistry, and pharmacology. As a prerequisite core curriculum for clinical medical staff to consolidate professional foundations, construct clinical thinking, and standardize diagnosis and treatment operations, it occupies a pivotal position in the standardized training system for young in-hospital physicians ^[1]. From the perspective of clinical teaching practice, basic medicine is characterized by numerous and complex knowledge points, strong theoretical logic, and abstract microscopic mechanisms. For physicians undergoing standardized training and newly recruited medical staff with short working experience and limited clinical experience, simple classroom lectures fail to help them fully grasp core principles, easily leading to fragmented memory of knowledge points and superficial theoretical cognition ^[2]. The previous in-hospital continuing education of basic medicine mainly adopted offline cramming centralized teaching with a relatively fixed teaching mode. The lack of pre-class preview guidance and after-class consolidation and expansion resources, as well as the limited duration of a single practical training session, deprives trainees of opportunities for repeated practice, review, and error correction. Consequently, most trainees passively receive knowledge with weak awareness of active exploration and thinking, resulting in a disconnection between theory and practice, namely proficient theoretical mastery but non-standard clinical operation and poor transformation of theoretical knowledge in clinical scenarios ^[3]. Against the background of emerging medical education reform and quality improvement of continuing medical education, the traditional single offline centralized training model can no longer meet the hierarchical and lifelong learning needs of clinical medical staff for competency improvement ^[4]. Blended teaching based on information-based teaching platforms integrates the dual advantages of online fragmented autonomous learning and offline targeted teaching, breaking the temporal and spatial limitations of traditional teaching, and has been widely applied in the teaching reform of various medical courses ^[5]. Based on the actual situation of in-hospital training, this study optimized and constructed a closed-loop blended teaching process and verified its application effect in basic medical continuing education through a controlled trial, aiming to further improve the quality of in-hospital continuing medical education and provide practical support for the standardized training of clinical talents.

2. Materials and methods

2.1. Research subjects

A total of 40 on-the-job standardized training physicians and newly recruited clinical medical staff who participated in basic medical continuing education in the hospital from January to June 2025 were selected as research samples. They were divided into the observation group and the control group by parallel grouping, with 20 cases in each group. In the control group, there were 11 males and 9 females, aged 18–21 years, with an average age of (19.52±0.82) years. In the observation group, there were 10 males and 10 females, aged 18–22 years, with an average age of (19.58±0.89) years. All subjects participated in systematic basic medical continuing education for the first time without prior relevant learning experience, with good physical and mental status, and completed the whole process of theoretical learning, practical training, final assessment, and questionnaire survey. Baseline data, including age, gender composition, and pre-job basic evaluation scores, were comparable between the two groups, with no statistically significant differences ($P>0.05$).

2.1.1. Inclusion criteria

- (1) On-the-job standardized training physicians and newly recruited clinical medical staff of the hospital;
- (2) Participants who completed the whole process of basic medical theoretical and practical continuing education without long-term unexcused absence;
- (3) Participants who fully understood the study content, voluntarily participated in the survey, and cooperated with data collection.

2.1.2. Exclusion criteria

- (1) Medical staff with long-term further study, vacation, or secondment during the research period;
- (2) Participants with accumulated absences of 3 times or more who failed to complete the full training process;
- (3) Participants who did not finish online learning tasks, submitted invalid questionnaires, or had missing research data.

2.2. Teaching methods

2.2.1. Control group

The control group adopted the traditional in-hospital continuing medical education mode, carrying out standardized offline centralized teaching in accordance with the in-hospital basic medical training syllabus. Theoretical teaching was mainly based on teacher-led PPT explanation and centralized knowledge compilation, with only occasional random in-class questions and no unified pre-class preview arrangement. Practical training adopted centralized demonstration teaching: teachers uniformly demonstrated standardized operating procedures, and trainees observed, imitated, and practiced independently under routine roaming guidance of teachers. The training assessment consisted of a final closed-book theoretical examination and a unified practical assessment, without online preview, online Q&A, or after-class personalized expanded learning links. The whole training followed the traditional fixed in-hospital teaching process^[6].

2.2.2. Observation group

On the basis of conventional in-hospital teaching, the observation group adopted the Chaoxing Learning Platform to construct a closed-loop blended training model of *online pre-class guidance, offline targeted in-class learning, online after-class review and expansion, and diversified process evaluation* in combination with the dual characteristics of abstract theory and practicality of basic medicine courses. This model realized in-depth integration of online fragmented autonomous learning, offline targeted teaching, and practical reinforcement. The detailed implementation process optimized for in-hospital teaching practice was as follows.

Online pre-class guidance. Three days before centralized offline teaching, teachers uploaded targeted, streamlined teaching courseware, key knowledge micro-lessons, logical mind maps, pre-class self-test question banks, and preview thinking questions based on the key and difficult points of current training. For abstract knowledge that is difficult to visualize, such as anatomical structures, physiological metabolism, and pathological evolution, 3D structural demonstration animations and dynamic videos of physiological mechanisms were provided to help trainees intuitively understand abstract theories. For highly theoretical content, including pharmacological mechanisms and pathological classification, simplified clinical scenario cases were matched to guide trainees to think in combination with clinical practice. Trainees completed

previews and self-tests in their fragmented spare time, and the platform automatically recorded learning duration, task completion, and error data. Teachers accurately sorted out common difficult problems of trainees based on background learning data to support targeted intensive explanation and Q&A in offline classes. Meanwhile, an online discussion section was opened to encourage active communication of preview doubts and cultivate trainees' active thinking habits ^[7].

Offline targeted in-class learning. The traditional cramming teaching mode was abandoned, and hierarchical intensive explanation and targeted Q&A were carried out, focusing on difficult problems fed back from pre-class preview. Interactive teaching, such as group discussion and scenario analysis, was conducted, combined with real clinical cases and working scenarios, to guide trainees to sort out knowledge logic and establish associative thinking between basic theories and clinical practice. The practical training adopted a dual mode of *online virtual simulation preview* + *offline practical reinforcement training*. Trainees were familiar with standardized operating procedures and avoided common operational errors through the virtual simulation platform before class. In class, teachers disassembled core operating key points step by step and corrected non-standard operational details pertinently, making up for the shortcomings of traditional practical training such as short single training time, insufficient repeated practice, and inadequate individual guidance ^[8]. In-class quizzes, group achievement reports, and random questioning were interspersed to timely test phased training effects and improve classroom efficiency.

Online after-class review and expansion. After each training session, teachers pushed chapter knowledge summaries, cutting-edge clinical research cases, special consolidation question banks, and expanded literature resources via the platform to help trainees systematically sort out classroom knowledge and broaden their knowledge breadth. Special review tests and error-sorting tasks were released for key and difficult knowledge points. The platform generated error analysis reports through automatic correction, guiding trainees to accurately identify weak points and conduct targeted remediation. Regular after-class tasks such as case analysis and knowledge review summaries were assigned, with trainees submitting results online and teachers providing one-on-one comments and guidance to realize personalized tutoring. A regular online Q&A mechanism was established to timely answer trainees' after-class questions, form a closed-loop teaching system, and promote knowledge internalization and continuous improvement of clinical competence.

Construction of a diversified process assessment system. Breaking the traditional single final summative assessment model, an integrated online-offline comprehensive evaluation mechanism was established. The process assessment, accounting for 40% of the total score, included online preview quality, online homework completion, in-class interaction performance, practical training results, and phased test scores. The final unified closed-book examination and comprehensive practical assessment served as the summative assessment, accounting for 60% of the total score. The whole-process recording of trainees' learning status objectively reflected their real learning level, guiding trainees to attach importance to daily accumulation and avoid cramming for examinations and superficial knowledge mastery.

2.3. Observation indicators

- (1) Training assessment scores: Unified closed-book theoretical examinations and standardized clinical practical assessments were conducted after the training cycle. Both tests were scored out of 100 points, and the comprehensive score was the average of the two scores to evaluate the overall training effect of

the two groups.

- (2) Autonomous learning effect score: A self-designed in-hospital learning effect questionnaire was adopted for evaluation from four dimensions: autonomous learning initiative, in-depth knowledge understanding, clinical thinking improvement, and scientific research ability expansion, with 25 points for each dimension and a total score of 100 points. Higher scores indicated better learning effects.
- (3) Training satisfaction: Anonymous questionnaire surveys were performed to divide trainees' training experience into three levels: very satisfied, satisfied, and dissatisfied. Training satisfaction rate = (number of very satisfied cases + number of satisfied cases)/total number of cases × 100%.

2.4. Statistical methods

All data in this study were sorted and analyzed using SPSS 26.0 statistical software. Measurement data were expressed as mean ± standard deviation, and an independent-samples t-test was used for inter-group comparison; count data were expressed as cases (percentage) [n(%)], and a χ^2 test was used for inter-group comparison. The test level α was set at 0.05, and $P < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of training assessment scores between the two groups

Unified assessment after training showed that the observation group had significantly higher theoretical scores, clinical practical scores, and comprehensive scores than the control group, with statistically significant inter-group differences ($P < 0.001$) (Table 1).

Table 1. Comparison of training assessment scores of medical staff between the two groups (points, Mean ± SD)

Group	Number of cases	Theoretical score	Practical operation score	Comprehensive score
Observation group	20	85.28±4.22	88.06±3.92	86.68±3.54
Control group	20	78.30±5.10	80.50±4.78	79.36±4.22
<i>t</i> value	-	4.782	5.216	5.635
<i>P</i> value	-	<0.001	<0.001	<0.001

3.2. Comparison of autonomous learning effect scores between the two groups

Questionnaire survey results indicated that the observation group had significantly higher scores in the four dimensions of autonomous learning initiative, knowledge understanding depth, clinical thinking improvement, and scientific research ability expansion, as well as higher total questionnaire scores than the control group, with statistically significant inter-group differences ($P < 0.001$) (Table 2).

Table 2. Comparison of autonomous learning effect scores of medical staff between the two groups (points, Mean ± SD)

Group	Number of cases	Autonomous learning initiative	Knowledge understanding depth	Clinical thinking improvement	Scientific research ability expansion	Total score
Observation group	20	22.32±1.50	21.95±1.60	22.12±1.45	21.62±1.70	88.01±5.22

Control group	20	18.62±2.10	18.21±2.02	17.93±2.18	17.55±2.33	72.31±6.82
<i>t</i> value	-	6.425	6.218	7.012	6.158	8.265
<i>P</i> value	-	<0.001	<0.001	<0.001	<0.001	<0.001

3.3. Comparison of teaching satisfaction between the two groups

The training satisfaction rate of the observation group was 95.00%, which was significantly higher than 80.00% in the control group, and the inter-group difference was statistically significant ($P<0.05$) (Table 3).

Table 3. Comparison of teaching satisfaction of medical staff between the two groups [n(%)]

Group	Number of cases	Very satisfied	Satisfied	Dissatisfied	Satisfaction rate
Observation group	20	14(70.00)	5(25.00)	1(5.00)	19(95.00)
Control group	20	9(45.00)	7(35.00)	4(20.00)	16(80.00)
χ^2 value	-	-	-	-	4.114
<i>P</i> value	-	-	-	-	0.043

4. Discussion

Basic medical continuing education is a core link in the standardized training of young clinical talents. Its training quality directly affects the clinical knowledge reserve, basic operation standardization, and clinical thinking ability of medical staff, serving as a crucial cornerstone for the continuous improvement of clinical post competency^[9]. The traditional centralized training model previously adopted in our hospital has a single teaching form and limited resource supply, featuring one-way knowledge output by teachers and passive knowledge reception by trainees without active exploration and in-depth thinking. Meanwhile, the limited duration of practical training fails to meet trainees' needs for repeated practice and error correction, resulting in the common problem of proficient theoretical memory but non-standard clinical operation and disconnection between basic theories and clinical scenarios, which cannot adapt to the training standards of applied clinical medical talents in the new era^[10].

Optimized based on in-hospital teaching practice, the blended teaching model in this study breaks the fixed process of traditional continuing education and constructs a full-process closed-loop training system. The pre-class online guidance link decomposes abstract and difficult core theories of basic medicine through lightweight and visualized teaching resources, and urges active preview via task-driven methods, effectively enhancing trainees' autonomous learning awareness. In addition, teachers accurately grasp trainees' learning weaknesses based on platform learning data, transforming offline classroom teaching from indiscriminate lecturing to targeted teaching and greatly improving classroom relevance. The offline in-class teaching abandons cramming education, carries out interactive discussion teaching focusing on pre-class learning pain points combined with clinical cases, and shortens the gap between basic theories and clinical practice. The virtual-reality integrated practical training model makes up for the deficiencies of insufficient practical training frequency and inadequate personalized guidance in in-hospital teaching, helping trainees master standardized basic operations and improve operational standardization.

The online after-class review and expansion and diversified process evaluation mechanism corrects the traditional assessment drawback of attaching importance to final examinations while neglecting learning processes, guiding trainees to focus on daily knowledge accumulation and regular review to realize

continuous knowledge internalization and progressive competency improvement. The study data showed that the observation group had significantly better theoretical and practical assessment scores, comprehensive abilities including autonomous learning, clinical critical thinking, and scientific research expansion, and higher training satisfaction than the control group. These findings fully demonstrate that the blended teaching model can effectively solve the existing pain points of in-hospital basic medical continuing education, balance knowledge imparting, skill training, and literacy improvement, and conform to the lifelong, precise, and practical reform trend of continuing medical education.

This study has certain limitations. It is a single-center and small-sample teaching practice with limited research coverage and no long-term follow-up observation of post-competency. Future studies will further expand the sample size, carry out multi-center controlled trials in cooperation with multiple medical institutions, refine hierarchical training schemes according to the teaching characteristics of different basic medicine disciplines such as anatomy, physiology and pathology, continuously optimize online teaching resource allocation and in-hospital teaching procedures, and improve the blended teaching system of basic medicine adapted to medical institutions, so as to provide more comprehensive practical support for the reform of medical continuing education.

5. Conclusion

The optimized online and offline blended teaching model applied in in-hospital basic medical continuing education can effectively make up for various shortcomings of traditional centralized teaching, significantly improve medical staff's mastery of basic theories and standardization of clinical operations, effectively cultivate trainees' autonomous learning ability and comprehensive clinical critical thinking literacy, and enhance the satisfaction of in-hospital continuing medical education. With stable training effects, strong operability, and high adaptability, this teaching model meets the needs of hierarchical training of clinical post talents. It can be adopted as a regular reform scheme for basic medical continuing education in medical institutions and promoted in in-hospital and peer medical institutions.

Disclosure statement

The author declares no conflict of interest.

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Research on Strategies for Integrating Pre-hospital Emergency Training into Higher Vocational Nursing Teaching from the Perspective of Job Requirements

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Abstract: As one of the first links in the public health emergency response system, pre-hospital emergency care directly affects whether seriously ill patients live or die. Currently, there are serious deficiencies in the pre-hospital emergency talent cultivation of higher vocational nursing education, such as a disconnect between teaching content and actual work, and a lack of integration of skill training and clinical thinking. Therefore, educators need to adjust the teaching system according to the needs of jobs at present. Based on the deep integration of pre-hospital emergency training and higher vocational nursing education, this paper presents the core concepts, analyzes the demands for job competencies, studies the current teaching situation, and systematically explores the necessity and feasibility of such integration. The three main directions for optimization are curriculum content, teaching models, and assessment systems; simultaneously, dual guarantees will be provided for faculty development and resource construction. This paper hopes to establish a job-competency-oriented education-job integration path and provide theoretical support and practical references for teaching reform in pre-hospital emergency care for higher vocational nursing students.

Keywords: Pre-hospital emergency care; Higher-vocational nursing; Job requirements; Teaching integration ; Education-job integration

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1. Introduction

Pre-hospital emergency care refers to the first medical assistance provided to people before they reach the hospital. Promptly and correctly organized rescue work can save lives. With the acceleration of urbanization and aging of the population in China, the demand for regular emergency services and responses to public health emergencies has been increasing steadily, and high-level professional expectations have been placed on pre-hospital emergency personnel. High-level vocational nursing education aims to train technically

proficient and skilled nurses who will serve as the main force for pre-hospital emergency teams after graduation. However, traditional nursing education focuses on in-hospital nursing knowledge. Pre-hospital emergency content is often spread across optional courses or thematic lectures without a system or job-targeted focus ^[1]. Therefore, students have difficulty adapting to the new environment in the emergency department. Therefore, in order to improve the quality of talent cultivation and conduct theoretical research on optimizing emergency education systems, a systematic integration strategy for pre-hospital emergency training and higher vocational nursing education based on actual job requirements should be explored.

2. Relevant concepts and theoretical foundations

2.1. Definition of core concepts

Pre-hospital emergency care refers to the first few minutes after a serious illness or injury occurs, when trained professionals provide immediate medical assistance and safely transport the patient to a hospital. The main characteristics are time pressure, environmental uncertainty, resource scarcity, and autonomous decision-making in intervention. Higher-vocational nursing education is a kind of higher vocational education that aims to cultivate high-quality, technically competent nursing personnel for primary-level medical and health institutions, and focuses equally on practical ability and professional literacy. Job requirements refer to all-around competence expectations for employees in terms of knowledge systems, operating skills, clinical thinking, communication and cooperation, and emergency handling. They connect education and work at the same time. Education-job integration refers to incorporating job competency standards into all links of curriculum design, teaching implementation, and assessment to achieve seamless alignment between school education and professional practice. In short, it is to reduce the gap between schools and workplaces and enable students to learn by doing and learn through doing.

2.2. Job-requirement-oriented theory

Based on the idea of competency-based education, job-requirement-oriented theory proposes that the goals and contents of vocational education should start with the competence demands of job positions. Based on the results of job analysis, identify the knowledge, skills, and attitudes required for the main work of the position, and then reverse-engineer teaching objectives and learning activities. In the area of pre-hospital emergency care, this theory requires educators to carry out fieldwork in emergency centers and emergency departments, investigate frequent emergency cases, common operations, and essential decision-making points, and convert abstract occupational norms into teachable and learnable curriculum components. Offer some ideas for teaching integration; change the logic from “What teachers can teach” to “What employers want,” and ensure that the direction and results of talent cultivation are effective.

2.3. Education-integration theory of education and employment

Under the policy system of industry-education integration, the four types of education-job integrated education theory are: objective integration, content integration, process integration, and evaluation integration. Objective integration needs to map job-competency goals to curriculum teaching goals equally. Content integration aims to turn typical job tasks into teaching projects or learning scenarios. Process integration advocates organizing teaching activities according to actual or simulated work processes. Evaluation integration puts forward using industrial norms as the basis for academic assessment. This

theory does not use the old way of “learning before doing,” but instead proposes a spiral growth model of alternating study and application. Education-job integration in pre-hospital emergency training simulates real-world workflows, such as dispatch command, on-site assessment, and team cooperation, to help students gain a deeper understanding of their future jobs during school ^[2].

3. Current status of pre-hospital emergency teaching in higher-vocational nursing and job requirements

3.1. Analysis of core competence requirements for pre-hospital emergency posts

The five types of core competency requirements for pre-hospital emergency practitioners are: rapid assessment and decision-making; basic and advanced life-support operations; on-site management of trauma hemostasis, bandaging, immobilization, and transportation; team communication and dispatch coordination; stress, psychological adjustment, and self-protection. Based on the text analysis of job descriptions for local emergency centers, emergency nurses need to complete all steps of the workflow independently during off-duty hours, such as assessing the scene’s safety, making an initial diagnosis, providing emergency treatment, and deciding whether to transfer, within about 8-12 minutes; thus, they require excellent clinical judgment and proficient procedural skills. In addition, there are many unpredictable circumstances in emergencies, such as traffic accident scenes, residential areas, and public gathering places; therefore, multi-skilled training in traditional nursing education, such as intravenous injection and vital sign observation, is no longer sufficient.

3.2. Investigation of pre-hospital emergency teaching in higher vocational nursing

Based on the current teaching situation, three typical higher vocational colleges with nursing programs in the province were selected for this study. Talent-training schemes, curriculum norms, and interviews with professional teachers were analyzed to organize pre-hospital emergency teaching implementation. Research shows that most pre-hospital emergency content is taught by emergency nurses or critical-care nurses, and the average number of theoretical class hours is around 12–18, with no more than 8 practical class hours. Practical training focuses on isolated skills, such as cardiopulmonary resuscitation and bag-valve-mask ventilation, and lacks systematic drills of full emergency workflows. Most of the interviewed teachers do not have first-hand experience in front-line pre-hospital emergency work, and their teaching cases are based on textbooks or second-hand materials without real-life situations. Interns are rarely involved in actual emergency calls or rescue work during their internship and are mainly observers. In short, the current teaching mode has fragmented knowledge, isolated skills, and virtualized scenarios, and fails to help students form a complete pre-hospital emergency response system.

3.3. Adaptability gaps between teaching and work requirements

Misalignment between teaching and job demands is shown by inconsistent goals, a lack of relevant content, and outdated assessments. Most of the objectives at the objective level focus on learning basic emergency skills, but posts require all-around competence to handle emergencies independently in complex and changing environments; thus, there is a hierarchy gap. At the content level, pre-hospital-specific components such as on-site safety control, triage, and telemedicine cooperation are rarely covered, and many class hours are spent on procedures that are used infrequently in actual work, resulting in a low correlation between teaching content and real-life applications. Existing evaluations focus on operational standardization at the

assessment stage and fail to provide effective measurement instruments for job-critical attributes such as emergency decision-making ability, humanistic care, and teamwork. Therefore, although the students have passed the course exams, they will be unable to handle real-world out-of-class assignments.

4. Necessity and feasibility of integrating pre-hospital emergency training with nursing teaching

4.1. Necessity of job-curriculum integration for talent cultivation

Socially, the number of annual pre-hospital emergency outcalls in local cities keeps rising, and there is a continuous shortage of emergency doctors and nurses. Graduates of high-level vocational nursing programs are now the main supply of frontline emergency staff. However, due to a lack of coordination between institutional education and on-the-job training, new hires take a long time to adapt and have a relatively low pass rate for independent post-assessments; thus, both manpower costs and operating risks for the emergency system increase indirectly. Fragmented pre-hospital education does not meet the professional development needs of students. Many graduates need to relearn basic skills such as off-site evaluation, doctor-patient communication, and urgent airway management after starting work, which is an indirect loss of educational investment. Therefore, promoting pre-hospital emergency training and integrating it into higher-vocational nursing education is an unavoidable path to reduce the period of job adaptation and enhance the talent-training efficiency at its origin ^[3].

4.2. Foundational conditions for teaching integration

Mature Conditions Support Current Teaching-Integration Practices: Politically, national documents issued by the Ministry of Education on deepening industry-education integration encourage industry and enterprises to participate in the formulation of teaching standards and provide institutional support for cooperation between emergency centers and colleges. Technologically, high-fidelity simulators, virtual-reality emergency training systems, and online case libraries are becoming more accessible. They can create various difficult pre-hospital emergency situations and other problems at the university level to compensate for the lack of real-life practice opportunities. In terms of faculty, enhanced cultivation of dual-competency teachers can help colleges strengthen instructors' practical abilities by organizing off-campus training sessions and part-time work for emergency center staff. Some colleges have been developing their own curricula and school-enterprise cooperation models.

4.3. Core values of teaching integration

Teaching Integration Creates Values at Three Levels: Talent cultivation builds a step-by-step competence-development path of cognition-simulation-practice to enable students to move from knowledge acquisition to internalized emergency thinking, thus allowing graduates to take up positions and work effectively after graduation. Integration promotes the transformation of the curriculum system from static knowledge transmission to dynamic competence construction, drives renewal in teaching content and pedagogy, innovates assessment, and improves the overall quality of programs. Industrial development provides stable talent co-cultivation channels for colleges and emergency institutions, reduces the cycle of pre-service training for new emergency staff, lowers social manpower-training costs, reserves talents for standardized emergency-technique promotion and continuous quality improvement, and achieves significant public-health

benefits.

5. Integration strategies of pre-hospital emergency training and nursing teaching based on job requirements

5.1. Curriculum-content optimization based on job standards

Optimization of curriculum content should directly reference pre-hospital emergency job competence standards and build a progressive curriculum consisting of basic, core, and extended modules. The general module will cover all nursing students and provide them with general emergency skills, such as CPR and airway management, hemostasis, bandaging, immobilization, transport, and recognition of common acute diseases, etc., so everyone can learn them. The main module will focus on the specific work of emergency nurses, such as on-site command for mass-casualty incidents, advanced life-support teamwork, emergency documentation and information reporting, and use project-based learning for content organization. The extended module is for students who wish to pursue careers in emergency services; it offers special courses such as pre-hospital trauma life support and pediatric emergency care and is in line with certification programs organized by emergency centers. At the same time, a dynamic content-updating mechanism will be introduced to adjust teaching priorities annually based on feedback from emergency centers about changes in job requirements and keep the content relevant to practice.

5.2. Teaching model innovation in line with job scenarios

Teaching-model innovation aims to overcome spatial-temporal barriers between classrooms and workplaces, and promotes immersive pedagogy based on scenarios, tasks, and reflections. Authentic emergency cases will be used to create teaching situations. High-fidelity simulation equipment has been built to recreate accident scenes, residential areas, and ambulance bays, and students can carry out the entire task chain of alarm reception and mission dispatch, on-site intervention, and handover during transportation in a high-pressure simulated environment. Contingency variables, such as equipment failure, agitated family members, and sudden patient deterioration, are added to train emergency decision-making and psychological resilience. Authentic work materials, such as emergency center dispatch records and in-ambulance videos, can also be used for teaching discussions. Invite front-line emergency workers to give class talks and bring real-life scenarios into the classroom to help students feel more involved in their studies.

5.3. Reconstruction of assessment systems based on job competency

The reconstruction of the assessment system should give equal weight to process-oriented and summative evaluations, integrate skill assessment with scenario-based assessment, and establish multi-dimensional evaluation mechanisms based on job competence. In addition to the standardized single-procedure test, other forms of skills tests are also available. Students need to complete all the steps of the emergency workflow in a short amount of time, including assessment, intervention, communication, and documentation, and this will be jointly graded by college teachers and emergency center mentors. Competency-based rating scales for pre-hospital emergency posts have been developed to evaluate the dimensions of rationality in clinical decision-making, efficiency and standardization of operations, effectiveness of team communication, and performance in humanistic care. Continuous records of individual competence growth are obtained by accumulating results from multiple simulation drills. In addition, some parts of the pre-service certification examination at

emergency centers can be incorporated into institutional assessments to promote closer cooperation between academic evaluation and occupational entry, enhance students' employment competitiveness and professional confidence, etc. ^[4].

6. Implementation guarantees and prospects of integrated teaching

6.1. Guarantee for faculty capacity improvement

The faculty's ability will directly affect the implementation of integrated teaching. A training-practice-research trinity teacher development system should be built. Colleges should develop special training plans for emergency-teaching staff, regularly select key teachers to take part in no less than a two-week full-time on-post practice at emergency centers, fully participate in out-call missions, dispatch and quality control, and gain an in-depth understanding of the actual job logic. Joint teaching-research mechanisms will be established by emergency-center specialists and college instructors to hold monthly collective lesson preparations, case studies, and teaching peer reviews to supplement theoretical instruction with practical guidance. Teachers are motivated to participate in emergency skill competitions and revisions of industrial standards to stay informed about new developments in the cutting-edge industry. In addition, special teaching-reform research projects will be organized to help teachers carry out action research on the problems in integrated teaching, improve teaching quality through research, and promote the spiral development of faculty competence.

6.2. Guarantee for practical training resource construction

The three requirements for practical-training resources are: high-fidelity simulation, systematic completeness, and openness. Fidelity requires building high-fidelity pre-hospital emergency training rooms equipped with emergency mannequins, defibrillators, ventilators, and monitors, as well as audio-video recording-and-playback systems for full-process documentation and debriefing of emergency drills. Systematic completeness demands the construction of online-offline integrated teaching-resource banks, which should include typical emergency case databases, operation video libraries, question banks, and virtual simulation training software for both self-directed learning and flexible teaching. Openness will allow the training facilities to participate in the service personnel training and skills competition organized by the emergency center, achieving school-enterprise facility sharing and resource circulation. Colleges need to set aside special construction funds for the staged renovation of training rooms and establish equipment maintenance-replacement mechanisms to maintain good practical training conditions according to industrial changes.

6.3. Expected results and prospects of integrated teaching

Integrated teaching after implementation will likely achieve many positive results. All-round pre-hospital emergency capabilities for students will be strengthened; the cycle of job adaptation will be reduced, and the first-time pass rate for independent post-assessments will rise significantly. Teachers' dual-competency quality will be improved, and a stable school-enterprise dual-collaboration mechanism for emergency-teaching teams will be established. Academic programs will gain wider social recognition and higher employment rates for nursing majors in emergency care, creating unique institutional brands. In the long run, successful integrated teaching practices can be expanded to community first-aid training and public dissemination of emergency knowledge, thereby exercising the colleges' social service function. Future studies will continuously collect data on the career development of graduates for longitudinal effect

evaluation, iteratively optimize integration strategies, and explore the construction of regional emergency education alliances to promote the integration of teaching standards and industrial standards^[5].

7. Conclusion

In-depth integration of pre-hospital emergency training and higher vocational nursing education is a system of projects that responds to the demand for enhanced social emergency service capabilities and addresses the mismatch between talent cultivation and job requirements. Based on the job requirements, this study will systematically present the necessity, feasibility, and implementation path of integration, and put forward a three-dimensional strategy system covering curriculum, teaching and assessment, as well as support guarantee mechanisms. Integration should not be mistaken for the addition of more emergency courses. Therefore, it is necessary to reform the logical framework of teaching objectives based on job competence, rebuild teaching-process ecosystems according to real-life scenarios, and restructure assessment criteria focused on competence development. Only when educators incorporate job-post standards into all stages of teaching can they achieve the goal of “learning for application and competence upon assignment,” and provide more high-quality technically skilled nursing personnel for pre-hospital emergency services.

Disclosure statement

The authors declare no conflict of interest.

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Analysis of the Current Status and Influencing Factors of Psychological Distress in Malignant Tumor Patients during Chemotherapy

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Abstract: *Objective:* To systematically evaluate the current status of psychological distress among patients with malignant tumors during chemotherapy and analyze its multidimensional influencing factors. *Methods:* Evidence from domestic and international crosssectional and longitudinal studies over the past decade was integrated. Evidence was reviewed hierarchically from individual, disease/treatment, and social/environmental perspectives, and a multifactor path model was constructed. *Results:* The incidence of severe psychological distress during chemotherapy ranged from 20% to 35%. Independent risk factors included low economic status, high grade of treatment-related side effects, metastatic disease, and low social support. Fatigue and sleep disturbance exerted significant mediating effects between treatment-related factors and psychological distress. Moreover, economic hardship and deficient family support showed synergistic amplifying effects. *Conclusion:* Psychological distress is driven by multifactor interactions. The fatigue/sleep disturbance mediating chain and social buffering system constitute key intervention targets. A “two-step screening and three-tier intervention” system is recommended. Psychological distress management should be valued equally with somatic treatment to improve the effectiveness of integrated care.

Keywords: Malignant tumor; Chemotherapy; Psychological distress; Influencing factors; Social support

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1. Introduction

Chemotherapy is a relatively common type of treatment for cancer that can extend life. At the same time, there will be physical pain and other emotions. This distress will reduce the willingness to participate in treatment and may worsen the course of illness and quality of life. However, the identification and intervention rates of psychological distress in current clinical practice are still relatively low due to a lack of systematic knowledge about its many causes. Psychological distress results from a combination of various reasons, such as personal traits, health conditions, demands of medical care, and living environments.

Therefore, all-encompassing studies of the present situation and multiple factors affecting psychological distress during chemotherapy can offer practical support for developing personalized psychological support plans. Based on the assessment tool and epidemiological data, this paper investigates the reasons for changes at the individual, disease-treatment, and social-environmental levels, presents integrated models and intervention ideas, and offers a system of theoretical support for clinical work.

2. Assessment and current status of psychological distress

2.1. Definition and measurement tools of psychological distress

Psychological distress refers to a negative emotion caused by many reasons, which may include changes in thinking, behavior, and relationships with others, etc., and ranges from slight mood swings to serious mental illness. The Distress Thermometer (DT) is frequently used in clinical research as a quick-screening tool to measure the level of distress on a 0-10 scale, and a score of 4 or higher is considered clinically significant distress. The Hospital Anxiety and Depression Scale (HADS) and Brief Symptom Inventory-18 (BSI-18) are also frequently employed to assess the extent of anxiety, depression, and somatization. Different Instruments have different sensitivities and specificities. Due to its simplicity, the DT is suitable for regular screening in oncology departments, and multi-dimensional scales can be used to investigate various manifestations of distress. The selected measuring device will affect both the rate at which data are collected and the precision of the resulting factor analysis; therefore, it should meet the requirements of the study. Recently, some electronic adaptive assessment systems have begun to be introduced for dynamic observation and provide technical support for monitoring changes in patients' conditions during chemotherapy in time and space. Further research needs to be conducted to verify the practical value of these methods ^[1].

2.2. Overall incidence of psychological distress during chemotherapy

Based on multiple domestic and foreign cross-sectional studies and meta-analyses, the general prevalence of psychological distress among cancer patients undergoing chemotherapy is between 45% and 65%, and severe distress (DT score ≥ 7) occurs at about 20%–35% of this rate. The frequency of occurrence changes with chemotherapy stage: distress is relatively high before the first cycle of chemotherapy due to the shock of diagnosis and fear of treatment; by the middle of chemotherapy, many people have developed side effects. Although some patients' symptoms have eased after chemotherapy, about 30 percent still feel moderately to severely distressed. The proportion of distress detected is relatively high among inpatients receiving chemotherapy compared with outpatients, and this may be due to indicators of serious illness and feelings of social isolation in the hospital environment. In short, most people are stressed during chemotherapy. Regularly check whether the oncology nurse has added anything new. Strengthen dynamic assessment to identify a high-risk period. Proactive psychological support can be provided before the peak of side-effect accumulation to reduce overall distress and improve the quality of life for patients.

2.3. Distribution characteristics of psychological distress across cancer types and stages of treatment

Psychological distress varies among different types of cancer. Generally speaking, patients with head-and-neck cancer and pancreatic cancer experience more distress due to changes in their bodies and severe digestive problems. Although the survival rate of breast and prostate cancer patients is relatively high, they

still face certain psychological problems caused by reduced sexual function and altered body image. In terms of the stage of treatment, patients who have undergone adjuvant chemotherapy after surgery have better survival prospects and are less distressed than those who have received neoadjuvant or palliative chemotherapy; the latter are concerned about whether the treatment will work and how soon they will be ill again. Patients with recurrent or metastatic disease who have received re-chemotherapy show significantly higher levels of psychological distress than new patients, mainly in the form of hopelessness and fear of death. A larger number of chemotherapy cycles is associated with increased distress and cumulative side effects, especially at cycles 3–4. Therefore, different psychological support systems need to be designed according to the features of cancer and the stage of treatment, and resources should be concentrated on high-risk cancer types and advanced-stage groups.

3. Individual patient-related factors and psychological distress

3.1. Effects of age, gender and educational level

Age is related to psychological distress in a U-shaped manner: young patients experience severe distress due to disrupted social roles and fertility concerns; older patients have increased distress because they are physically weaker and feel a stronger sense of loss; middle-aged patients are relatively stable. Female patients generally report a higher proportion of distress compared to men, possibly because women are more emotionally expressive and sensitive to changes in their bodies. Educationally disadvantaged patients are at risk of developing catastrophic thinking due to a lack of health literacy and thus cannot understand the purpose of chemotherapy. At the same time, well-educated people have good access to information but are also more anxious about bad news on the Internet and face an “information paradox.” Therefore, the association between age or educational level and psychological distress is not linear. Address intragroup subcultural differences and provide targeted psychological education for patients of all ages, paying particular attention to the special needs of young and old people ^[2].

3.2. Roles of economic status and medical insurance

A large-scale macro-environmental stressor for psychological problems in cancer patients undergoing chemotherapy is financial pressure. Patients with high out-of-pocket expenses or household incomes below the local average have shown significantly higher distress scores, and this gap has been increasing over time after treatment. Medical insurance coverage reduces the sense of decision-making conflict among patients facing expensive targeted drugs; therefore, those who are fully insured (by both public and private health insurance) experience less psychological stress compared to those with only basic medical insurance. Fear of poverty caused by illness leads to ongoing financial worries. Even if the present expenses are low, there will still be some anxiety. Economic reasons increase people’s psychological burden directly and, at the same time, reduce their ability to live well by cutting off access to food and healthcare. Economic toxicity indicators should be added to clinical assessment. Provide information on medical assistance and cost-sharing schemes for disadvantaged patients to reduce the financial stress and improve the willingness to receive treatment.

3.3. Impact of previous psychological history and personality traits

Patients who have had anxiety disorders, depression or other mental health problems in the past are at a much

higher risk of experiencing psychological distress during chemotherapy, and this distress is often about twice as severe as that experienced by people without such a history. Neuroticism is associated with poor emotion regulation and thus increased susceptibility to somatization of chemotherapy side effects in individuals. Extraverted and conscientious people are more likely to use adaptive coping behavior and experience less stress. Optimism is generally considered to be protective; however, if a person has not received effective treatment and is still optimistic, they will be disappointed when their hopes are not realized and may suffer from “optimism-induced despair”. At the start of chemotherapy, conduct a baseline psychological assessment to identify vulnerable subgroups and offer preventive psychological education; thereby reducing the risk of psychological distress and promoting adaptive coping for high-risk individuals.

4. Disease- and treatment-related factors

4.1. Cancer stage, disease course and metastatic status

Patients with advanced-stage (Stage III–IV) cancer experience much higher levels of psychological distress compared to those at earlier stages of the disease, mainly due to a loss of hope resulting from changes in the goal of treatment from cure to relief. Disease duration and distress are not linearly related; acute stress is more likely to occur in the first year after diagnosis, and burnout-related depression tends to appear in chronically ill patients who have had their disease for more than two years. Distant metastases, especially bone and brain metastases, cause severe pain or other neurological disorders; thus, they directly lead to strong death anxiety and a sense of loss of control. A relatively large number of metastatic sites are associated with severe distress. Multiple organ metastases can cause various physical problems and reduce one’s ability to cope with stress. Based on the above characteristics, oncology teams need to provide different levels of psychological support at different times during the course of illness and spread of tumor. Early introduction of palliative care concepts for patients with advanced metastatic cancer can help them maintain their sense of self-worth and purpose in life during a short time.

4.2. Chemotherapy schedules, cycles and severity of side effects

High-intensity regimens that contain platinum or taxane drugs cause more severe neurotoxicity, myelosuppression, and gastrointestinal reactions, and thus result in more significant psychological distress compared with oral targeted or endocrine therapies. Accumulated side effects are exacerbated by extended chemotherapy cycles and increase distress. When the total amount of drugs reaches a certain level, people will feel tired, nauseated, and vomit repeatedly due to learned negative associations. A relatively high frequency of side effects indicates that the dose may be too large and thus causes psychological harm. Alopecia and hand-foot syndrome are also relatively common changes in physical appearance that affect one’s sense of self-worth. Frequent changes in the treatment plan indicate poor response to therapy and may lead to feelings of hopelessness and powerlessness ^[3]. Document the degree of side effects and record any discomfort experienced by patients after taking different medications to assess the psychological impact. Promptly address and treat anticipatory nausea caused by highly emetogenic drugs to prevent conditioning of aversion.

4.3. Mediating effects of pain, fatigue and sleep disturbance

Pain, cancer-related fatigue and sleep disorders are relatively frequent adverse reactions to chemotherapy

that may also affect one's emotional state. Based on structural equation modeling, chemotherapy-induced side effects cause about 40 percent of the variation in psychological distress through increased fatigue and disruption of circadian rhythm. Pain leads to sympathetic activation, reduced mobility, and thus poor emotion regulation. Sleep disorders reduce the function of the prefrontal cortex and weaken inhibition of negative thoughts; thus, a vicious cycle occurs. The above three symptoms often occur together and exacerbate psychological distress. Based on intervention studies, exercise-based fatigue management and cognitive-behavioral therapy for insomnia can reduce this mediator effect to some extent. Clustered symptom management should be used clinically to address psychological distress effectively, and among these, fatigue and sleep disorders need to be treated first to interrupt the vicious cycle.

5. Social support and healthcare-environment-related factors

5.1. Family support and attitudes of primary caregivers

Good family support can provide emotional and practical help to reduce stress for people receiving chemotherapy. All the above results are consistent with those from other research. Primary caregivers' attitudes are important; overprotection or negative comments will make the patient feel dependent and guilty, but calm acceptance and open communication can help them feel more in control. Spouse support also matters; infrequent talk between spouses and lack of empathy are linked to higher depression risk in older adults. A family's poor functioning due to conflict or emotional neglect increases a person's stress. Include families in the therapeutic system and organize caregiver communication training as part of the intervention plan. Optimize the pattern of intra-familial interaction to boost patients' sense of safety and adaptability.

5.2. Physician-patient communication quality and information support

The quality of physician-patient communication is relatively easy to improve in the hospital environment. Physicians can inform patients about the goals of chemotherapy, its possible side effects, and other treatment options, listen to their concerns sympathetically, and thus reduce both uncertainty and stress for the patients. If there is a lack of information or too much medical jargon, people will be confused and anxious. Information support provides patients with relevant health knowledge and ways to manage symptoms, as well as referral services for mental health professionals. Based on research, patients who receive organized information have been found to have a 25 percent lower pre-chemotherapy anxiety level. Communication satisfaction is positively correlated with consultation length; however, the extent to which deep-seated needs are met is more influential than how long they are consulted. The quality of communication should be emphasized over quantity in clinical practice. Organize special courses for doctors and nurses on communicating with patients effectively, help them learn how to talk to patients better, and so on.

5.3. Peer support and socialization

Peer support refers to communicating with other people who have been treated with the same type of chemotherapy, providing emotional support and sharing experiences to help rebuild a sense of self-worth and alleviate loneliness. Patients in mutual-aid groups or online patient communities have significantly lower psychological distress levels than those who are socially isolated, and this effect is even stronger for young and female patients. Social integration is negatively correlated with the severity of distress; however, too many social demands can lead to energy exhaustion and thus need to be regulated. Stigma often leads

to social exclusion. Patients with obvious changes in their bodies may feel embarrassed about going out and thus become more isolated. Motivate some high-quality peer interactions and promptly address signs of social withdrawal at the first opportunity. A hospital can build a platform for patients to communicate with each other and assess how long they can continue living independently ^[4].

6. Multi-factor comprehensive analysis and intervention implications

6.1. Independent risk factors derived from multi-factor regression analysis

Based on the results of large-scale regression analysis, the five independent risk factors for psychological distress during chemotherapy identified are: low household income, high-grade side effects, metastatic disease, previous psychiatric disorders, and low social support; most of these have odds ratios between 2.0 and 4.5. After adjusting for other factors, the individual impact of age and education is generally reduced, and they are likely to operate via cognitive appraisal and socio-economic paths. Sleep disturbance appears in all the models as a final equation and has the highest standardized regression coefficient; thus, it is considered a mediator. Identify the independent risk factors to develop a simple screening tool that can identify high-risk individuals for targeted intervention. Avoid multicollinearity among the variables to prevent overfitting of the model and ensure the stability and applicability of the screening tool for clinical promotion.

6.2. Path model of psychological distress and interaction effects

Path models built by Structural Equation Modeling show that disease severity affects psychological distress through two parallel paths: a direct path and an indirect path mediated by the chain of “treatment side effects → fatigue → sleep disturbance,” and this indirect path accounts for about 45 percent of the total effect. Interaction analysis shows that economic hardship and lack of family support work together to increase distress; together, they cause much more severe harm than either would alone. A neurotic personality is more likely to feel tired due to side effects and thus feels vulnerable. Good communication between doctors and patients reduces anxiety caused by information asymmetry. The above path model has identified the primary intervention sites: the fatigue-sleep axis and the social buffering system. It verifies the philosophy of intervention that gives equal weight to symptom relief and social support, and offers a clear theoretical basis for subsequent specific clinical studies ^[5].

6.3. Practical recommendations for clinical psychological intervention strategies

Based on the above overall model, the construction of a “two-step screening and three-tier intervention” system is proposed. First, regularly perform DT tests for all chemotherapy patients. Screen-positive cases will be further examined for fatigue, sleep disorders, and lack of social support. Patients who are mildly distressed will be given psychological education and self-care instructions. Those with moderate distress will be offered combined cognitive-behavioral therapy and family communication classes. Patients with serious distress need psychiatric help and other drugs. Strengthen training in physician-patient communication skills and hold information review meetings at key times. Fatigue management and sleep-hygiene education will be added to the daily work process of nurses to break the chain of causality at its origin. Oncology centers should build multi-disciplinary psychological support teams to carry out regular case reviews and adjust interventions dynamically according to changes in circumstances for continuous efficacy and personalized care.

7. Conclusion

Psychological distress in patients with cancer during chemotherapy is a multifaceted problem resulting from the combined effects of individual factors, illness severity, side effects of treatment, and social environment. This study systematically summarizes the prevalence and multiple dimensions of determinants, and explores the mediating effect of fatigue-sleep disturbance and the buffering function of social support. Most of the existing research uses cross-sectional data and cannot determine causality; therefore, there has been little exploration of why different chemotherapeutic drugs cause varying degrees of distress. In the future, some research will use extended follow-up and ecological momentary assessment to observe changes over time in distress, and randomized controlled intervention trials based on path models will also be conducted. Only when psychological distress management is given the same weight as physical disease treatment can the ideal of patient-centered integrated care be realized, and thus the aim of all-encompassing oncology care achieved.

Disclosure statement

The author declares no conflict of interest.

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Research on the Application of Scenario-based Simulation Teaching Combined with Pre-hospital Emergency Scenarios in Higher Vocational Nursing Training

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Abstract: In light of the teaching reform for pre-hospital emergency training in higher vocational nursing, this paper examines the problems of rigid traditional teaching methods, distorted clinical scenarios, and weak emergency response ability among students, and proposes a system for applying scenario-simulation teaching. Based on constructivism, situated learning, and skill transfer theory, this paper presents multiple scenario constructions, a three-stage closed-loop process design, and an optimized process management scheme. Based on the above analysis, it can be seen that the new system will help students learn better in practice. At the same time, there are also practical deficiencies, such as too much dependence on teachers and a narrow scope of assessment. Therefore, the following optimization strategies are proposed: build a dynamic resource bank, introduce a group rotation mechanism, and adopt multi-dimensional process-oriented evaluation; provide systematic empirical support for the reform of higher vocational nursing practical teaching.

Keywords: Scenariosimulation teaching; Prehospital emergency care; Higher vocational nursing; Practical training reform; Skill transfer

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1. Introduction

The first link in the public health emergency response system is pre-hospital emergency care. The time and accuracy of this decision will directly affect whether a seriously ill patient can live, so the nursing staff's clinical judgment, operating ability, and mental health need to be very good. High-quality vocational nursing education aims to train excellent technically skilled personnel for the front line, and the quality of practical training will directly affect their post-graduation employment prospects. However, most of the pre-hospital emergency training in higher vocational colleges still follows the traditional model of "teacher demonstration of technical procedures followed by passive imitation practice by students," and thus fails to help students

gain a deep understanding of the complexity and urgency of real-life emergency situations. Build a high-fidelity clinical environment and use scenario-simulation teaching to have students actively construct clinical thinking through role-playing and dynamic interaction, thereby connecting classroom learning with actual medical practice. Systematically sort out the relevant theoretical basis and current teaching conditions, identify structural deficiencies in practical training, design and implement targeted simulation-teaching schemes, and summarize improvement measures through effect verification and reflection; thus, provide evidence-based operational frameworks for teaching reform in peer institutions.

2. Overview of the research

2.1. Connotation and characteristics of scenario-simulation teaching

Based on the idea of constructivism, scenario-simulation teaching is employed. In short, it builds a real-life work environment by setting up a physical space, assigning roles, and organizing events based on the desired teaching goals. Learners take part in the entire process of problem-solving from their own experiences and build knowledge and skills through repeated practice and reflection. It has three basic attributes: situation authenticity, task completeness, and generative interaction; therefore, it goes beyond mere case studies or role-playing^[1].

First, it offers a good experience. Learners are placed in a simulated emergency environment and receive simultaneous visual, auditory, tactile, and time-pressure stimuli for deep immersion. Second, it is highly integrative; thus, it can connect knowledge from different fields such as anatomy-physiology, pharmacology, communication skills, and ethics of care in emergency situations. Third, it will inspire thought. Organized debriefing after the simulation can help students move away from their initial emotional reactions and engage in rational thinking and strategy planning based on the actual situation.

2.2. Core contents and requirements for pre-hospital emergency practical training

The pre-hospital emergency training system includes off-site risk assessment, first aid for injuries, basic life support, airway management and ventilation, hemorrhage control and bandaging, fracture immobilization and safe transport, as well as psychological support for patients and their families. Finally, educators want to help students learn how to respond promptly, reasonably, and effectively during the golden hour of rescue.

Training requirements should include standardized individual operations, such as sufficient compression depth and full-chest recoil during CPR, correct bag-valve-mask technique, and coordinated emergency work and effective teamwork. Pre-hospital environments in reality are highly uncertain; there may be a lack of information, supply shortages, and bystander interference. In addition, practical training should enhance adaptive communication skills; students need to give clear instructions, regulate multiple-party emotions, and organize off-site orders in a disorderly and noisy environment. Therefore, the content of pre-hospital emergency training should go beyond technical drills and promote all-around abilities such as clinical thinking, risk assessment, and professional responsibility.

2.3. Current situation of higher vocational nursing practical teaching

Under the impetus of national vocational education reform and the Healthy China initiative, significant progress has been made in the hardware facilities for higher vocational nursing education. Many colleges have established multi-functional simulation wards and virtual-reality interactive systems. Pedagogy and

teaching methods have not been updated in line with new hardware developments. Classroom practice is still mainly in the form of checklist-driven mechanical drills, and students are considered proficient after completing these procedures. There is no good adaptive training for changes in the course of illness, equipment failure, or problems with doctor-patient communication.

There is a serious lack of “dual-qualified” teachers who have strong theoretical foundations and rich front-line clinical emergency experience; thus, high-quality simulation cases cannot develop normally. Although a few colleges have introduced standardized patients or simple situation skits, these are still superficial additions rather than an organized, regular part of the curriculum. In short, most high-level vocational nursing practical training is at a critical stage of change from “skill rehearsal” to “clinical competency-oriented education.”

3. Theoretical foundations of the research

3.1. Constructivist learning theory

Constructivist Learning Theory does not believe in the transmission of knowledge. Knowledge is not a passive reflection of the external world; rather, it is a subjective meaning system that people construct actively through their interactions with the environment, cooperation among peers, and self-exploration based on previous experiences in a particular social-cultural context.

In pre-hospital emergency training, students face dynamic clinical situations and need to identify the main problems, use available resources effectively, make urgent decisions, and bear the consequences; this is in line with the idea of “authentic task-based learning” proposed by constructivists. Scenario-simulation teaching offers a safe, scaffolded environment. Learners can test the intervention strategy without harming actual patients, correct errors, and learn how to apply abstract textbook knowledge flexibly ^[2].

3.2. Situated learning theory

According to the theory of situated learning, learning is “legitimate peripheral participation.” To gain both explicit professional knowledge and tacit practical skills, learners need to participate in real or high-fidelity simulated communities of practice through progressive observation, hands-on experience, and the formation of a professional identity.

Pre-hospital emergency care is very situation-specific. Learners will not have developed a good sense of place and adaptability in a multiple-choice environment. Scenario-simulation teaching can create various situations, such as street accidents, sudden illnesses at home, and construction-site injuries. Add time pressure, background noise, and upset family members to increase ecological validity intentionally. Learning by doing helps students learn about their roles and operating rules better, reduces the difference between what they learn in class and what they need to know for their jobs, and promotes the application of knowledge.

3.3. Skill transfer theory

The general idea of skill transfer theory is to apply the abilities learned in one place to other places. To improve transfer efficiency, expand the range of training, introduce various tasks, and enable learners to learn general problem-solving skills.

The cases of pre-hospital emergency scenarios are diverse. If only the standard procedures are repeated in training, students will have rigid procedural memories. Their performance drops significantly when there

is a change in the real-world environment. Scenario-simulation teaching can build multiple versions of case libraries for various causes, age groups, and off-site constraints to expand task diversity. Debriefing sessions help students learn general rules for decision-making, convert surface-level motor skill memory into high-level strategic ability, and enhance their adaptability to new and difficult situations.

4. Existing problems in pre-hospital emergency training for higher vocational nursing

4.1. Rigid and monotonous practical-teaching modes

The current dominant model for pre-hospital emergency training is still a traditional linear process: teacher lecture, procedural demonstration, repeated group practice by students, and final skill assessment at the end of the term. The entire teaching rhythm is teacher-led, and students complete the checklist to take the test. Monotonous practice fails to train dynamic clinical assessment and prioritization skills, so many students can perform individual operations well but are unable to make timely decisions in the event of sudden changes in health status.

At present, the standards for assessment also focus on process. Quality of clinical thinking, team communication efficiency, and emotion regulation ability are not primary evaluation indices. The above bias in assessment will encourage teachers to lead students to learn by rote and fail to promote all-around development of their clinical skills ^[3].

4.2. Discrepancy between practical training scenarios and real-world clinical conditions

Training laboratories are generally clean, well-lit, well-equipped, and quiet; they are far from the actual pre-hospital environment of dim light, small spaces, slippery floors, loud surroundings, and emotional or obstructive family members. Students have been trained in these protected laboratory environments and thus lack real-life perception of hazards, limited resource allocation, and interpersonal conflict management.

Most of the current scenarios are static initial-state simulations and do not show how diseases change over time, such as vomiting or ventricular fibrillation during CPR. Students have rarely been exposed to consecutive unforeseen difficulties and thus face significant “reality shock syndrome” upon their first clinical internship; consequently, their professional self-confidence is weakened.

4.3. Deficiencies in students’ all-round emergency practical ability

Due to a fixed teaching mode and de-contextualized scenarios, higher vocational nursing students show clear deficiencies in pre-hospital emergency response in terms of cognition-decision-making, technical operation, and emotional regulation. Students have difficulty quickly assessing all the injured people and prioritizing their care; they focus too much on minor injuries and fail to help others. Operationally, the technical performance declines under high-pressure conditions; typical errors include inadequate compression depth and improper placement of a tourniquet, as well as unclear command delivery and role overlap among team members. Most students feel anxious, mentally blank, or avoidant in the presence of actual patients psychologically. The reasons for these shortcomings are not only a lack of technical knowledge but also an overall failure to provide training on emergency decision-making and psychological adjustment mechanisms.

5. Design and implementation of scenario-simulation teaching

5.1. Construction of pre-hospital emergency simulation scenarios

Based on the campus emergency simulation teaching center, mobile partition walls, high-fidelity projection screens, professional audio equipment, and other simulation props have been installed. The four representative cases are as follows: sudden illness at home, urban road traffic accident, construction-site fall injury, and sports-field injury. All the scenarios had a standard first-aid kit and a configurable equipment failure simulation device.

Based on the three-level progressive system, the scenario construction was divided into three parts: physical reality restoration, psychological atmosphere rendering, and authentic task embedding. Space arrangement, light color temperature, and background noise are all examples of context. Teachers and standardized patients performed spontaneous performances under time pressure. Conflicting clues, such as obstructive family members, communication breakdowns, and low-powered rescue equipment, were present, and students had to choose among them due to resource limitations ^[4].

5.2. Design of scenario-simulation teaching procedures

The three stages of the closed-loop system were: Pre-simulation Orientation, Immersive Simulation Execution, and Guided Debriefing, to ensure consistent learning and deep thinking. In the pre-simulation orientation, teachers provided short case materials and role assignments, and students completed mental preparation and off-site risk assessment in five minutes. The immersion simulation period was 15–20 minutes long, and it generally followed the same process as on-site assessment, emergency response, and safe transfer. Teachers triggered pre-set clinical deterioration scenarios via central control for off-site testing. Guided debriefing used a non-punitive evaluation method and had students first share their own emotions and thoughts, then have peers observe. Then, the teacher posed some heuristic questions at the critical points of decision-making to guide the students' clinical reasoning.

5.3. Teaching implementation and process control

Two natural parallel classes of Grade-2024 nursing majors from a higher vocational college were selected as the research subjects. The experimental group used scenario-simulation teaching, and the control group was taught conventionally. The total number of teaching hours, curriculum content, and teachers were the same for both groups.

Six-person training groups were formed in the experimental class, and two other observers recorded the group's interaction data. Role rotation was used to give all the students a chance to be the on-site commander, technical operator, information recorder, and patient counselor. Critical control measures: Clarify the boundary between simulation and actual clinical practice to avoid excessive psychological pressure; set up a "safe-word" mechanism for voluntary emergency interruption; schedule a 10-minute rest period after each simulation. Multi-dimensional process archives have been created to store operation records, decision-making paths, and communication logs.

6. Application effects and teaching optimization strategies

6.1. Analysis of teaching outcomes

Objective structured clinical examination and self-developed emergency-decision-making scales were used

for evaluation. Based on the statistics, the experimental group performed better than the control group in all three areas: completeness of emergency response, rationality of clinical decision-making, and efficiency of team communication. According to the qualitative data in the reflective journals, scenario-simulation provided a realistic emergency situation and strengthened students' sense of purpose and emotional strength. Classroom observations found that the experimental class students had more high-level questions and logical analyses during debriefing. In addition, clinical preceptors gave the experimental-class students more than 10 percentage points higher scores for off-site adaptation in the early stages of clinical internship and confirmed favorable long-term skill transfer effects.

6.2. Practical deficiencies of the teaching model

Although the results were good, there were serious problems in practice. First, high-quality scenario design requires teachers' clinical emergency experience and script-writing skills. Inconsistent plot logic or too many conflicting clues in some simulation cases led to cognitive dissonance among students. Second, full-cycle simulations are time-consuming. Only three or four groups can finish the drills in a normal class period. Many students were in the observer role and did not participate actively or focus well. Third, assessments have focused on final exams; process-oriented behavioral data, such as changes in emotion and reaction speed during decision-making, have been neglected and cannot reflect the gradual progress of learning^[5].

6.3. Optimization countermeasures for higher vocational nursing practical training

Based on the above deficiencies, four feasible remediation measures are put forward. First, establish a dynamic teaching resource library with core basic cases and adjustable-parameter modules. Teachers can adjust the difficulty level and context to reduce the workload of independent case development. Second, set up an organizational system for simulated-drill rotation and parallel small-group operation. Large classes are divided into mini-units that run different cases simultaneously, and then joint debriefing sessions are held to increase the frequency of participation and immersion within a limited number of class hours. Third, develop behavior-anchored process-evaluation scales, decompose non-technical skills into observable behavioral indicators, and integrate peer-assessment and self-assessment weights to build multi-source evaluation closed loops. Fourth, organize regular emergency-center-on-the-job training courses for teachers. Senior outstanding students are selected to act as auxiliary simulated participants and help build a stable faculty and personnel support system.

7. Conclusion

Scenario-simulation teaching offers a new model for transforming pre-hospital emergency training at higher vocational nursing schools by moving away from "skill-drill-centered" education towards "clinical-situation-centered" learning. Through the entire research chain of theoretical review, problem diagnosis, scheme design, and effect verification, this study has found that scenario-simulation teaching can effectively motivate deep-level student participation, reduce the gap between classroom training and actual clinical practice, and enhance all-around emergency skills. However, it will also have relatively higher demands for faculty qualifications and optimized teaching organization and evaluation systems. In the future, extend the duration of longitudinal follow-up studies to investigate how different intensities and frequencies of simulation affect the long-term career development of nursing talents. Virtual reality, artificial intelligence, and simulation

teaching can also be integrated in depth to build adaptive-diagnosis intelligent training systems, and thus provide strong support for high-quality emergency care personnel cultivation under the Healthy China Initiative.

Disclosure statement

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Cooperation Mode



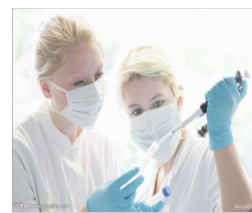
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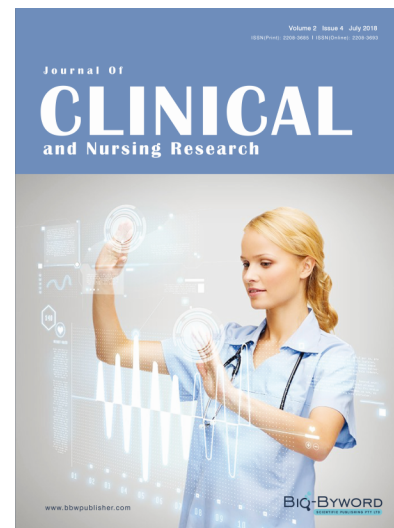
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constructed, with specific intervention measures as follows.

Preoperative refined risk assessment and pre-intervention. One day before surgery, the pediatric-specific Braden Q pressure injury risk assessment scale was used for special assessment of children. Multiple indicators, including children's age, weight, skin elasticity, nutritional status, limb mobility, estimated operation duration, intraoperative cardiopulmonary bypass, and hypothermia intervention, were comprehensively evaluated to accurately stratify low, medium, and high risk levels, establish individualized nursing files, and formulate targeted protection protocols. Special emphasis and enhanced targeted protection were placed on high-risk children with young age, low body weight, and estimated operation duration longer than 2 hours. Preoperative full-body skin cleaning was performed thoroughly, focusing on skin folds such as neck, armpits, lumbosacral region, and heels to remove sweat, stains, and residual sundries and avoid local compression and stimulation by foreign matter. Meanwhile, clinical nutritionists collaborated to evaluate children's nutritional status. For children with mild malnutrition and poor skin elasticity, families were guided to supplement high-quality protein and vitamins preoperatively to improve the tolerance of skin tissues. Special health education was conducted for families to elaborate on high-risk factors, key protection points, and cooperation matters of pressure injuries in pediatric cardiothoracic surgery, so as to improve family nursing cooperation.

Intraoperative refined body position management and decompression protection. Surgical body positions were individually and finely adjusted according to children's body shape, skeletal development, and specific surgical procedures to avoid long-term compression of bony prominences and shear force-induced skin damage. For children undergoing supine surgery, flexible medical decompression foam dressings were pasted on stressed parts, including the occiput, scapula, lumbosacral region, and heels, to replace traditional cotton cushions, and silica gel decompression positional pads were adopted to evenly disperse body pressure. For children undergoing congenital heart disease and thoracic deformity surgery, the shank elevation method was applied to suspend the heels completely, thoroughly eliminate compression on terminal parts, and reduce the risk of heel pressure injuries. Surgical bed sheets were fully flattened before surgery to avoid skin compression by folds and sundries; intraoperative negative pressure suction operations were standardized to prevent skin traction and friction caused by pipelines. In view of the slowed peripheral circulation induced by intraoperative cardiopulmonary bypass and hypothermia, limb warmth was maintained without affecting surgical operations to ensure normal skin blood perfusion. Intraoperative disinfectant, blood, and exudate were wiped away promptly to keep the skin dry throughout the operation and prevent damage to the skin barrier caused by moisture stimulation.

Postoperative refined dynamic skin monitoring and special nursing. Immediately after children returned to the ward postoperatively, comprehensive full-body skin assessment was performed, focusing on intraoperative key stressed parts. The skin color, integrity, swelling, and congestion were recorded in detail to improve the postoperative skin monitoring files. Special skin assessment was conducted every 1 hour within 6 hours after surgery and every 2 hours within 24 hours after surgery to accurately identify early occult skin damage and timely intervene in initial abnormal symptoms such as skin flushing and local congestion. Individualized turning plans were formulated based on children's postoperative cardiopulmonary function recovery. Turning movements were gentle without dragging or pulling limbs to minimize skin shear force and friction damage. Bed units were kept flat, dry, and debris-free throughout the nursing period, and damp clothes and bed linens were replaced in a timely manner. For children with postoperative bed rest and

ventilator-assisted ventilation, fixed pipelines and electrode patches were loosened regularly to avoid long-term local skin compression. In addition, individualized postoperative nutritional support was strengthened, and dietary protocols were formulated according to children's age, weight, and condition to enhance body resistance and skin tissue repair capacity.

Refined nursing quality control and continuous improvement. A special quality control group for pressure injuries in the department was established to organize regular professional training on pediatric skin protection and refined operations for nursing staff, so as to strengthen their ability to identify high-risk factors and master specialized nursing skills. The implementation of nursing measures, including skin risk assessment, decompression protection, and dynamic monitoring, was inspected daily. Skin abnormality data were summarized weekly to systematically analyze high-risk causes, and intervention procedures were optimized for weak links in nursing. A closed-loop nursing management model of risk assessment-precise intervention-dynamic monitoring-problem improvement was formed to continuously improve the quality of perioperative skin protection ^[1].

2.3. Observation indicators

- (1) Incidence of pressure injuries: The occurrence of pressure injuries in children during the perioperative period (from preoperative to 72 hours postoperatively) was statistically analyzed. The injury grade was determined in accordance with the international pressure injury grading standard, and the total incidence was calculated.
- (2) Occurrence of abnormal skin conditions: The number of cases and total incidence of various abnormal skin conditions, including skin flushing, moisture-induced injury, and friction damage, were compared between the two groups.
- (3) Nursing satisfaction: A self-made family nursing satisfaction scale of the hospital was adopted for investigation, with a total score of 100 points. Scores of 90–100 points were defined as very satisfied, 70–89 points as satisfied, and <70 points as dissatisfied. Nursing satisfaction rate = (number of very satisfied cases + number of satisfied cases)/total number of cases × 100%.

2.4. Statistical methods

SPSS 26.0 statistical software was used for data analysis. Measurement data were expressed as mean ± standard deviation (Mean ± SD), and *t*-test was used for inter-group comparison; count data were expressed as cases (percentage) [n(%)], and χ^2 test was used for inter-group comparison. The test level α was set as 0.05, and $P < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of perioperative pressure injury incidence between the two groups

Only 1 case of stage I pressure injury occurred in the observation group, with an incidence of 2.33%; 7 cases of stage I–II pressure injuries occurred in the control group, with an incidence of 16.28%. The incidence of pressure injuries in the observation group was significantly lower than that in the control group, and the difference was statistically significant ($\chi^2=4.965$, $P=0.026$).

3.2. Comparison of abnormal skin conditions between the two groups

The incidence of each abnormal skin condition, including skin flushing, moisture-induced injury, and friction damage, in the observation group was significantly lower than that in the control group, and the total incidence of abnormal skin conditions was remarkably lower, with a highly statistically significant inter-group difference ($P<0.001$) (Table 1).

Table 1. Comparison of perioperative abnormal skin conditions between the two groups [n(%)]

Group	Number of cases	Skin flushing	Moisture-induced injury	Friction damage	Total abnormal incidence
Observation group	43	2(4.65)	1(2.33)	0(0.00)	3(6.98)
Control group	43	8(18.60)	6(13.95)	4(9.30)	18(41.86)
χ^2 value	-	4.074	3.888	4.195	14.692
P value	-	0.044	0.048	0.041	<0.001

3.3. Comparison of family nursing satisfaction between the two groups

The family nursing satisfaction rate of the observation group was 95.35%, which was significantly higher than 76.74% in the control group, and the inter-group difference was statistically significant ($P<0.05$) (Table 2).

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

Group	Number of cases	Very satisfied	Satisfied	Dissatisfied	Satisfaction rate
Observation group	43	32(74.42)	9(20.93)	2(4.65)	41(95.35)
Control group	43	21(48.84)	12(27.91)	10(23.26)	33(76.74)
χ^2 value	-	-	-	-	6.198
P value	-	-	-	-	0.013

4. Discussion

Children undergoing cardiothoracic surgery belong to an extremely high-risk group for pressure injuries. The superposition of multiple risk factors, including the anatomical and physiological particularities of children's skin, prolonged intraoperative immobilization, intraoperative hypothermia and cardiopulmonary bypass intervention, and long-term postoperative bed rest, leads to a significantly higher risk of skin damage than children undergoing general surgery^[6]. Pressure injuries not only cause physical pain, crying, and restlessness in children and affect postoperative cardiopulmonary function recovery and feeding status, but may also induce complications such as skin infection and unhealed wounds, prolong hospital stay, and increase family medical burden and clinical nursing pressure, serving as a vital adverse factor affecting the rehabilitation effect of pediatric cardiothoracic surgery^[7]. Therefore, constructing a scientific and standardized refined perioperative skin protection system is the core measure to reduce the incidence of pressure injuries and improve the quality of pediatric cardiothoracic specialized nursing.

The conventional perioperative skin nursing model in clinical practice is extensive, dominated by passive postoperative observation and symptomatic treatment. It lacks precise preoperative risk screening, detailed intraoperative protection and continuous postoperative monitoring, and fails to effectively intervene in hidden high-risk factors such as positional shear force, long-term local low-pressure compression and moisture stimulation. The nursing model is deficient in foresight and pertinence, cannot meet the skin

protection needs of delicate children's skin, and has limited clinical preventive effects ^[8]. Adhering to the modern evidence-based nursing concept, the refined nursing model adopted in this study breaks the passivity and one-sidedness of traditional nursing, constructs an integrated whole-process closed-loop protection system covering the preoperative, intraoperative, and postoperative periods, and realizes accurate prevention and control of pressure injury risks ^[9].

Preoperative individualized risk stratification was performed via the dedicated Braden Q scale to accurately identify high-risk children, and targeted skin pre-intervention, nutritional intervention, and health education were carried out to avoid inducing factors of pressure injuries from the source and lay a foundation for perioperative skin protection. Intraoperatively, the extensive traditional body position placement method was abandoned, and individualized body position arrangement was conducted based on children's body shape and surgical procedures. Specialized decompression dressings and silica gel positional pads were applied to effectively disperse pressure on bony prominences. Meanwhile, intraoperative adverse stimuli such as moisture, friction, and low temperature were strictly controlled to minimize intraoperative skin damage ^[10]. Postoperatively, high-frequency dynamic skin monitoring was implemented to capture early occult skin damage in a timely manner. Combined with individualized turning nursing, pipeline skin protection, and nutritional support, the progression of skin damage was blocked to fully protect the integrity of children's skin. In addition, the special quality control and continuous improvement mechanism standardized nursing operation procedures, made up for the loopholes in routine nursing, and ensured the effective implementation of nursing measures.

The results of this study showed that the observation group had a significantly lower incidence of pressure injuries and total abnormal skin conditions, and remarkably higher family nursing satisfaction than the control group, confirming that refined nursing can effectively avoid high-risk factors for perioperative skin damage in pediatric cardiothoracic surgery and greatly reduce the incidence of pressure injuries and various abnormal skin conditions. The underlying reason is that refined nursing focuses on clinical nursing details, implements targeted interventions for exclusive high-risk factors of pediatric cardiothoracic surgery, and balances individuation and comprehensiveness, which effectively compensates for the shortcomings of routine nursing. It can not only accurately protect children's delicate skin and reduce physical damage, but also improve families' medical experience through detailed and high-quality whole-process nursing services, conforming to the development concept of modern pediatric precision nursing and humanistic nursing.

Meanwhile, this study has certain limitations. It is a single-center and small-sample clinical study with a follow-up period limited to 72 hours postoperatively, failing to observe the long-term skin recovery status of children. Future studies can carry out multi-center, large-sample controlled trials with prolonged follow-up periods, further optimize the refined nursing intervention process, and refine individualized protection protocols for children of different age groups and different surgical types, so as to provide more comprehensive evidence-based support for clinical standardized promotion.

5. Conclusion

The application of refined nursing intervention in the perioperative nursing of children undergoing pediatric cardiothoracic surgery can effectively identify and avoid high-risk factors for pressure injuries, significantly reduce the incidence of perioperative pressure injuries and various abnormal skin conditions, fully maintain the integrity of children's skin, and reduce the occurrence of postoperative complications. Meanwhile, it

can effectively optimize the quality of nursing services, improve family nursing satisfaction, and enhance doctor-patient relationships. With significant intervention effects and strong practicality, this nursing model conforms to the refinement development trend of specialized nursing and is worthy of clinical promotion and application in pediatric cardiothoracic departments.

Disclosure statement

The author declares no conflict of interest.

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Application Research of Online and Offline Blended Teaching in Continuing Medical Education of Basic Medicine

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Abstract: *Objective:* In view of the practical pain points of in-hospital continuing medical education, this study aimed to explore the application value of online and offline blended teaching in basic medical training for medical staff, so as to solve the practical problems of low participation enthusiasm of trainees, difficulty in understanding abstract theories, and poor connection between theoretical learning and clinical practice in traditional centralized teaching. It provides implementable practical evidence for medical institutions to optimize the reform path of basic medical continuing education. *Methods:* A total of 40 on-the-job standardized training physicians and newly recruited clinical medical staff in our hospital were enrolled and divided into two groups via a parallel control design, with 20 cases in each group. The control group adopted the traditional in-hospital training mode of centralized offline lectures combined with on-site practical demonstration. Based on the in-hospital teaching conditions, the observation group constructed an integrated blended training system of *pre-class online preview, in-class offline intensive teaching and practical operation, and after-class online review and expansion* adapted to the disciplinary characteristics of basic medicine. After the training cycle, unified assessments and questionnaire surveys were conducted to compare the differences in theoretical and practical scores, autonomous learning ability, and training satisfaction between the two groups. *Results:* The observation group achieved significantly higher scores in theoretical assessment, clinical practical operation, and comprehensive evaluation, as well as higher scores in autonomous learning initiative, in-depth knowledge understanding, clinical critical thinking ability, and scientific research literacy. The overall training satisfaction was also remarkably improved, and all inter-group differences were statistically significant ($P < 0.05$). *Conclusion:* The targeted blended teaching model can effectively compensate for the shortcomings of traditional in-hospital basic medical continuing education, substantially improve medical staff's theoretical mastery and standardization of clinical operation, and cultivate trainees' autonomous learning ability and clinical thinking capacity. Complying with the training requirements of lifelong learning and progressive ability improvement in continuing medical education, this model is suitable for regular promotion and application in medical institutions.

Keywords: Blended teaching; Basic medicine; Continuing medical education; Teaching reform; Standardized clinical training

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1. Introduction

Basic medicine covers core disciplines including human anatomy, physiology, pathology, biochemistry, and pharmacology. As a prerequisite core curriculum for clinical medical staff to consolidate professional foundations, construct clinical thinking, and standardize diagnosis and treatment operations, it occupies a pivotal position in the standardized training system for young in-hospital physicians ^[1]. From the perspective of clinical teaching practice, basic medicine is characterized by numerous and complex knowledge points, strong theoretical logic, and abstract microscopic mechanisms. For physicians undergoing standardized training and newly recruited medical staff with short working experience and limited clinical experience, simple classroom lectures fail to help them fully grasp core principles, easily leading to fragmented memory of knowledge points and superficial theoretical cognition ^[2]. The previous in-hospital continuing education of basic medicine mainly adopted offline cramming centralized teaching with a relatively fixed teaching mode. The lack of pre-class preview guidance and after-class consolidation and expansion resources, as well as the limited duration of a single practical training session, deprives trainees of opportunities for repeated practice, review, and error correction. Consequently, most trainees passively receive knowledge with weak awareness of active exploration and thinking, resulting in a disconnection between theory and practice, namely proficient theoretical mastery but non-standard clinical operation and poor transformation of theoretical knowledge in clinical scenarios ^[3]. Against the background of emerging medical education reform and quality improvement of continuing medical education, the traditional single offline centralized training model can no longer meet the hierarchical and lifelong learning needs of clinical medical staff for competency improvement ^[4]. Blended teaching based on information-based teaching platforms integrates the dual advantages of online fragmented autonomous learning and offline targeted teaching, breaking the temporal and spatial limitations of traditional teaching, and has been widely applied in the teaching reform of various medical courses ^[5]. Based on the actual situation of in-hospital training, this study optimized and constructed a closed-loop blended teaching process and verified its application effect in basic medical continuing education through a controlled trial, aiming to further improve the quality of in-hospital continuing medical education and provide practical support for the standardized training of clinical talents.

2. Materials and methods

2.1. Research subjects

A total of 40 on-the-job standardized training physicians and newly recruited clinical medical staff who participated in basic medical continuing education in the hospital from January to June 2025 were selected as research samples. They were divided into the observation group and the control group by parallel grouping, with 20 cases in each group. In the control group, there were 11 males and 9 females, aged 18–21 years, with an average age of (19.52±0.82) years. In the observation group, there were 10 males and 10 females, aged 18–22 years, with an average age of (19.58±0.89) years. All subjects participated in systematic basic medical continuing education for the first time without prior relevant learning experience, with good physical and mental status, and completed the whole process of theoretical learning, practical training, final assessment, and questionnaire survey. Baseline data, including age, gender composition, and pre-job basic evaluation scores, were comparable between the two groups, with no statistically significant differences ($P>0.05$).

2.1.1. Inclusion criteria

- (1) On-the-job standardized training physicians and newly recruited clinical medical staff of the hospital;
- (2) Participants who completed the whole process of basic medical theoretical and practical continuing education without long-term unexcused absence;
- (3) Participants who fully understood the study content, voluntarily participated in the survey, and cooperated with data collection.

2.1.2. Exclusion criteria

- (1) Medical staff with long-term further study, vacation, or secondment during the research period;
- (2) Participants with accumulated absences of 3 times or more who failed to complete the full training process;
- (3) Participants who did not finish online learning tasks, submitted invalid questionnaires, or had missing research data.

2.2. Teaching methods

2.2.1. Control group

The control group adopted the traditional in-hospital continuing medical education mode, carrying out standardized offline centralized teaching in accordance with the in-hospital basic medical training syllabus. Theoretical teaching was mainly based on teacher-led PPT explanation and centralized knowledge compilation, with only occasional random in-class questions and no unified pre-class preview arrangement. Practical training adopted centralized demonstration teaching: teachers uniformly demonstrated standardized operating procedures, and trainees observed, imitated, and practiced independently under routine roaming guidance of teachers. The training assessment consisted of a final closed-book theoretical examination and a unified practical assessment, without online preview, online Q&A, or after-class personalized expanded learning links. The whole training followed the traditional fixed in-hospital teaching process^[6].

2.2.2. Observation group

On the basis of conventional in-hospital teaching, the observation group adopted the Chaoxing Learning Platform to construct a closed-loop blended training model of *online pre-class guidance, offline targeted in-class learning, online after-class review and expansion, and diversified process evaluation* in combination with the dual characteristics of abstract theory and practicality of basic medicine courses. This model realized in-depth integration of online fragmented autonomous learning, offline targeted teaching, and practical reinforcement. The detailed implementation process optimized for in-hospital teaching practice was as follows.

Online pre-class guidance. Three days before centralized offline teaching, teachers uploaded targeted, streamlined teaching courseware, key knowledge micro-lessons, logical mind maps, pre-class self-test question banks, and preview thinking questions based on the key and difficult points of current training. For abstract knowledge that is difficult to visualize, such as anatomical structures, physiological metabolism, and pathological evolution, 3D structural demonstration animations and dynamic videos of physiological mechanisms were provided to help trainees intuitively understand abstract theories. For highly theoretical content, including pharmacological mechanisms and pathological classification, simplified clinical scenario cases were matched to guide trainees to think in combination with clinical practice. Trainees completed

previews and self-tests in their fragmented spare time, and the platform automatically recorded learning duration, task completion, and error data. Teachers accurately sorted out common difficult problems of trainees based on background learning data to support targeted intensive explanation and Q&A in offline classes. Meanwhile, an online discussion section was opened to encourage active communication of preview doubts and cultivate trainees' active thinking habits ^[7].

Offline targeted in-class learning. The traditional cramming teaching mode was abandoned, and hierarchical intensive explanation and targeted Q&A were carried out, focusing on difficult problems fed back from pre-class preview. Interactive teaching, such as group discussion and scenario analysis, was conducted, combined with real clinical cases and working scenarios, to guide trainees to sort out knowledge logic and establish associative thinking between basic theories and clinical practice. The practical training adopted a dual mode of *online virtual simulation preview + offline practical reinforcement training*. Trainees were familiar with standardized operating procedures and avoided common operational errors through the virtual simulation platform before class. In class, teachers disassembled core operating key points step by step and corrected non-standard operational details pertinently, making up for the shortcomings of traditional practical training such as short single training time, insufficient repeated practice, and inadequate individual guidance ^[8]. In-class quizzes, group achievement reports, and random questioning were interspersed to timely test phased training effects and improve classroom efficiency.

Online after-class review and expansion. After each training session, teachers pushed chapter knowledge summaries, cutting-edge clinical research cases, special consolidation question banks, and expanded literature resources via the platform to help trainees systematically sort out classroom knowledge and broaden their knowledge breadth. Special review tests and error-sorting tasks were released for key and difficult knowledge points. The platform generated error analysis reports through automatic correction, guiding trainees to accurately identify weak points and conduct targeted remediation. Regular after-class tasks such as case analysis and knowledge review summaries were assigned, with trainees submitting results online and teachers providing one-on-one comments and guidance to realize personalized tutoring. A regular online Q&A mechanism was established to timely answer trainees' after-class questions, form a closed-loop teaching system, and promote knowledge internalization and continuous improvement of clinical competence.

Construction of a diversified process assessment system. Breaking the traditional single final summative assessment model, an integrated online-offline comprehensive evaluation mechanism was established. The process assessment, accounting for 40% of the total score, included online preview quality, online homework completion, in-class interaction performance, practical training results, and phased test scores. The final unified closed-book examination and comprehensive practical assessment served as the summative assessment, accounting for 60% of the total score. The whole-process recording of trainees' learning status objectively reflected their real learning level, guiding trainees to attach importance to daily accumulation and avoid cramming for examinations and superficial knowledge mastery.

2.3. Observation indicators

- (1) Training assessment scores: Unified closed-book theoretical examinations and standardized clinical practical assessments were conducted after the training cycle. Both tests were scored out of 100 points, and the comprehensive score was the average of the two scores to evaluate the overall training effect of

the two groups.

- (2) Autonomous learning effect score: A self-designed in-hospital learning effect questionnaire was adopted for evaluation from four dimensions: autonomous learning initiative, in-depth knowledge understanding, clinical thinking improvement, and scientific research ability expansion, with 25 points for each dimension and a total score of 100 points. Higher scores indicated better learning effects.
- (3) Training satisfaction: Anonymous questionnaire surveys were performed to divide trainees' training experience into three levels: very satisfied, satisfied, and dissatisfied. Training satisfaction rate = (number of very satisfied cases + number of satisfied cases)/total number of cases $\times 100\%$.

2.4. Statistical methods

All data in this study were sorted and analyzed using SPSS 26.0 statistical software. Measurement data were expressed as mean $\pm$ standard deviation, and an independent-samples t-test was used for inter-group comparison; count data were expressed as cases (percentage) [n(%)], and a χ^2 test was used for inter-group comparison. The test level α was set at 0.05, and $P < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of training assessment scores between the two groups

Unified assessment after training showed that the observation group had significantly higher theoretical scores, clinical practical scores, and comprehensive scores than the control group, with statistically significant inter-group differences ($P < 0.001$) (Table 1).

Table 1. Comparison of training assessment scores of medical staff between the two groups (points, Mean $\pm$ SD)

Group	Number of cases	Theoretical score	Practical operation score	Comprehensive score
Observation group	20	85.28 $\pm$ 4.22	88.06 $\pm$ 3.92	86.68 $\pm$ 3.54
Control group	20	78.30 $\pm$ 5.10	80.50 $\pm$ 4.78	79.36 $\pm$ 4.22
<i>t</i> value	-	4.782	5.216	5.635
<i>P</i> value	-	<0.001	<0.001	<0.001

3.2. Comparison of autonomous learning effect scores between the two groups

Questionnaire survey results indicated that the observation group had significantly higher scores in the four dimensions of autonomous learning initiative, knowledge understanding depth, clinical thinking improvement, and scientific research ability expansion, as well as higher total questionnaire scores than the control group, with statistically significant inter-group differences ($P < 0.001$) (Table 2).

Table 2. Comparison of autonomous learning effect scores of medical staff between the two groups (points, Mean $\pm$ SD)

Group	Number of cases	Autonomous learning initiative	Knowledge understanding depth	Clinical thinking improvement	Scientific research ability expansion	Total score
Observation group	20	22.32 $\pm$ 1.50	21.95 $\pm$ 1.60	22.12 $\pm$ 1.45	21.62 $\pm$ 1.70	88.01 $\pm$ 5.22

Control group	20	18.62±2.10	18.21±2.02	17.93±2.18	17.55±2.33	72.31±6.82
<i>t</i> value	-	6.425	6.218	7.012	6.158	8.265
<i>P</i> value	-	<0.001	<0.001	<0.001	<0.001	<0.001

3.3. Comparison of teaching satisfaction between the two groups

The training satisfaction rate of the observation group was 95.00%, which was significantly higher than 80.00% in the control group, and the inter-group difference was statistically significant ($P<0.05$) (Table 3).

Table 3. Comparison of teaching satisfaction of medical staff between the two groups [n(%)]

Group	Number of cases	Very satisfied	Satisfied	Dissatisfied	Satisfaction rate
Observation group	20	14(70.00)	5(25.00)	1(5.00)	19(95.00)
Control group	20	9(45.00)	7(35.00)	4(20.00)	16(80.00)
χ^2 value	-	-	-	-	4.114
<i>P</i> value	-	-	-	-	0.043

4. Discussion

Basic medical continuing education is a core link in the standardized training of young clinical talents. Its training quality directly affects the clinical knowledge reserve, basic operation standardization, and clinical thinking ability of medical staff, serving as a crucial cornerstone for the continuous improvement of clinical post competency^[9]. The traditional centralized training model previously adopted in our hospital has a single teaching form and limited resource supply, featuring one-way knowledge output by teachers and passive knowledge reception by trainees without active exploration and in-depth thinking. Meanwhile, the limited duration of practical training fails to meet trainees' needs for repeated practice and error correction, resulting in the common problem of proficient theoretical memory but non-standard clinical operation and disconnection between basic theories and clinical scenarios, which cannot adapt to the training standards of applied clinical medical talents in the new era^[10].

Optimized based on in-hospital teaching practice, the blended teaching model in this study breaks the fixed process of traditional continuing education and constructs a full-process closed-loop training system. The pre-class online guidance link decomposes abstract and difficult core theories of basic medicine through lightweight and visualized teaching resources, and urges active preview via task-driven methods, effectively enhancing trainees' autonomous learning awareness. In addition, teachers accurately grasp trainees' learning weaknesses based on platform learning data, transforming offline classroom teaching from indiscriminate lecturing to targeted teaching and greatly improving classroom relevance. The offline in-class teaching abandons cramming education, carries out interactive discussion teaching focusing on pre-class learning pain points combined with clinical cases, and shortens the gap between basic theories and clinical practice. The virtual-reality integrated practical training model makes up for the deficiencies of insufficient practical training frequency and inadequate personalized guidance in in-hospital teaching, helping trainees master standardized basic operations and improve operational standardization.

The online after-class review and expansion and diversified process evaluation mechanism corrects the traditional assessment drawback of attaching importance to final examinations while neglecting learning processes, guiding trainees to focus on daily knowledge accumulation and regular review to realize

continuous knowledge internalization and progressive competency improvement. The study data showed that the observation group had significantly better theoretical and practical assessment scores, comprehensive abilities including autonomous learning, clinical critical thinking, and scientific research expansion, and higher training satisfaction than the control group. These findings fully demonstrate that the blended teaching model can effectively solve the existing pain points of in-hospital basic medical continuing education, balance knowledge imparting, skill training, and literacy improvement, and conform to the lifelong, precise, and practical reform trend of continuing medical education.

This study has certain limitations. It is a single-center and small-sample teaching practice with limited research coverage and no long-term follow-up observation of post-competency. Future studies will further expand the sample size, carry out multi-center controlled trials in cooperation with multiple medical institutions, refine hierarchical training schemes according to the teaching characteristics of different basic medicine disciplines such as anatomy, physiology and pathology, continuously optimize online teaching resource allocation and in-hospital teaching procedures, and improve the blended teaching system of basic medicine adapted to medical institutions, so as to provide more comprehensive practical support for the reform of medical continuing education.

5. Conclusion

The optimized online and offline blended teaching model applied in in-hospital basic medical continuing education can effectively make up for various shortcomings of traditional centralized teaching, significantly improve medical staff's mastery of basic theories and standardization of clinical operations, effectively cultivate trainees' autonomous learning ability and comprehensive clinical critical thinking literacy, and enhance the satisfaction of in-hospital continuing medical education. With stable training effects, strong operability, and high adaptability, this teaching model meets the needs of hierarchical training of clinical post talents. It can be adopted as a regular reform scheme for basic medical continuing education in medical institutions and promoted in in-hospital and peer medical institutions.

Disclosure statement

The author declares no conflict of interest.

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Research on Strategies for Integrating Pre-hospital Emergency Training into Higher Vocational Nursing Teaching from the Perspective of Job Requirements

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Abstract: As one of the first links in the public health emergency response system, pre-hospital emergency care directly affects whether seriously ill patients live or die. Currently, there are serious deficiencies in the pre-hospital emergency talent cultivation of higher vocational nursing education, such as a disconnect between teaching content and actual work, and a lack of integration of skill training and clinical thinking. Therefore, educators need to adjust the teaching system according to the needs of jobs at present. Based on the deep integration of pre-hospital emergency training and higher vocational nursing education, this paper presents the core concepts, analyzes the demands for job competencies, studies the current teaching situation, and systematically explores the necessity and feasibility of such integration. The three main directions for optimization are curriculum content, teaching models, and assessment systems; simultaneously, dual guarantees will be provided for faculty development and resource construction. This paper hopes to establish a job-competency-oriented education-job integration path and provide theoretical support and practical references for teaching reform in pre-hospital emergency care for higher vocational nursing students.

Keywords: Pre-hospital emergency care; Higher-vocational nursing; Job requirements; Teaching integration ; Education-job integration

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1. Introduction

Pre-hospital emergency care refers to the first medical assistance provided to people before they reach the hospital. Promptly and correctly organized rescue work can save lives. With the acceleration of urbanization and aging of the population in China, the demand for regular emergency services and responses to public health emergencies has been increasing steadily, and high-level professional expectations have been placed on pre-hospital emergency personnel. High-level vocational nursing education aims to train technically

proficient and skilled nurses who will serve as the main force for pre-hospital emergency teams after graduation. However, traditional nursing education focuses on in-hospital nursing knowledge. Pre-hospital emergency content is often spread across optional courses or thematic lectures without a system or job-targeted focus ^[1]. Therefore, students have difficulty adapting to the new environment in the emergency department. Therefore, in order to improve the quality of talent cultivation and conduct theoretical research on optimizing emergency education systems, a systematic integration strategy for pre-hospital emergency training and higher vocational nursing education based on actual job requirements should be explored.

2. Relevant concepts and theoretical foundations

2.1. Definition of core concepts

Pre-hospital emergency care refers to the first few minutes after a serious illness or injury occurs, when trained professionals provide immediate medical assistance and safely transport the patient to a hospital. The main characteristics are time pressure, environmental uncertainty, resource scarcity, and autonomous decision-making in intervention. Higher-vocational nursing education is a kind of higher vocational education that aims to cultivate high-quality, technically competent nursing personnel for primary-level medical and health institutions, and focuses equally on practical ability and professional literacy. Job requirements refer to all-around competence expectations for employees in terms of knowledge systems, operating skills, clinical thinking, communication and cooperation, and emergency handling. They connect education and work at the same time. Education-job integration refers to incorporating job competency standards into all links of curriculum design, teaching implementation, and assessment to achieve seamless alignment between school education and professional practice. In short, it is to reduce the gap between schools and workplaces and enable students to learn by doing and learn through doing.

2.2. Job-requirement-oriented theory

Based on the idea of competency-based education, job-requirement-oriented theory proposes that the goals and contents of vocational education should start with the competence demands of job positions. Based on the results of job analysis, identify the knowledge, skills, and attitudes required for the main work of the position, and then reverse-engineer teaching objectives and learning activities. In the area of pre-hospital emergency care, this theory requires educators to carry out fieldwork in emergency centers and emergency departments, investigate frequent emergency cases, common operations, and essential decision-making points, and convert abstract occupational norms into teachable and learnable curriculum components. Offer some ideas for teaching integration; change the logic from “What teachers can teach” to “What employers want,” and ensure that the direction and results of talent cultivation are effective.

2.3. Education-integration theory of education and employment

Under the policy system of industry-education integration, the four types of education-job integrated education theory are: objective integration, content integration, process integration, and evaluation integration. Objective integration needs to map job-competency goals to curriculum teaching goals equally. Content integration aims to turn typical job tasks into teaching projects or learning scenarios. Process integration advocates organizing teaching activities according to actual or simulated work processes. Evaluation integration puts forward using industrial norms as the basis for academic assessment. This

theory does not use the old way of “learning before doing,” but instead proposes a spiral growth model of alternating study and application. Education-job integration in pre-hospital emergency training simulates real-world workflows, such as dispatch command, on-site assessment, and team cooperation, to help students gain a deeper understanding of their future jobs during school ^[2].

3. Current status of pre-hospital emergency teaching in higher-vocational nursing and job requirements

3.1. Analysis of core competence requirements for pre-hospital emergency posts

The five types of core competency requirements for pre-hospital emergency practitioners are: rapid assessment and decision-making; basic and advanced life-support operations; on-site management of trauma hemostasis, bandaging, immobilization, and transportation; team communication and dispatch coordination; stress, psychological adjustment, and self-protection. Based on the text analysis of job descriptions for local emergency centers, emergency nurses need to complete all steps of the workflow independently during off-duty hours, such as assessing the scene’s safety, making an initial diagnosis, providing emergency treatment, and deciding whether to transfer, within about 8-12 minutes; thus, they require excellent clinical judgment and proficient procedural skills. In addition, there are many unpredictable circumstances in emergencies, such as traffic accident scenes, residential areas, and public gathering places; therefore, multi-skilled training in traditional nursing education, such as intravenous injection and vital sign observation, is no longer sufficient.

3.2. Investigation of pre-hospital emergency teaching in higher vocational nursing

Based on the current teaching situation, three typical higher vocational colleges with nursing programs in the province were selected for this study. Talent-training schemes, curriculum norms, and interviews with professional teachers were analyzed to organize pre-hospital emergency teaching implementation. Research shows that most pre-hospital emergency content is taught by emergency nurses or critical-care nurses, and the average number of theoretical class hours is around 12–18, with no more than 8 practical class hours. Practical training focuses on isolated skills, such as cardiopulmonary resuscitation and bag-valve-mask ventilation, and lacks systematic drills of full emergency workflows. Most of the interviewed teachers do not have first-hand experience in front-line pre-hospital emergency work, and their teaching cases are based on textbooks or second-hand materials without real-life situations. Interns are rarely involved in actual emergency calls or rescue work during their internship and are mainly observers. In short, the current teaching mode has fragmented knowledge, isolated skills, and virtualized scenarios, and fails to help students form a complete pre-hospital emergency response system.

3.3. Adaptability gaps between teaching and work requirements

Misalignment between teaching and job demands is shown by inconsistent goals, a lack of relevant content, and outdated assessments. Most of the objectives at the objective level focus on learning basic emergency skills, but posts require all-around competence to handle emergencies independently in complex and changing environments; thus, there is a hierarchy gap. At the content level, pre-hospital-specific components such as on-site safety control, triage, and telemedicine cooperation are rarely covered, and many class hours are spent on procedures that are used infrequently in actual work, resulting in a low correlation between teaching content and real-life applications. Existing evaluations focus on operational standardization at the

assessment stage and fail to provide effective measurement instruments for job-critical attributes such as emergency decision-making ability, humanistic care, and teamwork. Therefore, although the students have passed the course exams, they will be unable to handle real-world out-of-class assignments.

4. Necessity and feasibility of integrating pre-hospital emergency training with nursing teaching

4.1. Necessity of job-curriculum integration for talent cultivation

Socially, the number of annual pre-hospital emergency outcalls in local cities keeps rising, and there is a continuous shortage of emergency doctors and nurses. Graduates of high-level vocational nursing programs are now the main supply of frontline emergency staff. However, due to a lack of coordination between institutional education and on-the-job training, new hires take a long time to adapt and have a relatively low pass rate for independent post-assessments; thus, both manpower costs and operating risks for the emergency system increase indirectly. Fragmented pre-hospital education does not meet the professional development needs of students. Many graduates need to relearn basic skills such as off-site evaluation, doctor-patient communication, and urgent airway management after starting work, which is an indirect loss of educational investment. Therefore, promoting pre-hospital emergency training and integrating it into higher-vocational nursing education is an unavoidable path to reduce the period of job adaptation and enhance the talent-training efficiency at its origin ^[3].

4.2. Foundational conditions for teaching integration

Mature Conditions Support Current Teaching-Integration Practices: Politically, national documents issued by the Ministry of Education on deepening industry-education integration encourage industry and enterprises to participate in the formulation of teaching standards and provide institutional support for cooperation between emergency centers and colleges. Technologically, high-fidelity simulators, virtual-reality emergency training systems, and online case libraries are becoming more accessible. They can create various difficult pre-hospital emergency situations and other problems at the university level to compensate for the lack of real-life practice opportunities. In terms of faculty, enhanced cultivation of dual-competency teachers can help colleges strengthen instructors' practical abilities by organizing off-campus training sessions and part-time work for emergency center staff. Some colleges have been developing their own curricula and school-enterprise cooperation models.

4.3. Core values of teaching integration

Teaching Integration Creates Values at Three Levels: Talent cultivation builds a step-by-step competence-development path of cognition-simulation-practice to enable students to move from knowledge acquisition to internalized emergency thinking, thus allowing graduates to take up positions and work effectively after graduation. Integration promotes the transformation of the curriculum system from static knowledge transmission to dynamic competence construction, drives renewal in teaching content and pedagogy, innovates assessment, and improves the overall quality of programs. Industrial development provides stable talent co-cultivation channels for colleges and emergency institutions, reduces the cycle of pre-service training for new emergency staff, lowers social manpower-training costs, reserves talents for standardized emergency-technique promotion and continuous quality improvement, and achieves significant public-health

benefits.

5. Integration strategies of pre-hospital emergency training and nursing teaching based on job requirements

5.1. Curriculum-content optimization based on job standards

Optimization of curriculum content should directly reference pre-hospital emergency job competence standards and build a progressive curriculum consisting of basic, core, and extended modules. The general module will cover all nursing students and provide them with general emergency skills, such as CPR and airway management, hemostasis, bandaging, immobilization, transport, and recognition of common acute diseases, etc., so everyone can learn them. The main module will focus on the specific work of emergency nurses, such as on-site command for mass-casualty incidents, advanced life-support teamwork, emergency documentation and information reporting, and use project-based learning for content organization. The extended module is for students who wish to pursue careers in emergency services; it offers special courses such as pre-hospital trauma life support and pediatric emergency care and is in line with certification programs organized by emergency centers. At the same time, a dynamic content-updating mechanism will be introduced to adjust teaching priorities annually based on feedback from emergency centers about changes in job requirements and keep the content relevant to practice.

5.2. Teaching model innovation in line with job scenarios

Teaching-model innovation aims to overcome spatial-temporal barriers between classrooms and workplaces, and promotes immersive pedagogy based on scenarios, tasks, and reflections. Authentic emergency cases will be used to create teaching situations. High-fidelity simulation equipment has been built to recreate accident scenes, residential areas, and ambulance bays, and students can carry out the entire task chain of alarm reception and mission dispatch, on-site intervention, and handover during transportation in a high-pressure simulated environment. Contingency variables, such as equipment failure, agitated family members, and sudden patient deterioration, are added to train emergency decision-making and psychological resilience. Authentic work materials, such as emergency center dispatch records and in-ambulance videos, can also be used for teaching discussions. Invite front-line emergency workers to give class talks and bring real-life scenarios into the classroom to help students feel more involved in their studies.

5.3. Reconstruction of assessment systems based on job competency

The reconstruction of the assessment system should give equal weight to process-oriented and summative evaluations, integrate skill assessment with scenario-based assessment, and establish multi-dimensional evaluation mechanisms based on job competence. In addition to the standardized single-procedure test, other forms of skills tests are also available. Students need to complete all the steps of the emergency workflow in a short amount of time, including assessment, intervention, communication, and documentation, and this will be jointly graded by college teachers and emergency center mentors. Competency-based rating scales for pre-hospital emergency posts have been developed to evaluate the dimensions of rationality in clinical decision-making, efficiency and standardization of operations, effectiveness of team communication, and performance in humanistic care. Continuous records of individual competence growth are obtained by accumulating results from multiple simulation drills. In addition, some parts of the pre-service certification examination at

emergency centers can be incorporated into institutional assessments to promote closer cooperation between academic evaluation and occupational entry, enhance students' employment competitiveness and professional confidence, etc. ^[4].

6. Implementation guarantees and prospects of integrated teaching

6.1. Guarantee for faculty capacity improvement

The faculty's ability will directly affect the implementation of integrated teaching. A training-practice-research trinity teacher development system should be built. Colleges should develop special training plans for emergency-teaching staff, regularly select key teachers to take part in no less than a two-week full-time on-post practice at emergency centers, fully participate in out-call missions, dispatch and quality control, and gain an in-depth understanding of the actual job logic. Joint teaching-research mechanisms will be established by emergency-center specialists and college instructors to hold monthly collective lesson preparations, case studies, and teaching peer reviews to supplement theoretical instruction with practical guidance. Teachers are motivated to participate in emergency skill competitions and revisions of industrial standards to stay informed about new developments in the cutting-edge industry. In addition, special teaching-reform research projects will be organized to help teachers carry out action research on the problems in integrated teaching, improve teaching quality through research, and promote the spiral development of faculty competence.

6.2. Guarantee for practical training resource construction

The three requirements for practical-training resources are: high-fidelity simulation, systematic completeness, and openness. Fidelity requires building high-fidelity pre-hospital emergency training rooms equipped with emergency mannequins, defibrillators, ventilators, and monitors, as well as audio-video recording-and-playback systems for full-process documentation and debriefing of emergency drills. Systematic completeness demands the construction of online-offline integrated teaching-resource banks, which should include typical emergency case databases, operation video libraries, question banks, and virtual simulation training software for both self-directed learning and flexible teaching. Openness will allow the training facilities to participate in the service personnel training and skills competition organized by the emergency center, achieving school-enterprise facility sharing and resource circulation. Colleges need to set aside special construction funds for the staged renovation of training rooms and establish equipment maintenance-replacement mechanisms to maintain good practical training conditions according to industrial changes.

6.3. Expected results and prospects of integrated teaching

Integrated teaching after implementation will likely achieve many positive results. All-round pre-hospital emergency capabilities for students will be strengthened; the cycle of job adaptation will be reduced, and the first-time pass rate for independent post-assessments will rise significantly. Teachers' dual-competency quality will be improved, and a stable school-enterprise dual-collaboration mechanism for emergency-teaching teams will be established. Academic programs will gain wider social recognition and higher employment rates for nursing majors in emergency care, creating unique institutional brands. In the long run, successful integrated teaching practices can be expanded to community first-aid training and public dissemination of emergency knowledge, thereby exercising the colleges' social service function. Future studies will continuously collect data on the career development of graduates for longitudinal effect

evaluation, iteratively optimize integration strategies, and explore the construction of regional emergency education alliances to promote the integration of teaching standards and industrial standards ^[5].

7. Conclusion

In-depth integration of pre-hospital emergency training and higher vocational nursing education is a system of projects that responds to the demand for enhanced social emergency service capabilities and addresses the mismatch between talent cultivation and job requirements. Based on the job requirements, this study will systematically present the necessity, feasibility, and implementation path of integration, and put forward a three-dimensional strategy system covering curriculum, teaching and assessment, as well as support guarantee mechanisms. Integration should not be mistaken for the addition of more emergency courses. Therefore, it is necessary to reform the logical framework of teaching objectives based on job competence, rebuild teaching-process ecosystems according to real-life scenarios, and restructure assessment criteria focused on competence development. Only when educators incorporate job-post standards into all stages of teaching can they achieve the goal of “learning for application and competence upon assignment,” and provide more high-quality technically skilled nursing personnel for pre-hospital emergency services.

Disclosure statement

The authors declare no conflict of interest.

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Analysis of the Current Status and Influencing Factors of Psychological Distress in Malignant Tumor Patients during Chemotherapy

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Abstract: *Objective:* To systematically evaluate the current status of psychological distress among patients with malignant tumors during chemotherapy and analyze its multidimensional influencing factors. *Methods:* Evidence from domestic and international crosssectional and longitudinal studies over the past decade was integrated. Evidence was reviewed hierarchically from individual, disease/treatment, and social/environmental perspectives, and a multifactor path model was constructed. *Results:* The incidence of severe psychological distress during chemotherapy ranged from 20% to 35%. Independent risk factors included low economic status, high grade of treatment-related side effects, metastatic disease, and low social support. Fatigue and sleep disturbance exerted significant mediating effects between treatment-related factors and psychological distress. Moreover, economic hardship and deficient family support showed synergistic amplifying effects. *Conclusion:* Psychological distress is driven by multifactor interactions. The fatigue/sleep disturbance mediating chain and social buffering system constitute key intervention targets. A “two-step screening and three-tier intervention” system is recommended. Psychological distress management should be valued equally with somatic treatment to improve the effectiveness of integrated care.

Keywords: Malignant tumor; Chemotherapy; Psychological distress; Influencing factors; Social support

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1. Introduction

Chemotherapy is a relatively common type of treatment for cancer that can extend life. At the same time, there will be physical pain and other emotions. This distress will reduce the willingness to participate in treatment and may worsen the course of illness and quality of life. However, the identification and intervention rates of psychological distress in current clinical practice are still relatively low due to a lack of systematic knowledge about its many causes. Psychological distress results from a combination of various reasons, such as personal traits, health conditions, demands of medical care, and living environments.

Therefore, all-encompassing studies of the present situation and multiple factors affecting psychological distress during chemotherapy can offer practical support for developing personalized psychological support plans. Based on the assessment tool and epidemiological data, this paper investigates the reasons for changes at the individual, disease-treatment, and social-environmental levels, presents integrated models and intervention ideas, and offers a system of theoretical support for clinical work.

2. Assessment and current status of psychological distress

2.1. Definition and measurement tools of psychological distress

Psychological distress refers to a negative emotion caused by many reasons, which may include changes in thinking, behavior, and relationships with others, etc., and ranges from slight mood swings to serious mental illness. The Distress Thermometer (DT) is frequently used in clinical research as a quick-screening tool to measure the level of distress on a 0-10 scale, and a score of 4 or higher is considered clinically significant distress. The Hospital Anxiety and Depression Scale (HADS) and Brief Symptom Inventory-18 (BSI-18) are also frequently employed to assess the extent of anxiety, depression, and somatization. Different Instruments have different sensitivities and specificities. Due to its simplicity, the DT is suitable for regular screening in oncology departments, and multi-dimensional scales can be used to investigate various manifestations of distress. The selected measuring device will affect both the rate at which data are collected and the precision of the resulting factor analysis; therefore, it should meet the requirements of the study. Recently, some electronic adaptive assessment systems have begun to be introduced for dynamic observation and provide technical support for monitoring changes in patients' conditions during chemotherapy in time and space. Further research needs to be conducted to verify the practical value of these methods ^[1].

2.2. Overall incidence of psychological distress during chemotherapy

Based on multiple domestic and foreign cross-sectional studies and meta-analyses, the general prevalence of psychological distress among cancer patients undergoing chemotherapy is between 45% and 65%, and severe distress (DT score ≥ 7) occurs at about 20%–35% of this rate. The frequency of occurrence changes with chemotherapy stage: distress is relatively high before the first cycle of chemotherapy due to the shock of diagnosis and fear of treatment; by the middle of chemotherapy, many people have developed side effects. Although some patients' symptoms have eased after chemotherapy, about 30 percent still feel moderately to severely distressed. The proportion of distress detected is relatively high among inpatients receiving chemotherapy compared with outpatients, and this may be due to indicators of serious illness and feelings of social isolation in the hospital environment. In short, most people are stressed during chemotherapy. Regularly check whether the oncology nurse has added anything new. Strengthen dynamic assessment to identify a high-risk period. Proactive psychological support can be provided before the peak of side-effect accumulation to reduce overall distress and improve the quality of life for patients.

2.3. Distribution characteristics of psychological distress across cancer types and stages of treatment

Psychological distress varies among different types of cancer. Generally speaking, patients with head-and-neck cancer and pancreatic cancer experience more distress due to changes in their bodies and severe digestive problems. Although the survival rate of breast and prostate cancer patients is relatively high, they

still face certain psychological problems caused by reduced sexual function and altered body image. In terms of the stage of treatment, patients who have undergone adjuvant chemotherapy after surgery have better survival prospects and are less distressed than those who have received neoadjuvant or palliative chemotherapy; the latter are concerned about whether the treatment will work and how soon they will be ill again. Patients with recurrent or metastatic disease who have received re-chemotherapy show significantly higher levels of psychological distress than new patients, mainly in the form of hopelessness and fear of death. A larger number of chemotherapy cycles is associated with increased distress and cumulative side effects, especially at cycles 3–4. Therefore, different psychological support systems need to be designed according to the features of cancer and the stage of treatment, and resources should be concentrated on high-risk cancer types and advanced-stage groups.

3. Individual patient-related factors and psychological distress

3.1. Effects of age, gender and educational level

Age is related to psychological distress in a U-shaped manner: young patients experience severe distress due to disrupted social roles and fertility concerns; older patients have increased distress because they are physically weaker and feel a stronger sense of loss; middle-aged patients are relatively stable. Female patients generally report a higher proportion of distress compared to men, possibly because women are more emotionally expressive and sensitive to changes in their bodies. Educationally disadvantaged patients are at risk of developing catastrophic thinking due to a lack of health literacy and thus cannot understand the purpose of chemotherapy. At the same time, well-educated people have good access to information but are also more anxious about bad news on the Internet and face an “information paradox.” Therefore, the association between age or educational level and psychological distress is not linear. Address intragroup subcultural differences and provide targeted psychological education for patients of all ages, paying particular attention to the special needs of young and old people ^[2].

3.2. Roles of economic status and medical insurance

A large-scale macro-environmental stressor for psychological problems in cancer patients undergoing chemotherapy is financial pressure. Patients with high out-of-pocket expenses or household incomes below the local average have shown significantly higher distress scores, and this gap has been increasing over time after treatment. Medical insurance coverage reduces the sense of decision-making conflict among patients facing expensive targeted drugs; therefore, those who are fully insured (by both public and private health insurance) experience less psychological stress compared to those with only basic medical insurance. Fear of poverty caused by illness leads to ongoing financial worries. Even if the present expenses are low, there will still be some anxiety. Economic reasons increase people’s psychological burden directly and, at the same time, reduce their ability to live well by cutting off access to food and healthcare. Economic toxicity indicators should be added to clinical assessment. Provide information on medical assistance and cost-sharing schemes for disadvantaged patients to reduce the financial stress and improve the willingness to receive treatment.

3.3. Impact of previous psychological history and personality traits

Patients who have had anxiety disorders, depression or other mental health problems in the past are at a much

higher risk of experiencing psychological distress during chemotherapy, and this distress is often about twice as severe as that experienced by people without such a history. Neuroticism is associated with poor emotion regulation and thus increased susceptibility to somatization of chemotherapy side effects in individuals. Extraverted and conscientious people are more likely to use adaptive coping behavior and experience less stress. Optimism is generally considered to be protective; however, if a person has not received effective treatment and is still optimistic, they will be disappointed when their hopes are not realized and may suffer from “optimism-induced despair”. At the start of chemotherapy, conduct a baseline psychological assessment to identify vulnerable subgroups and offer preventive psychological education; thereby reducing the risk of psychological distress and promoting adaptive coping for high-risk individuals.

4. Disease- and treatment-related factors

4.1. Cancer stage, disease course and metastatic status

Patients with advanced-stage (Stage III–IV) cancer experience much higher levels of psychological distress compared to those at earlier stages of the disease, mainly due to a loss of hope resulting from changes in the goal of treatment from cure to relief. Disease duration and distress are not linearly related; acute stress is more likely to occur in the first year after diagnosis, and burnout-related depression tends to appear in chronically ill patients who have had their disease for more than two years. Distant metastases, especially bone and brain metastases, cause severe pain or other neurological disorders; thus, they directly lead to strong death anxiety and a sense of loss of control. A relatively large number of metastatic sites are associated with severe distress. Multiple organ metastases can cause various physical problems and reduce one’s ability to cope with stress. Based on the above characteristics, oncology teams need to provide different levels of psychological support at different times during the course of illness and spread of tumor. Early introduction of palliative care concepts for patients with advanced metastatic cancer can help them maintain their sense of self-worth and purpose in life during a short time.

4.2. Chemotherapy schedules, cycles and severity of side effects

High-intensity regimens that contain platinum or taxane drugs cause more severe neurotoxicity, myelosuppression, and gastrointestinal reactions, and thus result in more significant psychological distress compared with oral targeted or endocrine therapies. Accumulated side effects are exacerbated by extended chemotherapy cycles and increase distress. When the total amount of drugs reaches a certain level, people will feel tired, nauseated, and vomit repeatedly due to learned negative associations. A relatively high frequency of side effects indicates that the dose may be too large and thus causes psychological harm. Alopecia and hand-foot syndrome are also relatively common changes in physical appearance that affect one’s sense of self-worth. Frequent changes in the treatment plan indicate poor response to therapy and may lead to feelings of hopelessness and powerlessness ^[3]. Document the degree of side effects and record any discomfort experienced by patients after taking different medications to assess the psychological impact. Promptly address and treat anticipatory nausea caused by highly emetogenic drugs to prevent conditioning of aversion.

4.3. Mediating effects of pain, fatigue and sleep disturbance

Pain, cancer-related fatigue and sleep disorders are relatively frequent adverse reactions to chemotherapy

that may also affect one's emotional state. Based on structural equation modeling, chemotherapy-induced side effects cause about 40 percent of the variation in psychological distress through increased fatigue and disruption of circadian rhythm. Pain leads to sympathetic activation, reduced mobility, and thus poor emotion regulation. Sleep disorders reduce the function of the prefrontal cortex and weaken inhibition of negative thoughts; thus, a vicious cycle occurs. The above three symptoms often occur together and exacerbate psychological distress. Based on intervention studies, exercise-based fatigue management and cognitive-behavioral therapy for insomnia can reduce this mediator effect to some extent. Clustered symptom management should be used clinically to address psychological distress effectively, and among these, fatigue and sleep disorders need to be treated first to interrupt the vicious cycle.

5. Social support and healthcare-environment-related factors

5.1. Family support and attitudes of primary caregivers

Good family support can provide emotional and practical help to reduce stress for people receiving chemotherapy. All the above results are consistent with those from other research. Primary caregivers' attitudes are important; overprotection or negative comments will make the patient feel dependent and guilty, but calm acceptance and open communication can help them feel more in control. Spouse support also matters; infrequent talk between spouses and lack of empathy are linked to higher depression risk in older adults. A family's poor functioning due to conflict or emotional neglect increases a person's stress. Include families in the therapeutic system and organize caregiver communication training as part of the intervention plan. Optimize the pattern of intra-familial interaction to boost patients' sense of safety and adaptability.

5.2. Physician-patient communication quality and information support

The quality of physician-patient communication is relatively easy to improve in the hospital environment. Physicians can inform patients about the goals of chemotherapy, its possible side effects, and other treatment options, listen to their concerns sympathetically, and thus reduce both uncertainty and stress for the patients. If there is a lack of information or too much medical jargon, people will be confused and anxious. Information support provides patients with relevant health knowledge and ways to manage symptoms, as well as referral services for mental health professionals. Based on research, patients who receive organized information have been found to have a 25 percent lower pre-chemotherapy anxiety level. Communication satisfaction is positively correlated with consultation length; however, the extent to which deep-seated needs are met is more influential than how long they are consulted. The quality of communication should be emphasized over quantity in clinical practice. Organize special courses for doctors and nurses on communicating with patients effectively, help them learn how to talk to patients better, and so on.

5.3. Peer support and socialization

Peer support refers to communicating with other people who have been treated with the same type of chemotherapy, providing emotional support and sharing experiences to help rebuild a sense of self-worth and alleviate loneliness. Patients in mutual-aid groups or online patient communities have significantly lower psychological distress levels than those who are socially isolated, and this effect is even stronger for young and female patients. Social integration is negatively correlated with the severity of distress; however, too many social demands can lead to energy exhaustion and thus need to be regulated. Stigma often leads

to social exclusion. Patients with obvious changes in their bodies may feel embarrassed about going out and thus become more isolated. Motivate some high-quality peer interactions and promptly address signs of social withdrawal at the first opportunity. A hospital can build a platform for patients to communicate with each other and assess how long they can continue living independently ^[4].

6. Multi-factor comprehensive analysis and intervention implications

6.1. Independent risk factors derived from multi-factor regression analysis

Based on the results of large-scale regression analysis, the five independent risk factors for psychological distress during chemotherapy identified are: low household income, high-grade side effects, metastatic disease, previous psychiatric disorders, and low social support; most of these have odds ratios between 2.0 and 4.5. After adjusting for other factors, the individual impact of age and education is generally reduced, and they are likely to operate via cognitive appraisal and socio-economic paths. Sleep disturbance appears in all the models as a final equation and has the highest standardized regression coefficient; thus, it is considered a mediator. Identify the independent risk factors to develop a simple screening tool that can identify high-risk individuals for targeted intervention. Avoid multicollinearity among the variables to prevent overfitting of the model and ensure the stability and applicability of the screening tool for clinical promotion.

6.2. Path model of psychological distress and interaction effects

Path models built by Structural Equation Modeling show that disease severity affects psychological distress through two parallel paths: a direct path and an indirect path mediated by the chain of “treatment side effects → fatigue → sleep disturbance,” and this indirect path accounts for about 45 percent of the total effect. Interaction analysis shows that economic hardship and lack of family support work together to increase distress; together, they cause much more severe harm than either would alone. A neurotic personality is more likely to feel tired due to side effects and thus feels vulnerable. Good communication between doctors and patients reduces anxiety caused by information asymmetry. The above path model has identified the primary intervention sites: the fatigue-sleep axis and the social buffering system. It verifies the philosophy of intervention that gives equal weight to symptom relief and social support, and offers a clear theoretical basis for subsequent specific clinical studies ^[5].

6.3. Practical recommendations for clinical psychological intervention strategies

Based on the above overall model, the construction of a “two-step screening and three-tier intervention” system is proposed. First, regularly perform DT tests for all chemotherapy patients. Screen-positive cases will be further examined for fatigue, sleep disorders, and lack of social support. Patients who are mildly distressed will be given psychological education and self-care instructions. Those with moderate distress will be offered combined cognitive-behavioral therapy and family communication classes. Patients with serious distress need psychiatric help and other drugs. Strengthen training in physician-patient communication skills and hold information review meetings at key times. Fatigue management and sleep-hygiene education will be added to the daily work process of nurses to break the chain of causality at its origin. Oncology centers should build multi-disciplinary psychological support teams to carry out regular case reviews and adjust interventions dynamically according to changes in circumstances for continuous efficacy and personalized care.

7. Conclusion

Psychological distress in patients with cancer during chemotherapy is a multifaceted problem resulting from the combined effects of individual factors, illness severity, side effects of treatment, and social environment. This study systematically summarizes the prevalence and multiple dimensions of determinants, and explores the mediating effect of fatigue-sleep disturbance and the buffering function of social support. Most of the existing research uses cross-sectional data and cannot determine causality; therefore, there has been little exploration of why different chemotherapeutic drugs cause varying degrees of distress. In the future, some research will use extended follow-up and ecological momentary assessment to observe changes over time in distress, and randomized controlled intervention trials based on path models will also be conducted. Only when psychological distress management is given the same weight as physical disease treatment can the ideal of patient-centered integrated care be realized, and thus the aim of all-encompassing oncology care achieved.

Disclosure statement

The author declares no conflict of interest.

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Research on the Application of Scenario-based Simulation Teaching Combined with Pre-hospital Emergency Scenarios in Higher Vocational Nursing Training

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Abstract: In light of the teaching reform for pre-hospital emergency training in higher vocational nursing, this paper examines the problems of rigid traditional teaching methods, distorted clinical scenarios, and weak emergency response ability among students, and proposes a system for applying scenario-simulation teaching. Based on constructivism, situated learning, and skill transfer theory, this paper presents multiple scenario constructions, a three-stage closed-loop process design, and an optimized process management scheme. Based on the above analysis, it can be seen that the new system will help students learn better in practice. At the same time, there are also practical deficiencies, such as too much dependence on teachers and a narrow scope of assessment. Therefore, the following optimization strategies are proposed: build a dynamic resource bank, introduce a group rotation mechanism, and adopt multi-dimensional process-oriented evaluation; provide systematic empirical support for the reform of higher vocational nursing practical teaching.

Keywords: Scenariosimulation teaching; Prehospital emergency care; Higher vocational nursing; Practical training reform; Skill transfer

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1. Introduction

The first link in the public health emergency response system is pre-hospital emergency care. The time and accuracy of this decision will directly affect whether a seriously ill patient can live, so the nursing staff's clinical judgment, operating ability, and mental health need to be very good. High-quality vocational nursing education aims to train excellent technically skilled personnel for the front line, and the quality of practical training will directly affect their post-graduation employment prospects. However, most of the pre-hospital emergency training in higher vocational colleges still follows the traditional model of "teacher demonstration of technical procedures followed by passive imitation practice by students," and thus fails to help students

gain a deep understanding of the complexity and urgency of real-life emergency situations. Build a high-fidelity clinical environment and use scenario-simulation teaching to have students actively construct clinical thinking through role-playing and dynamic interaction, thereby connecting classroom learning with actual medical practice. Systematically sort out the relevant theoretical basis and current teaching conditions, identify structural deficiencies in practical training, design and implement targeted simulation-teaching schemes, and summarize improvement measures through effect verification and reflection; thus, provide evidence-based operational frameworks for teaching reform in peer institutions.

2. Overview of the research

2.1. Connotation and characteristics of scenario-simulation teaching

Based on the idea of constructivism, scenario-simulation teaching is employed. In short, it builds a real-life work environment by setting up a physical space, assigning roles, and organizing events based on the desired teaching goals. Learners take part in the entire process of problem-solving from their own experiences and build knowledge and skills through repeated practice and reflection. It has three basic attributes: situation authenticity, task completeness, and generative interaction; therefore, it goes beyond mere case studies or role-playing^[1].

First, it offers a good experience. Learners are placed in a simulated emergency environment and receive simultaneous visual, auditory, tactile, and time-pressure stimuli for deep immersion. Second, it is highly integrative; thus, it can connect knowledge from different fields such as anatomy-physiology, pharmacology, communication skills, and ethics of care in emergency situations. Third, it will inspire thought. Organized debriefing after the simulation can help students move away from their initial emotional reactions and engage in rational thinking and strategy planning based on the actual situation.

2.2. Core contents and requirements for pre-hospital emergency practical training

The pre-hospital emergency training system includes off-site risk assessment, first aid for injuries, basic life support, airway management and ventilation, hemorrhage control and bandaging, fracture immobilization and safe transport, as well as psychological support for patients and their families. Finally, educators want to help students learn how to respond promptly, reasonably, and effectively during the golden hour of rescue.

Training requirements should include standardized individual operations, such as sufficient compression depth and full-chest recoil during CPR, correct bag-valve-mask technique, and coordinated emergency work and effective teamwork. Pre-hospital environments in reality are highly uncertain; there may be a lack of information, supply shortages, and bystander interference. In addition, practical training should enhance adaptive communication skills; students need to give clear instructions, regulate multiple-party emotions, and organize off-site orders in a disorderly and noisy environment. Therefore, the content of pre-hospital emergency training should go beyond technical drills and promote all-around abilities such as clinical thinking, risk assessment, and professional responsibility.

2.3. Current situation of higher vocational nursing practical teaching

Under the impetus of national vocational education reform and the Healthy China initiative, significant progress has been made in the hardware facilities for higher vocational nursing education. Many colleges have established multi-functional simulation wards and virtual-reality interactive systems. Pedagogy and

teaching methods have not been updated in line with new hardware developments. Classroom practice is still mainly in the form of checklist-driven mechanical drills, and students are considered proficient after completing these procedures. There is no good adaptive training for changes in the course of illness, equipment failure, or problems with doctor-patient communication.

There is a serious lack of “dual-qualified” teachers who have strong theoretical foundations and rich front-line clinical emergency experience; thus, high-quality simulation cases cannot develop normally. Although a few colleges have introduced standardized patients or simple situation skits, these are still superficial additions rather than an organized, regular part of the curriculum. In short, most high-level vocational nursing practical training is at a critical stage of change from “skill rehearsal” to “clinical competency-oriented education.”

3. Theoretical foundations of the research

3.1. Constructivist learning theory

Constructivist Learning Theory does not believe in the transmission of knowledge. Knowledge is not a passive reflection of the external world; rather, it is a subjective meaning system that people construct actively through their interactions with the environment, cooperation among peers, and self-exploration based on previous experiences in a particular social-cultural context.

In pre-hospital emergency training, students face dynamic clinical situations and need to identify the main problems, use available resources effectively, make urgent decisions, and bear the consequences; this is in line with the idea of “authentic task-based learning” proposed by constructivists. Scenario-simulation teaching offers a safe, scaffolded environment. Learners can test the intervention strategy without harming actual patients, correct errors, and learn how to apply abstract textbook knowledge flexibly ^[2].

3.2. Situated learning theory

According to the theory of situated learning, learning is “legitimate peripheral participation.” To gain both explicit professional knowledge and tacit practical skills, learners need to participate in real or high-fidelity simulated communities of practice through progressive observation, hands-on experience, and the formation of a professional identity.

Pre-hospital emergency care is very situation-specific. Learners will not have developed a good sense of place and adaptability in a multiple-choice environment. Scenario-simulation teaching can create various situations, such as street accidents, sudden illnesses at home, and construction-site injuries. Add time pressure, background noise, and upset family members to increase ecological validity intentionally. Learning by doing helps students learn about their roles and operating rules better, reduces the difference between what they learn in class and what they need to know for their jobs, and promotes the application of knowledge.

3.3. Skill transfer theory

The general idea of skill transfer theory is to apply the abilities learned in one place to other places. To improve transfer efficiency, expand the range of training, introduce various tasks, and enable learners to learn general problem-solving skills.

The cases of pre-hospital emergency scenarios are diverse. If only the standard procedures are repeated in training, students will have rigid procedural memories. Their performance drops significantly when there

is a change in the real-world environment. Scenario-simulation teaching can build multiple versions of case libraries for various causes, age groups, and off-site constraints to expand task diversity. Debriefing sessions help students learn general rules for decision-making, convert surface-level motor skill memory into high-level strategic ability, and enhance their adaptability to new and difficult situations.

4. Existing problems in pre-hospital emergency training for higher vocational nursing

4.1. Rigid and monotonous practical-teaching modes

The current dominant model for pre-hospital emergency training is still a traditional linear process: teacher lecture, procedural demonstration, repeated group practice by students, and final skill assessment at the end of the term. The entire teaching rhythm is teacher-led, and students complete the checklist to take the test. Monotonous practice fails to train dynamic clinical assessment and prioritization skills, so many students can perform individual operations well but are unable to make timely decisions in the event of sudden changes in health status.

At present, the standards for assessment also focus on process. Quality of clinical thinking, team communication efficiency, and emotion regulation ability are not primary evaluation indices. The above bias in assessment will encourage teachers to lead students to learn by rote and fail to promote all-around development of their clinical skills ^[3].

4.2. Discrepancy between practical training scenarios and real-world clinical conditions

Training laboratories are generally clean, well-lit, well-equipped, and quiet; they are far from the actual pre-hospital environment of dim light, small spaces, slippery floors, loud surroundings, and emotional or obstructive family members. Students have been trained in these protected laboratory environments and thus lack real-life perception of hazards, limited resource allocation, and interpersonal conflict management.

Most of the current scenarios are static initial-state simulations and do not show how diseases change over time, such as vomiting or ventricular fibrillation during CPR. Students have rarely been exposed to consecutive unforeseen difficulties and thus face significant “reality shock syndrome” upon their first clinical internship; consequently, their professional self-confidence is weakened.

4.3. Deficiencies in students’ all-round emergency practical ability

Due to a fixed teaching mode and de-contextualized scenarios, higher vocational nursing students show clear deficiencies in pre-hospital emergency response in terms of cognition-decision-making, technical operation, and emotional regulation. Students have difficulty quickly assessing all the injured people and prioritizing their care; they focus too much on minor injuries and fail to help others. Operationally, the technical performance declines under high-pressure conditions; typical errors include inadequate compression depth and improper placement of a tourniquet, as well as unclear command delivery and role overlap among team members. Most students feel anxious, mentally blank, or avoidant in the presence of actual patients psychologically. The reasons for these shortcomings are not only a lack of technical knowledge but also an overall failure to provide training on emergency decision-making and psychological adjustment mechanisms.

5. Design and implementation of scenario-simulation teaching

5.1. Construction of pre-hospital emergency simulation scenarios

Based on the campus emergency simulation teaching center, mobile partition walls, high-fidelity projection screens, professional audio equipment, and other simulation props have been installed. The four representative cases are as follows: sudden illness at home, urban road traffic accident, construction-site fall injury, and sports-field injury. All the scenarios had a standard first-aid kit and a configurable equipment failure simulation device.

Based on the three-level progressive system, the scenario construction was divided into three parts: physical reality restoration, psychological atmosphere rendering, and authentic task embedding. Space arrangement, light color temperature, and background noise are all examples of context. Teachers and standardized patients performed spontaneous performances under time pressure. Conflicting clues, such as obstructive family members, communication breakdowns, and low-powered rescue equipment, were present, and students had to choose among them due to resource limitations^[4].

5.2. Design of scenario-simulation teaching procedures

The three stages of the closed-loop system were: Pre-simulation Orientation, Immersive Simulation Execution, and Guided Debriefing, to ensure consistent learning and deep thinking. In the pre-simulation orientation, teachers provided short case materials and role assignments, and students completed mental preparation and off-site risk assessment in five minutes. The immersion simulation period was 15–20 minutes long, and it generally followed the same process as on-site assessment, emergency response, and safe transfer. Teachers triggered pre-set clinical deterioration scenarios via central control for off-site testing. Guided debriefing used a non-punitive evaluation method and had students first share their own emotions and thoughts, then have peers observe. Then, the teacher posed some heuristic questions at the critical points of decision-making to guide the students' clinical reasoning.

5.3. Teaching implementation and process control

Two natural parallel classes of Grade-2024 nursing majors from a higher vocational college were selected as the research subjects. The experimental group used scenario-simulation teaching, and the control group was taught conventionally. The total number of teaching hours, curriculum content, and teachers were the same for both groups.

Six-person training groups were formed in the experimental class, and two other observers recorded the group's interaction data. Role rotation was used to give all the students a chance to be the on-site commander, technical operator, information recorder, and patient counselor. Critical control measures: Clarify the boundary between simulation and actual clinical practice to avoid excessive psychological pressure; set up a "safe-word" mechanism for voluntary emergency interruption; schedule a 10-minute rest period after each simulation. Multi-dimensional process archives have been created to store operation records, decision-making paths, and communication logs.

6. Application effects and teaching optimization strategies

6.1. Analysis of teaching outcomes

Objective structured clinical examination and self-developed emergency-decision-making scales were used

for evaluation. Based on the statistics, the experimental group performed better than the control group in all three areas: completeness of emergency response, rationality of clinical decision-making, and efficiency of team communication. According to the qualitative data in the reflective journals, scenario-simulation provided a realistic emergency situation and strengthened students' sense of purpose and emotional strength. Classroom observations found that the experimental class students had more high-level questions and logical analyses during debriefing. In addition, clinical preceptors gave the experimental-class students more than 10 percentage points higher scores for off-site adaptation in the early stages of clinical internship and confirmed favorable long-term skill transfer effects.

6.2. Practical deficiencies of the teaching model

Although the results were good, there were serious problems in practice. First, high-quality scenario design requires teachers' clinical emergency experience and script-writing skills. Inconsistent plot logic or too many conflicting clues in some simulation cases led to cognitive dissonance among students. Second, full-cycle simulations are time-consuming. Only three or four groups can finish the drills in a normal class period. Many students were in the observer role and did not participate actively or focus well. Third, assessments have focused on final exams; process-oriented behavioral data, such as changes in emotion and reaction speed during decision-making, have been neglected and cannot reflect the gradual progress of learning^[5].

6.3. Optimization countermeasures for higher vocational nursing practical training

Based on the above deficiencies, four feasible remediation measures are put forward. First, establish a dynamic teaching resource library with core basic cases and adjustable-parameter modules. Teachers can adjust the difficulty level and context to reduce the workload of independent case development. Second, set up an organizational system for simulated-drill rotation and parallel small-group operation. Large classes are divided into mini-units that run different cases simultaneously, and then joint debriefing sessions are held to increase the frequency of participation and immersion within a limited number of class hours. Third, develop behavior-anchored process-evaluation scales, decompose non-technical skills into observable behavioral indicators, and integrate peer-assessment and self-assessment weights to build multi-source evaluation closed loops. Fourth, organize regular emergency-center-on-the-job training courses for teachers. Senior outstanding students are selected to act as auxiliary simulated participants and help build a stable faculty and personnel support system.

7. Conclusion

Scenario-simulation teaching offers a new model for transforming pre-hospital emergency training at higher vocational nursing schools by moving away from "skill-drill-centered" education towards "clinical-situation-centered" learning. Through the entire research chain of theoretical review, problem diagnosis, scheme design, and effect verification, this study has found that scenario-simulation teaching can effectively motivate deep-level student participation, reduce the gap between classroom training and actual clinical practice, and enhance all-around emergency skills. However, it will also have relatively higher demands for faculty qualifications and optimized teaching organization and evaluation systems. In the future, extend the duration of longitudinal follow-up studies to investigate how different intensities and frequencies of simulation affect the long-term career development of nursing talents. Virtual reality, artificial intelligence, and simulation

teaching can also be integrated in depth to build adaptive-diagnosis intelligent training systems, and thus provide strong support for high-quality emergency care personnel cultivation under the Healthy China Initiative.

Disclosure statement

The authors declare no conflict of interest.

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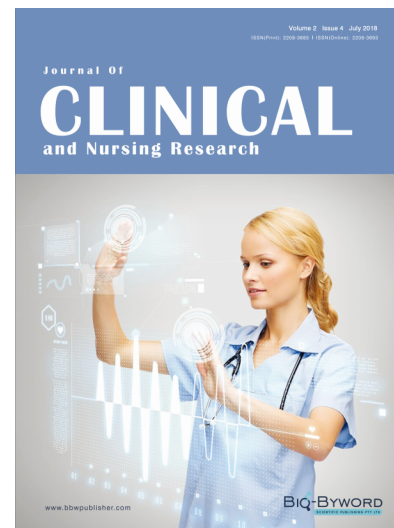
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