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Scenario-Based Simulation in Medical and Nursing Education (2019–2025): Research Progress and Practice Insights

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Abstract: ***With the transformation of medical education towards "competence-oriented" development, traditional theoretical teaching can hardly meet the clinical demand for practical talents. As a core means to connect "institutional education" with "clinical practice", the scenario-based simulation teaching method has been increasingly applied in the fields of medical and nursing education. This teaching method takes simulated real clinical scenarios as the carrier and guides learners to engage in immersive role-playing and problem-solving, thereby realizing the in-depth integration of theoretical knowledge and practical skills. It can significantly improve learners' clinical emergency response ability, humanistic communication ability, and teaching satisfaction. This article reviews the current application status of the scenario-based simulation teaching method in medical and nursing education, including its core application models, implementation effects, and existing problems. Furthermore, it proposes future development directions based on emerging practices such as the BOPPPS model and the Calgary-Cambridge communication model, aiming to provide references for medical and nursing educators to optimize teaching practices.***

Keywords: Scenario-Based Simulation Teaching Method, Medical Education, Nursing Education, Teaching Model, Application Progress**.**

1. Overview of Scenario-Based Simulation Teaching Method

The core goal of medical and nursing education is to cultivate professionals "capable of solving practical clinical problems". However, the traditional teaching model that "emphasizes theory over practice" leads to issues such as "unskilled operations and weak emergency response capabilities" among some learners when they enter clinical practice [1]. Originating from the structuralism of linguistics and behaviorism of psychology, the scenario-based simulation teaching method was first proposed by British scholars. It was introduced into China's education field in the 1990s and has since been gradually applied in medical and nursing teaching [2].

From the perspective of medical and nursing education, the scenario-based simulation teaching method refers to a teaching model where teachers design simulated scenarios incorporating "patient symptoms, diagnosis and treatment needs, and potential risks" based on the teaching syllabus and real clinical cases. Through role-playing, team collaboration, and operational drills, learners can master clinical skills and decision- making thinking in a "safe trial-and-error" environment [3]. Compared with traditional teaching, this method has three major advantages: first, it shortens the gap between theory and clinical practice through "scenario reconstruction". For example, it simulates low-probability and high-risk scenarios such as "anesthesia crises" and "triage in mass casualty incidents", making up for the limitations of "being difficult to encounter and dare to practice" in clinical practice [4]; second, it stimulates learners' initiative. Through group discussions and role immersion, learners are transformed from "passive listeners" to "active problem-solvers". For instance, scenario-based simulations based on the Calgary-Cambridge communication model guide nursing students to proactively explore doctor-patient communication skills [25]; third, it adapts to multi-stage educational needs. It can be used for "basic operation training" of undergraduate nursing students (e.g., prevention of patient falls) and "complex emergency management" of standardized training physicians (e.g., cardiopulmonary resuscitation combined with defibrillation) [4].

2. Application Progress of Scenario-Based Simulation Teaching Method in Medical and Nursing Education

2.1 Distribution of Application Fields

Currently, the scenario-based simulation teaching method has covered three core fields of medical and nursing education, with distinct application focuses in different fields. Additionally, new studies have further expanded the scope of sub-scenarios: Nursing Education Field: Accounting for an increased proportion of 40.74% (11 out of 27 studies), it now includes "specialized training for communication skills" and "cultivation of critical thinking" alongside traditional focuses on "operational standardization, humanistic care, and emergency nursing". For example, scenario-based simulations based on the Calgary-Cambridge communication model simulate scenarios such as "patients complaining about medical experiences" in the teaching of outpatient nurses, training nurses in empathetic expression and conflict resolution [25]; scenario-based simulations guided by the OBE (Outcome-Based Education) concept design scenarios like "nursing for patients with acute abdominal pain" in higher vocational nursing teaching. Through a closed loop of "goal-oriented scenario drilling - effect feedback", nursing students' critical thinking abilities are enhanced, with their scores on the Critical Thinking Scale being 12.6 points higher than those in the traditional group after teaching [20].Clinical Medicine Education Field: Accounting for 51.85% (14 out of

27 studies), it has added scenarios such as "collaborative management of critical illnesses" and "specialized training for aseptic techniques". For example, in the teaching of critical obstetric and gynecological illnesses, scenario-based simulations combined with the BOPPPS model design scenarios for "emergency management of postpartum hemorrhage" following six stages: "Bridge-in - Objective - Pre-assessment - Participation - Post-assessment - Summary". This has increased the standardization rate of emergency procedures for standardized training physicians by 38% and improved their team collaboration scores by 25% [28]; in the training of aseptic techniques, scenario-based simulations adopt the process of "demonstration of operations - error correction in scenarios - repeated drilling", increasing the qualification rate of aseptic operations for interns from 68% to 92% [21].Pharmacy Education Field: Accounting for 7.41% (2 out of 27 studies), it has added "complex scenarios in community pharmacy services". For example, simulating scenarios where "elderly patients take multiple medications simultaneously (with potential drug interactions)" to train pharmacists' abilities in medication assessment and guidance [11].

2.2 Core Application Models and Implementation Processes

At present, the scenario-based simulation teaching method has formed a multi-dimensional innovative model system. All models focus on "aligning with clinical needs and strengthening competency development" and emphasize "goal orientation" and "detail optimization" in their implementation processes. Specifically, they can be divided into three categories: "model - integrated", "technology - empowered", and "collaboration-oriented".

2.2.1 Model-Integrated Scenario-Based Simulation

Characterized by "taking structured teaching models as the framework to deepen the systematicness of scenario drilling", this category enhances the teaching efficiency and effectiveness of scenario-based simulations by integrating the logical advantages of mature teaching models: BOPPPS Model Integration: The teaching process is designed in six stages: "Bridge-in - Objective - Pre-assessment - Participation - Post-assessment - Summary". In the bridge-in stage, typical clinical cases (e.g., postpartum hemorrhage in obstetrics and gynecology, severe infections in respiratory departments) are used to stimulate learning interest; in the objective stage, specific competency development goals are clarified (e.g., mastering emergency procedures and team division of labor); in the pre-assessment stage, questions (e.g., "common causes of postpartum hemorrhage") are raised to assess prior knowledge; in the participation stage, group drills are organized, with teachers providing real-time guidance on operational details (e.g., controlling the intensity of uterine massage); in the post-assessment stage, the standardization of operations and the ability to apply knowledge are evaluated; in the summary stage, common mistakes are sorted out and core knowledge points are reinforced. After applying this model in the teaching of nursing students in respiratory departments, their theoretical assessment scores increased from 71.5 to 89.2 points, and teaching satisfaction reached 90.5%; in the teaching of critical obstetric and gynecological illnesses, the standardization rate of emergency procedures for standardized training physicians increased by 38%, and their team collaboration scores improved by 25%.Calgary-Cambridge Communication Model Integration: Focusing on "hierarchical improvement of communication skills", the implementation process includes setting communication goals (e.g., "alleviating the anxiety of family members and helping them understand surgical risks"), designing scenarios (simulating situations where family members question the necessity of surgery), role-playing (assigning roles of nurses, family members, and observers to recreate communication interactions), reviewing details (analyzing whether empathetic phrases such as "You are worried about the post-operative recovery, aren't you?" are used to assess communication effectiveness), and intensive training (repeating drills for weak areas such as "insufficient empathy" and "unclear expression"). After applying this model, the satisfaction rate of doctor-patient communication among outpatient nurses increased from 72% to 91%, and the patient complaint rate decreased by 40%, effectively improving the humanistic communication literacy of nursing staff. OBE Concept Integration: Guided by "competency-based outcomes", it builds a closed loop of "goal setting - scenario drilling - effect feedback". In higher vocational nursing teaching, scenarios such as nursing for patients with acute abdominal pain and management of diabetic ketoacidosis are designed, with teaching goals centered on "enhancing critical thinking" and "strengthening clinical decision-making abilities". The achievement of these abilities is verified through scenario drilling, and the teaching plan is continuously optimized based on feedback. After teaching, nursing students' scores on the Critical Thinking Scale were 12.6 points higher than those in the traditional group, and their ability to solve clinical problems was significantly improved.

2.2.2 Technology-Empowered Scenario-Based Simulation

This category expands the scenario dimensions and immersion of scenario-based simulations through technical means, breaking the temporal and spatial limitations and resource constraints of traditional practical training: VR Technology Empowerment: Relying on virtual reality (VR) technology to build highly realistic clinical environments, it can simulate nursing scenarios for different conditions (e.g., mild/severe COVID-19 patients) and different settings (general isolation wards, ICU wards). Learners can switch between virtual environments to practice targeted nursing measures (e.g., basic care for mild cases, vital sign monitoring and emergency collaboration for severe cases). In COVID-19 nursing teaching, this model helped learners become proficient in operations such as donning/doffing protective equipment and managing isolation wards, effectively improving their mastery of infection prevention knowledge and operational proficiency. Multiple Exposure Intensification: By repeatedly drilling the same type of clinical scenario and gradually increasing the difficulty and complexity, it achieves a step-by-step improvement in abilities. In pediatric emergency teaching, the first exposure focuses on "familiarizing with operational procedures" (e.g., steps of cardiopulmonary resuscitation); the second exposure emphasizes "simultaneous communication with parents" (e.g., briefly informing parents of progress during emergency

treatment to alleviate their anxiety); the third exposure adds "sudden interfering factors" (e.g., simulating equipment failures and sudden convulsions in children) to force learners to respond flexibly. After multiple rounds of drilling, learners' comprehensive emergency response capabilities increased by 45%, and the retention rate of knowledge and skills was significantly improved.

Microlecture Technology Assistance: Combining microlectures with scenario-based simulations, theoretical knowledge (e.g., key points of surgical instrument passing, basics of urinary stoma care) is delivered via microlectures before class to help learners familiarize themselves with operational principles and processes in advance; during class, the focus is on scenario-based simulation drilling to strengthen operational details and clinical application; after class, review through microlectures and extended cases are used to consolidate learning outcomes. In the teaching of urinary stoma care, this model increased the standardized rate of patients' self-care from 62% to 89% and reduced the incidence of complications by 35%, achieving an efficient connection of "theoretical preview - practical drilling - effect consolidation".

2.2.3 Collaboration-Oriented Scenario-Based Simulation

Centered on "cultivating multi-disciplinary collaboration capabilities and team cooperation awareness", this category adapts to the practical needs of multi-professional collaboration in clinical settings: Interprofessional Collaboration (IPE Concept): A multi-professional team consisting of nurses, physicians, and pharmacists is formed to conduct collaborative drilling around complex clinical scenarios (e.g., diabetic patients with ketoacidosis, triage in mass casualty incidents). The process includes team formation and division of labor (nurses monitoring vital signs, physicians formulating treatment plans, pharmacists assessing medication safety), scenario drilling (recreating the entire process of patient treatment and simulating links such as information transmission and decision-making discussions), team feedback (analyzing issues such as "delayed information transmission" and "unclear division of labor"), and plan optimization (jointly formulating a multi-disciplinary communication flowchart for critical illnesses). After application, the scores of nursing students' interprofessional collaboration awareness increased from 65.3 to 86.8 points, and the efficiency of team task completion improved by 30%, laying a solid foundation for multi-disciplinary collaboration in clinical practice.

Aseptic Technique Specialized Collaboration: For the core clinical skill of aseptic operation, the process of "demonstration of operations - error correction in scenarios - repeated drilling" is adopted. Learners are organized into collaborative groups, where one person performs the operation and the other observes and supervises, promptly pointing out issues such as "contamination of the aseptic area" and "incorrect operation sequence". Through team interaction, aseptic awareness and standardized operating habits are strengthened. After training, the qualification rate of aseptic operations for interns increased from 68% to 92%, effectively reducing the risk of clinical infections.

2.3 Teaching Evaluation and Implementation Effects

The evaluation dimensions of the scenario-based simulation teaching method have added "communication skills", "team collaboration", and "critical thinking", with more comprehensive data on implementation effects:

Competency Improvement: In addition to the original "clinical emergency response capabilities and satisfaction", new indicators include: 1) Communication skills: Scenario-based simulations based on the Calgary-Cambridge model increased the effectiveness score of outpatient nurses' communication from 68 to 89 points [25]; 2) Critical thinking: Scenario-based simulations guided by the OBE concept resulted in higher vocational nursing students' critical thinking scores being 12.6 points higher than those in the traditional group [20]; 3) Team collaboration: Scenario-based simulations combined with the BOPPPS model improved the team collaboration scores of standardized training physicians in obstetrics and gynecology by 25% [28].

Teaching Satisfaction: New data shows that the satisfaction rate of nursing students in the BOPPPS + scenario-based simulation group reached 90.5% [23], and the satisfaction rate of teachers in the interprofessional scenario-based simulation group reached 88% [36], both higher than those in the traditional teaching group (75%-80%).

Skill Improvement: After scenario-based simulation training for aseptic techniques, the qualification rate of aseptic operations for interns increased from 68% to 92% [21]; the combination of microlectures and scenario-based simulations in urinary stoma care increased the standardized rate of patients' self-care from 62% to 89% and reduced the incidence of complications by 35% [26].

3. Existing Problems in the Application of Scenario-Based Simulation Teaching Method

3.1 Insufficient Teaching Standardization

In addition to the existing "lack of unified scenario design and evaluation indicators", a new problem of "lack of application standards for models" has emerged: for example, the duration of the "participation stage" in scenario-based simulations combined with the BOPPPS model varies greatly among different institutions (set to 20 minutes in some institutions and 40 minutes in others), leading to fluctuations in teaching effects; in scenario-based simulations based on the Calgary-Cambridge communication model, there is no unified scale for "communication effect evaluation". Some studies use "subjective scoring by teachers", while others use "feedback from standardized patients", resulting in low comparability of results [25].

3.2 Single Evaluation System

A new problem of "lack of evaluation tools for special competencies" has arisen: for example, there is a lack of standardized evaluation tools for "critical thinking" and "details of interprofessional collaboration" (e.g., information

transmission efficiency in emergency situations). Only 5 studies adopted "objective scales" (such as the Critical Thinking Scale), while the rest still relied on "subjective descriptions"; long-term follow-up studies are still insufficient, with only 3 studies conducting follow-ups for more than 6 months, and none of them involved "the transfer effect of skills in different clinical scenarios" (e.g., whether the training effect of outpatient communication scenarios can be transferred to inpatient communication scenarios) [20, 25, 28].

3.3 Significant Differences in Resource Adaptation

The problem of "difficulty in promoting specialized models" exists: for example, scenario-based simulations using the BOPPPS model require supporting "pre-assessment question banks and post-assessment tools", which are difficult for primary institutions to improve due to a lack of professional designers; scenario-based simulations based on the Calgary-Cambridge communication model require "repeated training of standardized patients", and primary institutions struggle to maintain a team of standardized patients due to financial constraints, with only 15% of primary institutions conducting such teaching [25].

4. Future Development Directions of Scenario-Based Simulation Teaching Method

4.1 Constructing a "Model-Field-Stage" Three-Dimensional Standard Framework

On the basis of the original "field-stage" framework, a "model adaptation" dimension is added: it is recommended to formulate standards according to the sequence of "teaching model (BOPPPS/Calgary-Cambridge/OBE) → professional field → teaching stage". For example, in scenario-based simulations using the BOPPPS model for "critical obstetric and gynecological illnesses (field) - advanced stage (stage)", the duration of the "participation stage" is clearly defined as 30 minutes, and the post-assessment includes 5 core indicators (such as emergency procedures and medication accuracy) [28]; in scenario-based simulations based on the Calgary-Cambridge model for "outpatient nursing (field) - basic stage (stage)", a unified "communication effect evaluation scale (including 3 dimensions and 15 indicators: empathy, listening, and expression)" is established [25].

4.2 Improving the Multi-Dimensional Evaluation System

The development of "evaluation tools for special competencies" is required: 1) For critical thinking, the "Nursing Critical Thinking Disposition Inventory (CTDI-CV)" is introduced, and quantitative scoring is conducted based on "problem analysis speed and plan rationality" in scenario drilling [20]; 2) For interprofessional collaboration, a "team collaboration evaluation scale (including 3 dimensions: information transmission, division of labor and cooperation, and emergency decision-making)" is developed; 3) For long-term evaluation, "tracking of the transfer effect of clinical scenarios" is added, such as recording the application of nursing students' skills in different clinical scenarios (outpatient/inpatient/emergency) to assess the long-term value of teaching.

4.3 Promoting Resource Adaptation and Technology Integration

To address the problem of "difficulty in promoting specialized models" in primary institutions, the following proposals are put forward: 1) Develop "modular scenario packages": for example, the BOPPPS scenario-based simulation package includes "standardized pre-assessment question banks, scenario scripts, and evaluation forms", which can be directly applied by primary institutions; 2) Establish a "standardized patient sharing mechanism": institutions in the same region jointly train standardized patients and share them in turn to reduce the cost of individual institutions; 3) Promote "lightweight technical tools": for example, use "mobile phone screen recording + scenario scripts" to create simple VR materials to replace high-cost VR equipment, meeting the basic teaching needs of primary institutions [28].

4.4 Expanding Applications in Special Fields

On the basis of the original "psychiatric nursing, infectious disease nursing, and geriatric nursing", "chronic disease management" and "rehabilitation nursing" scenarios are added: for example, in scenario-based simulations for chronic disease management of diabetes, scenarios of "patients adjusting medications independently due to fluctuations in home blood glucose" are designed to train nurses' abilities in remote guidance and risk early warning; in scenario-based simulations for rehabilitation nursing, scenarios of "stroke patients with poor compliance with rehabilitation training" are simulated to train rehabilitation specialists' incentive strategies and plan adjustment abilities [26].

5. Conclusion

The scenario-based simulation teaching method has significant application value in the fields of medical and nursing education. Especially after integrating emerging concepts such as BOPPPS, Calgary-Cambridge, and OBE, its teaching form has become more refined, which can effectively improve learners' comprehensive abilities such as communication, collaboration, and critical thinking. Although there are currently problems such as insufficient standardization and difficulty in resource adaptation, this method is expected to further exert its advantages by constructing a three-dimensional standard framework, improving evaluation tools, and optimizing resources in primary institutions. In the future, it is necessary to continuously combine "local needs" with "international innovation", strengthen multi-center and long-term effect studies, and cultivate more medical and nursing professionals with "solid theoretical foundations, excellent practical skills, and strong comprehensive abilities" for clinical practice.

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