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Advances in the Application of Information Technology in Emergency Nursing Management

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Abstract: ***Objective:*** *To systematically review the research progress on the application of information technology in emergency nursing management over the past three years.* ***Methods:*** *PubMed, Wanfang, and CNKI databases were searched to retrieve original studies published between 2023 and 2026 on the application of mobile nursing systems, radio frequency identification (RFID), the Internet of Things (IoT), artificial intelligence (AI), and related technologies in emergency nursing management. Data were summarized from the perspectives of human resource scheduling, material traceability management, patient process optimization, quality monitoring and early warning, and clinical decision support.* ***Results:*** *Information technology has been deeply embedded in the entire process of emergency nursing management. In human resources, AI and optimization algorithms have been used for intelligent scheduling and workload prediction. In material management, RFID and IoT technologies have effectively shortened the time needed for emergency supply inventory and equipment location. In patient processes, AI-assisted triage has improved accuracy and efficiency. In quality control, nursing-sensitive indicator monitoring systems have been integrated into the national quality control indicator framework. In clinical decision support, knowledge-based systems provide auxiliary value. 5G and IoT technologies are promoting pre-hospital and in-hospital emergency integration.* ***Conclusion:*** *Information technology significantly improves the efficiency and safety of emergency nursing management, but still faces bottlenecks such as information silos and insufficient evidence quality. Future efforts should focus on clinical utility validation of AI decision support systems, construction of whole-process closed-loop management systems, and implementation science-based translational research.*

Keywords: Emergency nursing, Nursing management, Information technology, Mobile nursing, Internet of Things, Artificial intelligence.

1. Introduction

Emergency nursing management is characterized by high timeliness, multitasking, and information fragmentation. Traditional management models rely mainly on paper records, verbal handovers, and experience-based scheduling, resulting in systemic deficiencies such as delayed human resource allocation, time-consuming location of emergency supplies, incomplete handover information during transport, and logical errors in nursing documentation [1]. Mobile nursing systems, radio frequency identification (RFID), the Internet of Things (IoT), and artificial intelligence (AI) have gradually been integrated into emergency nursing management [2,3]. At the policy level, both the Evaluation Standards for the Application Level of Electronic Medical Record Systems and the Action Plan for Further Improving Nursing Services (2023–2025) have set clear requirements for nursing informatization [1].

Recent original studies have confirmed that personal digital assistant (PDA) scanning reduces medication errors [4], RFID-equipped emergency trolleys shorten inventory time [5], and electronic triage systems reduce patient waiting time [3]. However, existing literature mostly focuses on a single technology or an isolated link; systematic reviews integrating a holistic nursing management perspective are limited, and there is a lack of in-depth analysis of the practical obstacles to technology implementation under the high-pressure environment of emergency care [1]. Therefore, from the perspective of nursing management, this paper systematically reviews the research progress of information technology in various management dimensions of emergency nursing over the past three years, summarizes the evidence of effects, and analyzes existing bottlenecks and future development directions.

2. Technical Architecture and Classification of Emergency Nursing Informatization

2.1 Infrastructure Layer: Data Acquisition and Sensing Technology

The infrastructure layer constitutes the technical foundation of nursing informatization, mainly including mobile nursing terminals, automatic identification technology, and IoT sensing devices. Mobile nursing systems and bedside PDAs connect to hospital information systems via wireless networks, allowing nursing staff to complete vital sign entry, order execution, specimen collection confirmation, and nursing documentation at the bedside [6,4]. The integration of 5G technology with mobile nursing systems has significantly improved the speed and accuracy of verification [6]. PDA combined with barcode or QR code scanning can quickly identify patient identity, medications, and blood bag labels, thereby technically avoiding matching errors in patient identification and medication administration [4]. RFID technology can read information in batches without line-of-sight, providing obvious advantages in emergency supply management: it automatically records the person and time of access and enables expiration early warning and location tracking [5,7,8].

2.2 Data Integration Layer: Information Interconnection and Sharing Technology

The data integration layer aims to eliminate “information silos” among different information systems. The electronic emergency triage information system interfaces with hospital information systems, laboratory information systems, and picture archiving and communication systems. After patient registration, it can automatically retrieve past medical history,

laboratory results, and imaging reports to assist nursing staff in making rapid triage decisions [2,3]. The system incorporates the Modified Early Warning Score (MEWS) or the National Early Warning Score (NEWS), automatically calculates scores based on entered vital signs, and recommends triage levels and estimated waiting times [2,3]. Nursing electronic medical records, through structured templates and logic verification functions, improve documentation efficiency and facilitate quality traceability and data mining [6,4].

2.3 Intelligent Application Layer: Analytics and Decision Support Technology

The intelligent application layer uses AI, big data analytics, and algorithmic models to provide predictive analysis and decision support. Machine learning-based triage warning models can comprehensively analyze multimodal clinical data to identify high-risk groups such as those with sepsis or cardiac arrest [9,10]. Deep learning techniques have been used to identify drivers of nursing workload and extract key predictive indicators from routine clinical data [11,12]. Cloud-based management platforms integrate 5G, IoT, and AI technologies to achieve closed-loop information management from pre-hospital emergency care to in-hospital treatment [13]. Nursing decision support systems embed clinical guidelines into the nursing workflow, providing functions such as medication safety alerts and intelligent generation of SBAR
(Situation - Background - Assessment - Recommendation) standardized communication content [14]. These three types of technology are progressive and synergistic; their organic integration is a necessary condition for the intelligent transformation of emergency nursing management.

3. Integrated Application of Information Technology in Emergency Nursing Management

3.1 Intelligent Scheduling and Performance Evaluation of Nursing Human Resources

In scheduling, recent research has moved from experience-based scheduling to optimization algorithms and AI assistance. Hartford Hospital deployed an end-to-end automatic scheduling system based on a two-stage optimization model, using a robust optimization model combined with a mixed integer programming algorithm to generate individualized schedules, thereby improving scheduling efficiency and resource utilization [15]. Another study achieved coordinated scheduling of nursing manpower and material resources using a multi-objective integer programming model [16]. A scheduling model based on a deep neural network-assisted heuristic algorithm can allocate shifts individually according to nursing staff skill levels and job requirements, thus improving scheduling rationality and fairness [15,16].

In nursing workload assessment, AI and machine learning provide new quantitative tools.

Garcia et al [11] showed that a machine learning model could identify key drivers of nursing workload from routine clinical data and achieve workload prediction. A quasi-experimental study also found that AI scheduling systems positively improve nurses' sense of fairness and reduce turnover intention [17].

In nursing training and performance management, intelligent mobile office platforms have been gradually applied to emergency nursing education and training management, improving training efficiency and management quality through mobile learning, online assessment, and process tracking [16].

3.2 IoT Traceability Management of Emergency Supplies and Equipment

In emergency supply management, the integration of RFID technology with the IoT platform has significantly improved efficiency. Liu et al. [5] showed that RFID-enabled smart emergency trolleys achieve automatic recording of item access, real-time inventory updates, and automatic expiration alerts, markedly shortening inventory time and reducing item loss rates. Xiong and Tan [7] combined QR code technology with color management for emergency trolleys, achieving dynamic tracking of expiration dates and maintaining emergency readiness. In the pre-hospital setting, Zhao et al. [18] developed an intelligent supply management system based on a mobile application, enabling dynamic management of consumables, reducing inventory backlog, and avoiding resource waste.

In equipment management, the combination of IoT and ultra-wide band (UWB) positioning technology has become a research hotspot. Wang et al. [19] constructed an emergency equipment dispatching system based on UWB positioning technology that integrates centimeter-level positioning with intelligent dispatching algorithms, achieving real-time equipment location and smart deployment, thereby improving equipment utilization. Chen et al [20] used a multi-technology integrated patient trajectory tracking system to record the transport pathway of stroke patients in real time, providing data support for emergency process optimization. Tan et al [8] confirmed through a cluster-randomized trial that combining RFID with a Kanban system enabled automated management of emergency consumables inventory and achieved favorable cost-effectiveness.

3.3 Information-Based Closed-Loop Management of Patient Process Optimization and Transport Safety

In triage management, AI and mobile technologies are gradually being integrated into emergency triage practice. Yang et al. [9] conducted a retrospective cohort study showing that machine learning models have high accuracy in predicting ICU admission needs and identifying high-risk patients. Zheng et al. [10] reported in a prospective diagnostic accuracy study that large language models can provide triage recommendations based on symptoms and vital signs, showing potential for emergency severity assessment. Wang et al. [3] performed a before-after study showing that AI-assisted triage systems improve triage accuracy and shorten patient length of stay. Furthermore, a randomized controlled trial by Chen et al. [2] confirmed the feasibility of chatbots in emergency triage, which can relieve nursing staff

workload.

Patient transport safety is a critical component of emergency nursing quality. With the development of 5G technology, pre-hospital to in-hospital information integration is advancing. Chen et al. [21] showed that a 5G smart ambulance system can connect in real time with a tele-ICU centre, supporting continuous monitoring and remote guidance during interfacility transport of critically ill patients. Xu et al. [22] found that a 5G+smart emergency pre-hospital intervention improved the efficiency of traumatic shock patient management and reduced adverse events. Liu et al. [23] constructed a data-intelligence-driven critical care platform that integrates 5G, IoT, big data, and AI technologies to achieve closed-loop information management from pre-hospital emergency care to hospital discharge. For mass casualty incidents, Li et al. [24] developed an information-based nursing management plan that improved patient identification efficiency and treatment coordination.

3.4 Nursing Quality Indicator Monitoring and Risk Early Warning

Nursing quality monitoring is an important component of nursing management. In recent years, the national level has been steadily promoting the establishment of emergency nursing quality indicators. The Emergency Medicine and Other 6 Specialties Medical Quality Control Indicators (2024 Edition) issued by the National Health Commission clearly defines the statistical standards and evaluation requirements for emergency-related quality indicators [25]. Concurrently, research on nursing-sensitive indicators has deepened; Tang et al. [26] constructed a nursing quality-sensitive indicator system for emergency adult extracorporeal cardiopulmonary resuscitation, providing a standardized tool for quality evaluation in this specific context.

The introduction of information platforms has improved the timeliness and accuracy of nursing quality monitoring. Liu et al. [27] conducted a quasi-experimental study showing that a proactive information-based nursing quality management model effectively shortens emergency response time, improves nursing management quality, and reduces nursing risks. Khairat et al. [28] studied virtual nursing in U.S. emergency departments and found that the information-supported model improved waiting times and process measures such as documentation completeness. In emergency chest pain management, Chen et al. [29] performed a randomized controlled trial showing that a cloud-based management model reduced hospital arrival-to- treatment time, emergency length of stay, and triage time, while improving resuscitation success rate and patient satisfaction. Zhou et al. [13] similarly reported that cloud-based management shortened the time from symptom onset to first medical contact and increased the success rate of resuscitation in chest pain patients.

For patients with acute ST-segment elevation myocardial infarction, Wang et al. [30] developed a “smart emergency” information-based nursing process that effectively shortened door-to-balloon time and promoted process optimization.

3.5 Knowledge Base-Based Nursing Decision Support System

Nursing decision support systems (NDSS) are an important direction for intelligent emergency nursing. A randomized controlled trial by Zhang et al. [31] indicated that clinical decision support systems are generally associated with beneficial effects on the management quality of critically ill patients, but evidence for the emergency nursing subgroup remains insufficient, requiring more high-quality studies to support long-term effects. Knowledge base-based NDSS integrate clinical guidelines, nursing standards, and expert experience to provide real-time decision support for nursing staff. A multicentre randomized controlled trial by Li et al. [14] further confirmed that NDSS-assisted emergency triage management can improve triage accuracy and process efficiency.

4. Effectiveness Evaluation and Evidence Assessment

The effects of information technology in emergency nursing management have been validated in multiple studies, mainly reflected in four aspects: efficiency improvement, safety improvement, human resource optimization, and cost-effectiveness.

Efficiency improvement. The deployment of mobile nursing systems and PDAs allows nursing staff to complete core nursing operations at the bedside, reducing the number of trips to the nursing station and time consumption [4]. The PDA-driven optimized nursing process shortens medication order verification and execution time and reduces the incidence of risk events [4]. The application of 5G mobile nursing stations further improves the efficiency and accuracy of medication order verification [6]. In the pre-hospital setting, 5G+smart technology interventions improve the efficiency of traumatic shock patient management [22]. In chest pain patient management, the cloud-based management model reduces hospital arrival-to-treatment time, emergency length of stay, and triage time, and improves resuscitation success rate [29]. The application of virtual nursing systems also shows effects in shortening patient waiting time and improving nursing documentation completeness [28].

Safety improvement. Mobile nursing systems effectively prevent manual recording errors and create more face-to-face interaction time between nursing staff and patients [4]. The proactive information-based nursing quality management model shortens emergency response time and reduces the incidence of adverse events [27]. The pre-hospital emergency supply management system, using RFID and smart APP, reduces the expiration rate and loss rate of supplies [18], thereby improving treatment safety at the source.

Human resources and satisfaction. Intelligent scheduling systems improve nurses’ sense of scheduling fairness and reduce turnover intention [17]. AI workload prediction models provide new approaches for optimizing nursing staff allocation [11]. The application of intelligent mobile office platforms in emergency nursing education helps improve training efficiency and nursing staff satisfaction [16].

Cost-effectiveness. RFID-based intelligent supply

management systems reduce inventory backlog and material waste, and lower labor costs [8]. UWB equipment positioning systems improve equipment utilization and reduce time loss due to equipment searching [19]. However, it should be noted that most current studies are single-center before-after or observational designs; multicenter, high-quality evidence remains limited.

5. Current Problems and Future Trends

5.1 Existing Deficiencies

Despite the significant improvements brought by information technology to emergency nursing management, multiple challenges remain at the technical, organizational, ethical, and research levels.

At the technical level, the information silo problem is still prominent. The interfaces between the emergency nursing system and the hospital information system, laboratory information system, and picture archiving and communication system are not unified, leading to duplicate data entry and inconsistencies. System response speed slows down during peak hours, and hardware design issues such as small PDA screens, short battery life, and unstable RFID sensing have not been well resolved.

At the organizational level, the information literacy of nursing staff varies. Some nurses have a psychological resistance to technology, and too many non-urgent system alerts easily lead to alarm fatigue. The targeted training system is not well established, hindering the clinical translation of new technologies. Moreover, the application of AI involves complex issues such as data protection, algorithm bias, and infrastructure dependence, which impose higher requirements on nursing management [32].

At the ethical level, the risk of patient privacy data leakage increases with the deepening of informatization. Safety hazards such as loss of mobile terminals, interception of wireless transmission, and screen viewing by others exist. The disaster backup mechanism is not perfect; once the system fails, nursing work may be completely interrupted.

At the research level, high-quality evidence is still lacking. Evidence for the effectiveness of clinical decision support systems in the emergency nursing subgroup is insufficient [31]. Most AI triage models are based on retrospective, single-centre designs [9]; subjective indicators are susceptible to the Hawthorne effect, limiting the generalizability of findings.

5.2 Future Development Directions

Technical optimization: A whole-process information closed-loop should be built to achieve seamless pre-hospital to in-hospital data integration. 5G, IoT, and AI should be integrated to realize smart management from pre-hospital emergency care to discharge [23]. At the same time, the human-computer interaction design of mobile terminals should be improved to support voice control and one-handed operation, enhancing clinical applicability.

Organizational optimization: Information technology training for nursing staff should be strengthened, including integrating information system operation into high-fidelity simulation training [14], improving algorithmic literacy, and gradually building a human-machine collaborative emergency nursing management model.

Ethical safeguards: Data security and privacy protection mechanisms should be improved by adopting encryption transmission, access control, and remote wiping technologies [32]. Disaster backup and offline contingency procedures should be established, and regular drills conducted to ensure the sustainability of nursing work.

Research improvement: Priority should be given to multicenter, prospective studies using patient final outcomes as evaluation endpoints [10]. Implementation science research should be deepened, using mixed methods to analyze the facilitators and barriers to technology implementation, thereby providing strategic support for dissemination [11].

6. Conclusion

Studies on information technology in emergency nursing management published between 2023 and 2026 show that mobile nursing systems, RFID, IoT, AI and related technologies have significant value in optimizing human resource scheduling, material traceability management, improving triage accuracy, enhancing patient transport processes, and monitoring nursing quality. The integration of 5G technology with information systems is promoting pre-hospital to in-hospital emergency integration, and IoT combined with UWB positioning is improving the intelligence level of equipment management. However, systemic bottlenecks such as information silos, insufficient evidence quality, ethical risks, and hardware applicability remain. Future research should focus on clinical utility validation of AI decision support systems, construction of whole-process closed-loop management systems, optimization of human-machine collaborative working models, and implementation science-based translational research, so as to promote the continuous development of emergency nursing management toward a smarter, safer, and more efficient direction.

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