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Application and Prospect of Artificial Intelligence in Acute and Critical Care Nursing Teaching

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Abstract: Driven by social needs, national policies, and digital innovation, the traditional teaching model of acute and critical care nursing can no longer meet the demand for high-quality acute and critical care nursing talents in modern medical care. Artificial intelligence (AI) technology provides effective innovative solutions for acute and critical care nursing teaching through capabilities such as virtual simulation, big data technology, and natural language processing. This paper systematically sorts out the application scenarios of AI in acute and critical care nursing teaching, analyzes the current challenges such as technical costs, teachers' literacy, and ethical risks in application, and looks forward to the future development direction from the dimensions of technological integration, policy support, and talent training, aiming to provide useful references for the reform of acute and critical care nursing teaching.

Keywords: Artificial intelligence; Acute and critical care nursing; Nursing teaching; Virtual simulation; Large language model; Personalized learning

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1. Introduction

The "Action Plan for Further Improving Nursing Services (2023–2025)" jointly issued by the National Health Commission and the National Administration of Traditional Chinese Medicine clearly proposes to use new-generation information technologies such as AI and 5G to optimize nursing service processes and strengthen the informatization development of nursing, which provides a clear direction for the intelligent transformation of acute and critical care nursing teaching. Acute and critical care nursing requires nurses to have comprehensive abilities in rapid condition assessment, accurate operation execution, and multi-disciplinary collaborative response. Introducing AI-assisted teaching can construct virtual simulation training environments, supplement teaching resources, improve the practicality of nursing teaching, and exercise students' clinical adaptability.

2. Core application scenarios of AI in acute and critical care nursing teaching

2.1. Constructing clinical training scenarios with virtual simulation technology

Virtual simulation technology can reproduce acute and critical care clinical scenarios through the integration of 3D modeling and real-time interaction algorithms, allowing students to conduct operational drills [1]. Currently, mainstream application forms include VR intensive care unit (ICU) simulation, AR first-aid process guidance, and digital twin patient systems, with specific applications as follows.

2.1.1. VR intensive care scenario training

With VR devices such as HTC Vive and Oculus Rift, a virtual ICU can be constructed, including equipment such as multi-functional monitors, ventilators, and CRRT used in real scenarios. Students can operate virtual equipment through handles to simulate scenarios such as "adjusting ventilator parameters for patients with respiratory failure" and "infusing vasoactive drugs for patients with hypotension". The system advances the training process according to students' operation steps and corrects errors through voice prompts [2].

2.1.2. AR first-aid process visualization

In operation training such as cardiopulmonary resuscitation (CPR) and tracheal intubation, students can wear AR glasses. For example, during CPR training, the AR interface can real-time display prompts such as "compression depth 5–6 cm" and "compression frequency 100–120 times per minute", and correct compression angle deviations through motion capture technology to improve the standardization rate of students' CPR operations.

Digital Twin Patient System AI-driven virtual patients constructed based on real clinical cases are used in students' practical training. For example, an AI-driven acute myocardial infarction patient can be constructed, and the virtual patient will show symptoms such as arrhythmia and hypotension according to operational feedback. Students need to make accurate judgments on the patient's condition and take first-aid measures [3]. The system can determine whether their operations are correct based on the measures taken by students.

2.2. Creating intelligent teaching interaction and resource generation tools with large language models

Large language models represented by ChatGPT 4.0 and Wenxin Yiyan 4.0 can act as intelligent teaching assistants in acute and critical care nursing teaching by virtue of their natural language processing capabilities, with specific applications including the following three aspects.

Firstly, providing personalized Q&A for students to strengthen their learned knowledge. Students can ask difficult questions about acute and critical care nursing through the dialogue interface, such as "principles of fluid resuscitation in patients with septic shock". The model can not only output standardized answers but also expand with cases to guide students to deepen their understanding [4].

Secondly, generating clinical cases to provide efficient resource development support for teachers. Acute and critical care nursing teaching requires a large number of clinical cases. With large language models, teachers can obtain cases meeting teaching requirements by simply inputting keywords matching teaching focuses [5].

Thirdly, simulating inter-professional communication to train students' thinking logic. In acute and critical care nursing practice, nurses need to cooperate closely with doctors, and efficient inter-professional communication directly affects patient treatment efficiency and prognosis [6]. In training, teachers can set specific disease backgrounds according to teaching objectives, allowing students to report the condition to a "virtual

doctor" simulated by the model in the role of nurses. The doctor simulated by the model will ask follow-up questions based on the concerns of clinical doctors in assessing the condition.

2.3. Improving the precision of teaching evaluation with intelligent assessment and feedback systems

AI can make teaching evaluation more objective and comprehensive by collecting and analyzing students' learning data, providing a basis for teaching improvement.

Quantitative scoring of operational details is one of the important functions of intelligent assessment systems. In first-aid training simulations, the system deploys infrared sensors and motion capture cameras (such as Kinect) to real-time capture data of each operation step of students. For example, in defibrillation operation assessment, the system automatically records indicators such as electrode placement position, charging time, and interval between compression and defibrillation for scoring, and finally forms a quantitative assessment report [7].

Visual assessment of clinical thinking refers to converting students' thinking into analyzable and evaluable specific paths through virtual case decision-making tools. In the assessment, the system presents typical acute and critical care cases, such as nursing scenarios for patients with acute respiratory distress syndrome. Students need to sequentially complete the selection of inspection items and the formulation of treatment plans according to the condition [8]. The system records the order of students' decisions, the rationality of inspection items, and the matching degree between treatment plans and the condition, generating a visual thinking path map to help teachers locate the weak links of students' clinical thinking.

Dynamic monitoring of team collaboration can evaluate the critical team cooperation ability in acute and critical care nursing. For example, in training scenarios requiring team collaboration such as multi-person CPR and mass trauma treatment, the system captures the interaction details and operational coordination of team members throughout the process. After the training, the system can real-time generate a team collaboration heat map, marking the task participation of each member with different colors [9].

2.4. Implementing differentiated teaching support based on AI algorithms with personalized learning platforms

Building personalized learning platforms relying on AI algorithms can provide adaptive learning support for each student. This analysis method does not rely on a single data but comprehensively judges based on performance in multiple scenarios. The final learning needs analysis results generate personalized learning paths for students.

In addition, AI can continuously track students' learning and provide real-time learning feedback for teachers and students. Teachers can adjust the focus of classroom teaching accordingly, strengthen the explanation of weak knowledge points or add targeted training [10]. Through the platform, students can intuitively see their performance in different ability dimensions, clearly know the content they need to prioritize improving, and then independently formulate learning plans to improve targeted learning efficiency.

3. Challenges in the application of AI in acute and critical care nursing teaching

3.1. Technical costs and adaptability issues

The introduction of AI teaching equipment requires high investment. A complete VR ICU simulation system needs an investment of hundreds of thousands of yuan, and the separate purchase cost of the CRRT virtual training

module is about 150,000 yuan, which may exceed the budget capacity of some institutions. At the same time, existing AI tools, such as some virtual simulation software (e.g., Laerdal SimChart), are not interoperable with the existing teaching platforms of institutions (e.g., Chaoxing Learning Pass), resulting in students' operation records unable to be synchronized to the total score [11].

3.2. Insufficient teachers' AI literacy and teaching integration capabilities

Teachers of acute and critical care nursing need to have the ability to operate AI tools and design teaching, but the current teaching team has certain shortcomings. Firstly, the proportion of teachers who have received systematic AI technology training is low; secondly, some teachers regard AI as a substitute tool, simply replacing practical training with VR videos, lacking the ability to integrate AI technologies and tools into teaching design [12].

3.3. Ethical and data security risks

AI teaching involves students' operation data and virtual patient privacy information. If students' operation records and biometrics are not stored encrypted, they may be obtained by third parties. In addition, some students may use AI such as ChatGPT to write nursing case reports and experimental summaries, leading to an increase in academic misconduct.

3.4. Technology lacks clinical authenticity and humanistic care

Although AI technology can simulate clinical operations, it still lacks clinical authenticity. Virtual patients cannot fully restore the individual differences of real patients, resulting in students needing to re-adapt in real clinical practice [13]. At the same time, AI lacks the simulation of humanistic care in nurse-patient communication. For example, virtual patients cannot show emotions such as "anxiety and fear", making it difficult for students to improve their humanistic care literacy.

4. Future prospect of artificial intelligence in acute and critical care nursing teaching

4.1. Technological integration: 5G + AI building a "virtual-real integration" training system

In the future, the low-latency characteristics of 5G networks will realize real-time linkage between virtual training and real scenarios. Firstly, in real scenarios such as ambulances and emergency rooms, virtual resources can be called through AR glasses. For example, a "trauma assessment flow chart" can be superimposed at the first-aid scene to help students make quick decisions; secondly, multiple institutions share VR ICU and AI virtual patient resources to reduce the cost investment of individual institutions. At the same time, digital twin technology will further improve scene authenticity, constructing "personalized virtual patients" by collecting physiological data of real patients to exercise students' response capabilities [14].

4.2. Innovative teaching model: AI + evidence-based medicine building a dynamic knowledge base

The problem of knowledge lag in current AI teaching resources will be solved through "AI + evidence-based medicine": firstly, establishing an automatic update mechanism of "guidelines-cases". For example, when a new version of the International Cardiopulmonary Resuscitation Guidelines is released, the AI system automatically

revises parameters such as compression depth and ventilation ratio in CPR training and generates new cases; secondly, introducing an "AI evidence-based assistant", allowing students to call the latest research evidence at any time in case analysis to cultivate students' evidence-based thinking.

4.3. Strengthening teacher training and ethical construction: Improving the AI teaching support system

To address the insufficient AI literacy of teachers, a training system can be improved: primary training focuses on basic operation of AI tools, such as VR equipment use and ChatGPT case generation; intermediate training focuses on AI teaching design, such as curriculum arrangement of "virtual training + real practice"; advanced training focuses on AI technology research and development, such as participating in the development of virtual simulation cases [15]. At the same time, the national level is expected to introduce the "Ethical Norms for the Application of AI in Nursing Education" in the future, clarifying data security requirements and academic integrity requirements.

4.4. Deepening industry cooperation: School-enterprise co-construction of AI teaching and training bases

In accordance with the requirement of "deepening the integration of production and education" in the "Healthy China 2030" Planning Outline, future cooperation will be promoted between nursing institutions, AI enterprises, and medical institutions: firstly, co-constructing "acute and critical care AI training centers", with enterprises providing technical support (such as Huawei providing 5G networks and Yihuixun providing virtual simulation software) and medical institutions providing clinical cases; secondly, developing a "clinical-teaching" data interoperability system, allowing students' internship operation data in hospitals to be synchronized to the school's AI platform, so that teachers can adjust teaching focuses accordingly.

5. Conclusion

Artificial intelligence has brought innovative approaches to acute and critical care nursing teaching, and its application can effectively improve students' operational skills and clinical thinking. Currently, although AI technology faces challenges such as high costs and insufficient humanistic care, these problems will be gradually resolved with the development of 5G and digital twin technologies and the improvement of the policy system. In the future, acute and critical care nursing teaching must adhere to the principle of "technology as the form and talent training as the essence". It is necessary to give play to the advantages of AI in scenario simulation and data processing, while focusing on cultivating students' empathy and ethical awareness, so as to transport more high-quality acute and critical care nursing talents for the medical industry.

Disclosure statement

The authors declare no conflict of interest.

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