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Application Status and Progress of Artificial Intelligence in Clinical Nursing

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Abstract: *Objective*: With the intensification of global population aging, diversified upgrading of clinical nursing demands, and the prominent contradiction of nursing human resource shortage, artificial intelligence (AI) has become a core driving force for the reform of clinical nursing models. This paper systematically reviews the application status of AI in clinical nursing, analyzes the core challenges in its development, and proposes optimization strategies, so as to provide evidence-based references for the deep integration of AI and clinical nursing. *Methods*: Core research findings on AI in nursing at home and abroad were systematically integrated, covering key research directions including clinical technology implementation, nursing service optimization, humanistic nursing innovation, talent training, and R&D and application of intelligent equipment, followed by comprehensive analysis and critical review. *Results*: AI technologies have been implemented in full scenarios of clinical nursing, showing significant value in improving nursing efficiency, ensuring patient safety, and optimizing nursing outcomes. However, core problems remain, such as insufficient clinical translation of technologies, gaps in AI literacy among nurses, imperfect ethical and normative systems, and inadequate industrial standards and evidence-based support. *Conclusion*: The future integration of AI and nursing should adhere to the patient-centered core philosophy, build a nursing-led technology R&D system, lifelong career talent training, sound ethical norms and industrial standards, so as to promote the high-quality development of nursing in China.

Keywords: Artificial intelligence; Clinical nursing; Clinical decision support; Infection prevention and control; Nursing education; Research progress

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1. Introduction

The population aged 60 and above in China has exceeded 260 million, accounting for 18.7%, driving nursing demands toward complexity and full-cycle development [1]. Meanwhile, the nursing profession in China has long been plagued by human resource shortages, homogeneous services, and delayed prevention and control of adverse events; traditional nursing models can no longer meet developmental needs. The National Nursing

Development Plan (2021–2025) clearly proposes using information technologies including AI to innovate nursing service models [2]. At present, most relevant studies at home and abroad focus on model development and effect verification for single technologies and single scenarios; systematic clinical application frameworks and industrial standards have not yet been formed, and in-depth analysis of core issues such as the subject value of nursing and adaptability to clinical scenarios during technology implementation remains scarce. Accordingly, this paper systematically integrates key research findings, comprehensively reviews the application status of AI in clinical nursing scenarios, analyzes core developmental problems, and puts forward optimization strategies, providing theoretical and practical references for AI-enabled high-quality development of clinical nursing.

2. Core application status of artificial intelligence in clinical nursing scenarios

2.1. Research and development and clinical translation of intelligent clinical decision support systems

The clinical decision support system (CDSS) is a core carrier of AI-enabled clinical nursing. By integrating evidence-based nursing evidence, patient health data, and intelligent algorithms, it provides precise decision-making guidance for nurses and has achieved full-dimensional coverage from general functions to specialized scenarios [3].

The system is mainly applied to adverse event early warning and nursing plan optimization: early warning covers high-incidence events such as falls and pressure injuries; machine learning algorithms significantly improve early warning timeliness and accuracy compared with traditional scales [4]. The intraoperative pressure injury decision system developed by Chen Rongzhu et al. realizes closed-loop management and reduces incidence [5]. The Chinese version of the evidence-based decision-making ability scale localized by Wei Yongting et al. provides a standardized tool for effect evaluation [6].

In specialized scenarios, the system has been deeply applied in ICUs, urology, and other fields: ICU-based systems enable complication prediction and mortality risk assessment with high nurse acceptance; in chronic disease care, they improve the accuracy of nursing assessment and patient self-management ability, and support specialized training for junior nurses [7–9]. Although the system achieves full coverage, bottlenecks remain, including weak model generalization, poor integration with workflow, and low algorithm interpretability.

2.2. Intelligent upgrading of the full-cycle clinical care process

Through IoT sensing, big data analysis, automated execution, and other means, AI digitally reconstructs the full-cycle clinical care process covering admission, hospitalization, discharge, and home care, effectively solving core problems of traditional nursing such as insufficient manpower coverage, low efficiency, and delayed early warning [10].

In in-hospital condition monitoring, AI shifts from scheduled manual monitoring to real-time dynamic early warning; physiological signals are collected and warned via IoT devices, making up for shortcomings of traditional assessment. Intelligent systems have been formed for nosocomial infection prevention and control: the monitoring system developed by Fu Enqin et al. improves operational compliance and hand hygiene adherence; the AI hand hygiene monitoring system developed by Granqvist et al. significantly improves hand hygiene compliance among medical staff through real-time feedback and data-driven performance

interventions, and a nursing-led collaborative innovation framework guides technology translation [11–13]. In medication management, AI reduces the risk of medication errors and relieves nurses' workload. Transitional care breaks spatial and temporal restrictions via intelligent devices, building an integrated in-hospital and home care model [14].

In summary, the core value of AI in reconstructing the full clinical care process lies in overcoming the spatial and temporal limitations of manpower coverage in traditional nursing, realizing a shift from "passive response" to "active early warning".

2.3. Personalized and intelligent innovation of humanistic nursing services

As modern nursing transforms to be "patient-centered", traditional humanistic nursing suffers from homogeneity and discontinuous coverage due to manpower constraints; AI provides a new path for its upgrading [15].

In psychological nursing, AI enables all-weather personalized intervention. The mental health nursing chatbot developed by Kang et al. based on GPT-4.0 has been clinically verified to significantly reduce anxiety and depression, with high user satisfaction for its interactivity and empathy. In psychiatric nursing, computer vision accurately captures emotional changes and negative symptoms in patients with depression and schizophrenia, solving assessment difficulties caused by impaired emotional expression. The combination of large language models and mobile health devices supports remote nursing guidance and personalized health management for patients with chronic diseases and mental disorders, showing significant value in home transitional care.

In summary, AI provides technical support for upgrading humanistic nursing services and effectively compensates for the shortcomings of insufficient manpower and severe homogeneity in traditional services.

2.4. Comprehensive reform of nursing education and talent training models

AI not only reshapes clinical nursing practice but also drives nursing education toward personalization, contextualization, and practicality.

In academic nursing education, AIGC tools break the limitations of traditional teaching, promote personalized transformation, and form a full-process AI-assisted teaching system. Postgraduate students use AIGC to improve research efficiency but face academic integrity risks.

For in-service training and AI literacy improvement of clinical nurses, the overall AI literacy of clinical nurses in China is moderate, and the coverage of AI-related training is less than 20%. Significant gaps in AI literacy also exist among teachers and students in nursing schools; most nursing teachers lack systematic AI training, becoming a core constraint on AI nursing education.

In summary, AI provides a new direction for the reform of nursing education models, showing remarkable value in improving teaching effects, realizing personalized training, and enhancing nurses' AI literacy.

2.5. Expansion of application scenarios for embodied intelligence and nursing robots

Embodied intelligence equips nursing robots with intelligent interaction capabilities, serving as a core solution to ease nursing manpower shortages and a future developmental trend.

Robots undertake basic and specialized nursing operations, reducing nurses' workload and occupational exposure risks; home rehabilitation robots provide convenient programs for stroke patients. Their application

promotes nurses to transform into AI managers and decision-makers, enhancing professional value. The R&D and application of nursing robots offer effective solutions to ease nursing manpower shortages and reduce workload.

A systematic comparison of adaptive technologies, clinical scenarios, and common limitations of existing research across the five core application dimensions of AI in clinical nursing is shown in **Table 1**, intuitively presenting research characteristics and existing problems in each field.

Table 1. Comparison of application dimensions, core technologies, and research status of ai in key clinical nursing scenarios

Application dimension	Core adaptive technologies	Key clinical application scenarios	Common limitations of existing research
Intelligent clinical decision support	Machine learning, deep learning, evidence-based knowledge graph	Adverse event early warning, evidence-based decision support, acute risk prediction in psychiatry	Weak generalization, poor algorithm interpretability, low workflow integration
Full-cycle care upgrading	IoT sensing, computer vision, NLP	Real-time vital sign monitoring, infection control, medication management, home transitional care	Severe data silos, poor adaptability for vulnerable groups in home settings
Humanistic nursing innovation	Large language models, affective computing, computer vision	Personalized health education, real-time psychological monitoring, AI crisis intervention	Insufficient emotional interaction, weak generalization, missing privacy norms
Nursing Education & Training	AIGC, virtual simulation, digital twin	Virtual patient simulation, AI literacy training, research assistance	Disconnection between training and practice, unclear academic norms for AIGC
Nursing Robots & Embodied Intelligence	Multimodal sensing, motion control, emotional interaction	Nursing operations, high-risk care, home rehabilitation, patient transfer	Single-function design, poor clinical adaptability, high R&D and maintenance costs

3. Core challenges in the application of artificial intelligence in clinical nursing

The application of AI in nursing is still in the initial stage characterized by “heavy R&D, weak implementation”. Clinical translation and adaptability are insufficient; most single-center models have weak generalization and are disconnected from clinical needs. Deep learning suffers from algorithm black boxes, large language models tend to generate false information, and sensing technologies lack stability in complex scenarios [15]. Meanwhile, nurses show obvious gaps in AI literacy, with low training coverage and insufficient practical ability; teachers and students also lack competence. Some nurses resist AI due to fears of job replacement and weakened thinking, and complex operating procedures further hinder adoption.

In addition, data security and ethical norms are imperfect: privacy data involved in AI applications have management vulnerabilities, and leakage of psychiatric sensitive information is highly harmful. Problems such as algorithmic bias, lack of informed consent, unclear liability for adverse events, and academic integrity crises caused by AIGC also exist [10,15]. Unified industrial standards and high-quality evidence-based evidence are severely lacking; a full-process management system has not been established. Most existing studies are single-center and small-sample, with insufficient cost-benefit research, limiting large-scale promotion. **Figure 1** constructs a logical framework of core challenges and corresponding optimization strategies for AI clinical application in nursing, clearly showing the internal relationship between the four core challenges and targeted solutions, providing an overall roadmap for subsequent strategy formulation and implementation.

4. Future prospects

To address the core challenges of AI in clinical nursing, optimization should be promoted in four aspects: building a nursing-led technology R&D and clinical translation system, establishing a lifelong career AI literacy training system for nurses, improving ethical norms and security systems, and perfecting industrial standards and evidence-based systems. With technological breakthroughs such as multimodal large models, the patient-centered principle must be upheld, clarifying AI as an auxiliary tool and highlighting nurses as the main body, to drive fundamental reform of nursing service models.

5. Conclusion

Artificial intelligence provides important opportunities for nursing transformation and upgrading; full-scenario application can significantly improve nursing quality, efficiency, and patient safety. The technology is still in the initial stage, facing four core challenges: clinical translation, personnel literacy, ethical norms, and standard evidence.

The future should be clinical demand-oriented, build a nursing-led full-chain development system, achieve dual improvement of nursing quality and efficiency through human-machine collaboration, and promote the high-quality development of nursing in China.

Disclosure statement

The authors declare no conflict of interest.

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