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Application Status, Research Hotspots, and Future Prospects of Artificial Intelligence in Nursing in China

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ABSTRACT

With the rapid advancement of digital healthcare, artificial intelligence (AI) has emerged as a core driver of innovation in the nursing profession. Drawing on research findings related to AI applications in nursing in China over the past two decades, this study systematically synthesizes the current state of application, identifies research hotspots, analyzes existing challenges, and outlines future development directions. By integrating literature from databases including CNKI and Wanfang, as well as typical practical cases, it is revealed that AI has been applied across four core nursing scenarios: nursing education, clinical nursing, nursing management, and geriatric nursing. Key research hotspots have been formed, centered on "smart nursing equipment", "intelligent decision support", and "virtual simulation teaching". However, the field still confronts issues such as inadequate algorithm fairness, lagging digital literacy among nursing staff, and a lack of ethical norms. Moving forward, focus should be directed toward cutting-edge technologies like generative AI and digital twins, while strengthening interdisciplinary collaboration and ethical governance. This will facilitate the in-depth integration of AI and nursing, thereby advancing the high-quality development of the nursing profession.

Introduction

Driven by both the Healthy China 2030 Initiative and the "Digital China" strategy, the nursing field is undergoing a transformation from an "experience-driven" model to a "technology-collaborative-driven" one. Leveraging its strengths in data processing, scenario simulation, and intelligent decision-making, AI has effectively addressed long-standing challenges in traditional nursing, such as "uneven resource allocation", "disconnection between theory and practice", and "difficulties in quality control". For example, intelligent monitoring devices enable real-time early warning for critically ill patients, virtual simulation teaching enhances nursing students' clinical adaptability, and geriatric care robots alleviate the shortage of human resources in elderly care [1,2]. Visualization analysis indicates that the number of domestic studies on AI in nursing has grown exponentially, increasing from fewer than 50 articles per year in 2004 to 487 articles in 2024—underscoring that this field has become a central focus

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of nursing research [3, 4].

Nonetheless, current research remains fragmented: there is insufficient in-depth application in specialized nursing areas, low efficiency in technology translation (with most intelligent systems remaining in the laboratory stage), and a lack of a unified governance framework for ethical risks[5]. Therefore, systematically integrating existing research outcomes and clarifying the application boundaries and development pathways of AI in nursing is of great significance for driving innovation in nursing practice. This paper discusses four key aspects—application status, research hotspots, challenges, and prospects—to provide valuable references for clinical practice and scientific inquiry.

1. Current Application of Artificial Intelligence in Nursing in China

1.1 Nursing Education: From "One-way Indoctrination" to "Intelligent Empowerment"

AI has reshaped the entire "teaching-learning-assessment" cycle of nursing education, addressing limitations of traditional teaching such as "abstract and hard-to-grasp content", "limited practical opportunities", and "one-dimensional assessment". In basic course instruction, the integrated "Internet+VR+AI" model has become mainstream. For instance, in human anatomy courses for vocational nursing students, VR technology constructs three-dimensional organ models, while AI intelligently corrects anatomical positioning errors by real-time tracking students' operational trajectories—improving students' operational accuracy by over 35% [6,7]. In specialized courses, intelligent scenario simulation systems are widely employed in fields like "Emergency and Critical Care Nursing" and "Radiology Nursing". For example, the AI scenario module developed by Ren et al. [2] can simulate emergency situations such as "acute left heart failure" and "contrast agent allergy"; through immersive practice, students' scores on emergency response capabilities have increased by 28.6% compared to traditional teaching methods.

In terms of teaching model innovation, the "AI-integrated blended teaching" approach has yielded remarkable results. The Second Affiliated Hospital of Kunming Medical University adopted a "SPOC + flipped classroom + AI" model: prior to class, the AI system delivers personalized preview tasks (e.g., recommending videos on difficult radiology nursing topics based on students' past performance); during class, it analyzes the quality of group discussions in real time; and after class, it generates competency assessment reports. Ultimately, the average exit exam score of students in the experimental group was 12.3 points higher than that of the traditional group, with a teaching satisfaction rate of 95% [4]. Additionally, knowledge graph technology has advanced reforms in nursing ethics education. The "Nursing Ethics Knowledge Graph" developed by the West China School of Nursing, Sichuan University, enables "knowledge point association queries" and "intelligent matching of ethical cases", resolving the issue of scattered teaching resources and improving students' ethical decision-making scores by 40% [3].

1.2 Clinical Nursing: From "Passive Response" to "Precision Prediction"

AI applications in clinical nursing focus on "specialization" and "personalization", covering scenarios such as chronic disease management, emergency and critical care, and specialized disease nursing. In chronic disease management, AI-assisted diabetes care has become a key research focus. A survey conducted by Mo et al. [15] showed that 85.4% of healthcare professionals are willing to participate in AI-based diabetes management training; furthermore, AI systems can intelligently predict hypoglycemia risk by continuously monitoring blood glucose data, reducing the rate of unplanned emergency visits by 23.3%. In emergency and critical care

nursing, intelligent quality control systems have achieved significant outcomes: the "central monitoring station" for cardiovascular nursing quality control, developed by Fuwai Hospital of the Chinese Academy of Medical Sciences, integrates five-dimensional data (workload, task difficulty, core protocols, and specialized indicators). By real-time monitoring metrics such as venous blood collection barcode scanning rates and admission assessment completion rates, the AI system has reduced fall incidence by 20.78% and unplanned extubation rates by 30.36% [7].

Although AI applications in specialized nursing are still in their early stages, they have demonstrated considerable potential. In urological nursing internships, AI-assisted Problem-Based Learning (PBL) combined with progressive case teaching dynamically generates cases , guiding students to independently analyze nursing issues; this has improved interns' critical thinking scores by 5.2 points compared to the traditional group[5]. In advanced gynecological oncology nursing, nursing information platforms integrated with AI symptom analysis can automatically identify early warning signs such as "worsening cancer pain" and "nausea/vomiting", achieving a 100% triage accuracy rate and shortening referral decision-making time by 40 minutes compared to conventional processes[8, 9]. In ophthalmic nursing, AI-assisted fundus image analysis enables nurses to quickly identify diabetic retinopathy; however, its application is limited by "high equipment costs" and "low penetration in primary healthcare institutions" [6, 10].

1.3 Nursing Management: From "Manual Inspection" to "Data-Driven Governance"

AI has promoted the transformation of nursing management toward "refinement" and "full-process oversight", with key improvements in quality control and talent management. In quality control, the "intelligent central monitoring station" has become the dominant model. Beyond cardiovascular care, departments such as internal medicine and surgery have also explored AI-based quality control systems. By real-time capturing nursing record data, these systems automatically detect issues like "omission of pressure ulcer risk assessment" and "abnormal infusion rates", reducing the proportion of on-site inspection indicators from 92.0% to 37.4% and significantly enhancing management efficiency [7]

In talent management, AI-powered talent profiling enables "precision talent identification". The "Clinical Nursing Role Talent Profile"—developed by Wuhan Central Hospital Affiliated to Tongji Medical College of Huazhong University of Science and Technology using big data—extracts 20 characteristic indicators of nurses, including "operational proficiency", "emergency response ability", and "patient satisfaction". This provides a basis for role matching and hierarchical training, increasing nurses' role adaptation rate by 25% [6]. Additionally, AI optimizes nursing staffing: for example, an intelligent scheduling system developed by a hospital in Shenzhen automatically generates schedules by integrating factors such as patient volume, nurse skill levels, and department risk ratings, reducing nurses' overtime hours by 15% [18].

1.4 Geriatric Nursing: From "Basic Care" to "Smart Elderly Support"

In response to the growing aging population, AI has become a key tool for alleviating shortages in geriatric nursing resources, forming a three-in-one application system encompassing "rehabilitation assistance", "emotional companionship", and "health monitoring". In rehabilitation care, exoskeleton robots and brain-controlled wheelchairs are widely used: exoskeleton robots in Shenzhen's nursing homes assist elderly patients with hemiplegia in standing and walking, improving their independent mobility scores by 30%; "mind-controlled" brain-controlled wheelchairs achieve precise navigation through AI analysis of EEG signals, addressing mobility challenges for severely disabled elderly individuals [16, 17].

In emotional and health management, AI robots play a vital role. "Emotional support AI robots" deployed in some communities in Guangdong can identify changes in the elderly's emotional states through speech recognition and proactively provide psychological counseling. Intelligent systems in elderly canteens use facial recognition to identify individuals, automatically recommend personalized meals, and simultaneously record nutritional data [18, 17]. Furthermore, generative AI has emerged in elderly exercise rehabilitation: the GenAI system developed by Xu et al. [16] generates integrated Chinese-Western exercise prescriptions based on the elderly's physical data, increasing rehabilitation compliance by 42%.

2. Core Research Hotspots of AI in Nursing in China

Based on CiteSpace visualization analysis and literature synthesis, current domestic research on AI in nursing focuses on four key hotspots, exhibiting the dual trends of "technological deepening" and "scenario specialization" [11, 12].

2.1 Smart Nursing and Intelligent Equipment Applications

As the "foundation" of AI nursing research, this field focuses on three directions: "wearable devices", "intelligent monitoring systems", and "nursing robots". In wearable devices, research emphasizes "data accuracy optimization". For example, AI-enabled bracelets worn by patients with chronic pain can intelligently distinguish between "physiological pain" and "pathological pain" by monitoring multi-modal data (e.g., heart rate variability and skin resistance), achieving an identification accuracy of 89%[6,8.]. In intelligent monitoring, AI systems are evolving toward "multi-parameter integration"; for instance, cardiovascular monitoring equipment can simultaneously analyze ECG, blood pressure, and blood oxygen data, providing early warnings for arrhythmias 1–2 hours in advance [7]. In nursing robots, geriatric care robots and rehabilitation robots are priority research areas. Practices in Shenzhen and Guangdong show that nursing robots can perform basic services such as moxibustion, massage, and accompaniment for medical appointments, improving nurses' work efficiency by 20% [16, 18].

2.2 Nursing Management and Intelligent Decision Support

The core of research in this field lies in "data-driven quality improvement", encompassing two directions: first, "development of intelligent quality control systems". For example, the "five-dimensional quality control indicator system" proposed by Liu et al. [17] uses AI to real-time analyze nursing data and automatically generate quality control reports, addressing the "time-consuming and subjective" limitations of traditional manual inspections. Second, "advancement of clinical decision support systems". For example, AI systems in advanced gynecological oncology nursing can recommend referral pathways based on symptom data [8], and AI tools in diabetes management can intelligently match hypoglycemic regimens [15]; such systems improve the accuracy of nursing decisions by 30%–50%.

2.3 Nursing Education and Competence Development for Nursing Students

Research in this area centers on "AI-empowered teaching innovation", forming three trends: first, "refinement of virtual simulation teaching scenarios", expanding from basic nursing operations to specialized scenarios [13, 14]. Second, "optimization of personalized learning pathways": AI delivers customized learning resources by analyzing students' learning behaviors (e.g., video viewing duration and homework error rates) [15]. Third, "diversification of competence assessment dimensions", extending from "theoretical knowledge + operational skills" to "clinical thinking + ethical decision-making + emergency response capabilities". For example, the knowledge graph system developed by Zeng et al. [17] can assess the "depth and breadth" of students' ethical reasoning.

2.4 Specialized Nursing and Scenario-Specific Application

With in-depth research, AI in nursing is advancing toward "specialization", forming multiple sub-directions: in emergency and critical care nursing, AI focuses on "emergency scenario simulation" and "risk early warning" [19, 20]; in urological nursing, AI-assisted PBL teaching enhances interns' specialized operational skills [21, 22]; in ophthalmic nursing, AI explores scenarios such as fundus care and visual function rehabilitation [23,24]; in chronic pain nursing, AI covers the entire "assessment-prediction-intervention" process [25]. Additionally, AI applications in the context of "sports-medicine integration" have emerged as a new direction: generative AI can integrate sports medicine and clinical data to develop "exercise rehabilitation + nursing intervention" plans for patients [26].

3. Challenges in AI Application in Nursing

3.1 Technical Challenges: Inadequate Algorithm Fairness and Data Security

The "bias" and "black-box" nature of AI algorithms hinder their clinical application. On one hand, most algorithm training data is sourced from tertiary hospitals, lacking data from primary healthcare institutions, elderly patients, and patients with rare diseases—resulting in low accuracy of nursing decisions for vulnerable groups. For example, the accuracy of AI diabetes management systems in predicting hypoglycemia for elderly patients in primary hospitals is only 65%, far lower than the 90% accuracy observed for patients in tertiary hospitals [26, 27]. On the other hand, insufficient algorithm transparency makes it difficult for healthcare professionals to understand "why an AI system recommends a specific nursing plan", undermining clinical trust [14].

Data security risks constitute another critical concern. AI nursing systems require the collection of patients' private data , yet most institutions currently lack a full-process protection system covering "data encryption", "access control", and "emergency response", leading to frequent data breache[28]. Furthermore, a data-sharing mechanism for multi-center research has not been established, resulting in insufficient data for AI model training and poor generalization capabilities [29].

3.2 Talent Challenges: Lagging Digital Literacy Among Nursing Staff

There is a prominent "supply-demand mismatch" in AI skills among nursing staff. Surveys indicate that only 48.1% of nursing staff in China have received AI-related training, and the training content primarily focuses on "basic operations" , lacking advanced skills such as "AI result interpretation" and "algorithmic ethical judgment". A study by Mo et al. also found that only 12.6% of healthcare professionals can "fully understand" the decision-making logic of AI diabetes management systems. Additionally, the update of nursing education curricula is sluggish—most institutions have not incorporated "AI in nursing" into core courses, leaving nursing graduates ill-prepared to adapt to intelligent nursing environments [14, 17].

3.3 Ethical Challenges: Lack of Norms and Ambiguous Responsibility Attribution

The ethical governance system for AI in nursing remains incomplete, with three major controversies: first, the "privacy boundary" issue—patients have low acceptance of "AI collecting sensitive data ", and there is a lack of standardized procedures for "informed consent for data use" [28]. Second, the "responsibility attribution" issue—if an adverse event occurs due to an AI-recommended nursing plan, there are currently no clear regulations on whether responsibility lies with developers, healthcare institutions, or nursing staff [14, 17]. Third, the "loss of humanistic care" issue—while AI improves nursing efficiency, it cannot replace nurses'

"emotional support"; for example, geriatric care robots cannot comprehend the loneliness of the elderly, potentially leading to "impersonalized nursing" [29, 30].

3.4 Translation Challenges: Difficulties in Technology Implementation and Uneven Resource Allocation

Most AI nursing systems remain in the "laboratory stage" and are difficult to translate into clinical practice. The core reasons include: first, "high costs"—for example, the cost of a single set of VR scenario simulation equipment exceeds 100,000 RMB, which is unaffordable for primary institutions [31]. Second, "poor adaptability"—AI systems face difficulties in integrating with existing hospital information systems (HIS, LIS), resulting in data silos [7]. Third, "lack of long-term evaluation"—most studies only focus on short-term effects and lack clinical follow-up data for over 1 year, making it difficult to verify the long-term value of the technology [6].

Furthermore, uneven resource allocation exacerbates the "digital divide". AI nursing resources are concentrated in tertiary hospitals and key institutions in eastern coastal regions, while the application rate in central and western regions and primary institutions is less than 20% [17]. For example, exoskeleton robots are widely used in nursing homes in Shenzhen, whereas some nursing homes in central and western regions still rely solely on manual care[16, 17]; this gap further widens regional disparities in nursing service quality.

4. Future Prospects of AI in Nursing

4.1 Technological Frontiers: Focus on Generative AI and Digital Twins

Generative AI will drive nursing from "passive response" to "proactive innovation". In clinical nursing, GenAI can automatically generate "personalized nursing plans"—for example, integrating symptom data, genetic information, and lifestyle factors of patients with advanced gynecological cancer to develop comprehensive plans for "pain management + nutritional support + psychological intervention" [29]. In nursing education, GenAI can generate "dynamic cases" in real time; for instance, intelligently adjusting the difficulty and branching of "emergency and critical care scenarios" based on students' operational errors to enhance learning relevance [32].

Digital twin technology will enable "virtual-real collaborative nursing". This technology can create a "digital replica" of patients, simulating the effects of different nursing plans by real-time synchronizing physiological indicators. For example, constructing a digital twin model of elderly patients to predict the impact of "exoskeleton robot rehabilitation training" on pressure ulcer prevention makes nursing interventions more proactive [30]. Additionally, digital twins can be used for nursing staff training, such as simulating rare scenarios like "disaster nursing" and "large-scale infectious disease nursing" to improve emergency response capabilities [30].

4.2 Practical Directions: Enhance Specialized Penetration and Adaptation to Primary Care

AI in nursing needs to further advance toward "specialization" and "adaptation to primary care settings". In specialized fields, in-depth research should be conducted on sub-scenarios such as ophthalmology, pediatrics, and oncology; for example, developing AI systems for ophthalmic nursing to achieve full-process coverage of "fundus lesion screening + postoperative rehabilitation guidance + visual function training" [6]. In primary care institutions, "low-cost and user-friendly" AI tools need to be developed, such as "AI bracelets for chronic pain assessment" and "simplified diabetes monitoring apps" suitable for community hospitals, to lower application barriers [15, 29].

Moreover, interdisciplinary collaboration is a key pathway. It is essential to establish interdisciplinary teams consisting of "nursing + computer science + medicine + ethics": nursing experts participate in the demand design of AI systems, computer scientists optimize algorithm fairness, and ethicists formulate data usage norms to promote in-depth alignment between technology and clinical needs [14, 33].

4.3 Talent Development: Establish a Digital Literacy Training System

Nursing education must integrate "AI literacy" into its core competency framework. On one hand, curricula should be revised to include courses such as "Fundamentals of AI in Nursing", "Interpretation of Intelligent System Results", and "Nursing Ethics and AI", enabling nursing students to master both "technology application" and "risk assessment" capabilities [14, 28]. On the other hand, in-service training programs for nursing staff should adopt a "online + offline" model—for example, online courses on AI equipment operation and offline "AI emergency scenario drills"—and AI skills should be incorporated into nurse professional title evaluation criteria [15, 34].

4.4 Ethical Governance: Build a Dynamic Supervision and Normative System

A three-tier ethical governance framework of "government-industry-institution" should be established. At the government level, the Ethical Norms for AI in Nursing should be issued to clarify standards for data collection, algorithm transparency, and responsibility attribution [14]. At the industry level, an "AI Nursing Ethics Review Committee" should be established to conduct "pre-clinical ethical evaluation" and "post-clinical effect tracking" of intelligent systems [29]. At the institutional level, healthcare facilities need to implement an "AI nursing clinical application access system", allowing only systems that pass ethical review and data security certification to enter clinical practice [9]. Additionally, "patient participation" should be promoted—for example, developing standardized AI nursing informed consent templates to protect patients’ right to information and decision-making [34].

Conclusion

Artificial intelligence has become a core driver of innovation in China’s nursing profession, achieving significant outcomes in nursing education, clinical nursing, nursing management, and specialized nursing, and forming a diversified application landscape. However, challenges related to technology, talent, ethics, and translation still need to be addressed. In the future, guided by "clinical needs", efforts should be made to strengthen technological innovation and interdisciplinary collaboration, and establish a full-process guarantee system encompassing "technological security, talent adaptation, and ethical norms" to promote the in-depth integration of AI and nursing. Only in this way can the full value of AI be realized, enabling "precision, personalization, and efficiency" in nursing services and providing strong support for the implementation of the Healthy China initiative.

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