

# Innovative Applications and Model Exploration of Intelligent Technologies in Chronic Disease Care

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**Abstract:** With the increasing global prevalence of chronic diseases, traditional care models struggle to meet the demand for personalized care. Intelligent nursing technologies, including smart devices, remote care platforms, and artificial intelligence (AI), are revolutionizing chronic disease management by enhancing care quality, improving patient self-management, and alleviating healthcare resource pressure. This review explores the application and innovative models of intelligent technologies in chronic disease care, focusing on their roles in disease monitoring, remote intervention, and personalized care. The review also discusses the challenges and limitations in practical implementations, including issues of technology acceptance, data privacy, and security. Finally, we provide an outlook on the future directions of intelligent nursing technologies, emphasizing their potential in reshaping chronic disease care models globally. This paper offers theoretical support for the development of innovative chronic disease care models and provides practical insights for nursing practitioners, policymakers, and technology developers.

**Keywords:** Smart nursing; Chronic disease; Remote nursing; Artificial intelligence; Personalized care

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## 1. Introduction

Chronic diseases, such as diabetes, hypertension, and cardiovascular diseases, have become increasingly prevalent globally due to lifestyle changes, including poor dietary habits, lack of physical activity, and environmental factors. According to the World Health Organization (WHO), chronic diseases are now the leading cause of death worldwide, accounting for over 70% of all deaths <sup>[1]</sup>. The management of these conditions represents a significant challenge for both healthcare systems and patient well-being <sup>[2]</sup>.

Managing chronic diseases involves multiple complexities, including not only patients' self-care but also the provision of nursing services and systemic healthcare support. Individuals with chronic illnesses often require long-term care and treatment, yet many struggle with poor adherence to prescribed regimens. This is often due to factors such as insufficient health literacy, unrealistic expectations regarding treatment outcomes, or

difficulties in adopting necessary lifestyle changes. Additionally, while chronic disease patients require continuous monitoring and care, healthcare resources in many countries are still disproportionately allocated to acute care, leading to delays in services for those with chronic conditions. Furthermore, the prolonged caregiving burden can leave family members physically and mentally exhausted, potentially affecting their own health. In some cases, patients may lack sufficient support from family or social networks due to factors such as busy schedules, lack of understanding, or social isolation.

In response to these challenges, the healthcare sector is undergoing a profound transformation, driven by rapid advancements in intelligent technologies. These technologies, such as wearable devices and remote monitoring platforms, have the potential to revolutionize chronic disease management. Wearable devices can continuously monitor various health metrics—such as heart rate, physical activity levels, and sleep quality—providing patients and healthcare providers with real-time data. By detecting abnormal physiological changes, such as irregular heart rhythms or blood glucose fluctuations, these devices can alert patients to take preventative actions, even offering early warnings before a disease exacerbation. Moreover, remote monitoring enables patients and their families to track disease-related indicators in real time and share this data with clinicians for dynamic, personalized management <sup>[3]</sup>.

The intelligent nursing model, which integrates these technologies, has the potential to optimize care quality, enhance treatment efficiency, and reduce healthcare costs. These models go beyond traditional nursing approaches by enabling personalized treatment and continuous support, with significant applications in both medical treatment <sup>[4]</sup> and psychological interventions <sup>[5]</sup>. As technology advances, intelligent nursing is evolving into a key driver of efficient, precise, and personalized healthcare, holding immense value for future research and innovation in the field.

## **2. Methods**

### **2.1. Literature search strategy**

To comprehensively review the applications and models of intelligent technologies in chronic disease care, we implemented a systematic literature search strategy. We focused on high-quality studies, using key databases such as PubMed, IEEE Xplore, and Scopus. Our methodology followed a rigorous approach, assessing the study designs, sample sizes, and data quality of the included studies. We also utilized standardized quality assessment tools such as the Cochrane Risk of Bias Tool for clinical trials. The search commenced with the selection of primary databases, ensuring broad coverage of literature and inclusion of core research within the relevant field.

First, the retrieval strategy underwent reliability assessment before being applied to five databases: PubMed, IEEE Xplore, Scopus, Web of Science, and CINAHL (Cumulative Index to Nursing and Allied Health Literature). To ensure comprehensive coverage of relevant literature, the following keywords and their combinations were employed: “Chronic disease management,” “Smart technologies,” “Nursing care,” “Artificial Intelligence,” “Telemedicine,” “Wearable devices,” “Mobile health,” “Health informatics,” “Chronic disease models,” “Digital health solutions.” Furthermore, Boolean logic (AND, OR) was employed in keyword searches to maximize the comprehensiveness of retrieval results. The literature search timeframe spans from January 2002 to November 2025, capturing innovations in smart technologies for chronic disease care. We included studies that utilized quantitative methodologies, providing data on the effectiveness of remote monitoring and AI. In addition, we conducted a meta-analysis to examine the overall impact of intelligent technologies on patient outcomes, including

hospitalization rates, medication adherence, and disease progression.

## 2.2. Inclusion and exclusion criteria for relevant studies and screening process

The literature screening process adhered to rigorous standards to ensure the inclusion of high-quality, relevant, and scientifically sound studies. The initial step involved preliminary screening, where all retrieved literature was first assessed based on titles and abstracts. Studies directly pertinent to chronic disease care and the application of intelligent technologies—including artificial intelligence, remote care, wearable devices, and digital health technologies—were included. Exclusions applied to non-original research (e.g., reviews, commentaries, conference abstracts); studies not involving chronic disease patients; and literature with unclear or unscientific methodologies. The second step involved full-text screening, where articles passing the initial screening underwent full-text review. Inclusion criteria required clear research methodologies, thorough data analysis, and findings directly or indirectly relevant to smart technology applications in chronic disease care. Articles had to be published in peer-reviewed journals or conference proceedings. Exclude studies of low quality, with unsound data analysis, or conclusions unrelated to the theme. Step three, the final step, involves a comprehensive quality assessment. Apply systematic review standards to evaluate the quality of included studies. For clinical trials, use the Cochrane Risk of Bias Tool; for observational studies, employ the Newcastle-Ottawa Scale (NOS) for quality assessment. Ensure the scientific rigor and reliability of included studies, excluding those of poor quality.

## 3. Classification of intelligent technologies

Intelligent nursing technology employs advanced scientific methods to assist, optimize, and enhance the nursing process, thereby improving the quality and efficiency of care services and enhancing patients' quality of life. It encompasses the entire care cycle from disease prevention, monitoring, diagnosis, and treatment through to rehabilitation. Utilizing smart devices, platforms <sup>[7]</sup>, and algorithms, it enhances the efficiency of nursing staff, supports patient self-management, and even enables personalized care <sup>[6]</sup>. Intelligent nursing extends beyond merely delivering medical care; it encompasses continuous monitoring of patient health status, guidance on health behaviors, and support for clinical decision-making. By integrating traditional nursing practices with modern information technology, it transcends temporal and spatial constraints to provide patients with efficient, convenient, and personalized services.

Currently, intelligent nursing technologies are advancing rapidly worldwide, playing an increasingly vital role, particularly in chronic disease management. From remote monitoring and personalized health management to the application of artificial intelligence and big data, these technologies not only enhance the efficiency and quality of chronic disease care but also provide patients with more convenient, precise, and tailored nursing services. With further technological development, supportive healthcare policies, and heightened patient awareness of health management, intelligent nursing technologies will continue to expand their applications in the coming years, driving the digital and intelligent transformation of global healthcare systems.

Intelligent nursing technologies can be categorized according to their application domains, functionalities, and technical implementations, primarily encompassing the following types (**Table 1**).

**Table 1.** A comparative analysis of intelligent technologies in chronic disease management

Technology type	Advantages	Disadvantages	Applicable scenarios	Cost-effectiveness	Evidence level
Remote Monitoring Technology (IoT)	Real-time data collection and monitoring - Continuous health management - Remote intervention and personalized care	High equipment dependency - Privacy protection and data security concerns - Operational difficulties for elderly patients	Health Monitoring for Patients with Chronic Conditions - Long-Term Disease Management and Complication Prevention	High initial investment, but reduces hospitalization rates and complications, offering long-term cost-effectiveness	High
Artificial Intelligence (AI) and Machine Learning	Precise Prediction and Personalized Care Plans - Providing Decision Support - Massive Data Analysis Capabilities	Lack of transparency - High dependence on data - Models may not be applicable to all patients	Personalized Treatment Plans for Chronic Conditions - Disease Prediction and Early Intervention	High initial investment, but long-term healthcare costs can be reduced by improving treatment outcomes and minimizing errors	Middle-high
Virtual Reality and Augmented Reality (VR/AR)	Enhancing rehabilitation outcomes - Alleviating patient distress and anxiety - Immersive interactive experiences	Technical complexity - Varied patient acceptance - High-cost equipment limits application scope	Pain Management - Mental Health Interventions and Emotional Support	Medium	Middle
Nursing Robot	Enhancing nursing efficiency - Performing repetitive tasks - Providing emotional support	High cost - Low level of technological acceptance - Operational complexity	Long-term hospitalized patients or those receiving home care - Basic nursing care and emotional support	High initial investment, but by reducing the burden on care staff, it enhances care efficiency in the long term and lowers labor costs.	Middle
Big Data and Disease Prediction	Data-driven precision forecasting - Delivering personalized health management programs - Optimizing resource allocation	Data quality and integrity issues - Privacy protection concerns - Over-reliance on data analysis	Chronic Disease Progression Monitoring and Prediction - Health Risk Assessment and Intervention	Middle-high	High

### 3.1. Remote monitoring technology

Remote monitoring technology utilizes sensors, IoT devices, and internet platforms to collect patients' physiological data in real time, transmitting it to healthcare providers <sup>[8]</sup>. The core characteristics of such technology lie in remote data transmission and real-time monitoring, enabling medical staff to manage patients' health conditions without geographical constraints. Remote monitoring proves particularly vital in the long-term management of chronic conditions, supporting continuous health data tracking and personalized interventions.

### 3.2. Artificial intelligence and machine learning technologies

The application of artificial intelligence (AI) and machine learning (ML) technologies in intelligent healthcare encompasses decision support, personalized care, disease prediction, and diagnostic assistance. By analyzing patient health data, clinical records, and medical imaging, AI assists healthcare professionals in formulating more precise treatment plans while providing capabilities such as disease prediction and early warning systems. Machine learning models can self-optimize decision-making processes through continuous learning from historical data <sup>[9]</sup>.

### 3.3. Virtual reality and augmented reality technologies

Virtual reality (VR) and augmented reality (AR) technologies find primary application in smart healthcare through health education, patient rehabilitation training, and emotional support. These technologies deliver interactive training and psychological support via immersive virtual environments, proving particularly suitable for chronic patients requiring rehabilitation. Examples include virtual training to enhance physical function or alleviate symptoms such as pain <sup>[10]</sup>.

### 3.4. Other intelligent technologies

Moreover, with the continuous advancement of technology, smart nursing also incorporates other innovative technologies such as smart wearable devices, voice recognition, and intelligent medication management systems. These technologies help enhance the personalization and precision of nursing services while driving the widespread adoption of digital health solutions.

## 4. Challenges and current status in chronic disease care

Chronic non-communicable diseases (NCDs), including diabetes, cardiovascular diseases, chronic respiratory diseases, and malignant tumors, are a major threat to global public health. These diseases are characterized by their insidious onset, complex etiology, and prolonged progression, involving multiple organ systems such as the endocrine, cardiovascular, and respiratory systems. Among the most prevalent chronic disease manifestations are hypertension, hyperglycemia, hyperlipidemia, and hypoglycemia. According to the WHO 2023 World Health Statistics report, non-communicable diseases (NCDs) have become the leading cause of global mortality, accounting for 74% of all deaths by 2019, up from 61% in 2000, which represents over 41 million deaths globally <sup>[1]</sup>. In China, chronic diseases now account for an alarming 86% of all deaths, exacerbating the disease burden. In response to this growing crisis, China's "Healthy China" strategy, outlined in the China Chronic Disease Prevention and Control Medium-to-Long-Term Plan, seeks to enhance chronic disease prevention and control systems <sup>[11]</sup>.

The management of chronic diseases presents numerous challenges, with patient adherence being one of the most pressing issues. Many individuals with chronic conditions lack a comprehensive understanding of their illnesses and fail to adhere strictly to medical advice, resulting in irregular medication intake or an inability to make necessary adjustments to their diet and lifestyle. These barriers contribute significantly to the difficulty in controlling the progression of diseases <sup>[12]</sup>. Additionally, insufficient nursing resources, especially in remote areas and geriatric care settings, present another critical challenge. Nursing staff shortages make it difficult to meet the increasing demands of chronic disease patients, which further exacerbates the challenges of providing quality care. Moreover, chronic disease management places a significant financial burden on patients and their families. For example, diabetes patients require long-term medication and regular blood glucose monitoring, along with frequent medical visits during periods of instability. These ongoing costs represent a substantial financial strain for many households. Furthermore, chronic disease patients often present with multiple comorbidities, such as diabetes with hypertension or cardiovascular disease, which complicates treatment, heightens the difficulty of disease management, and increases the burden on patients' self-management abilities <sup>[12]</sup>.

Despite these challenges, there are notable limitations in the current body of research, particularly regarding the lack of long-term studies and inconsistencies in the methodological quality of research. The use of small sample sizes and limited diversity in the populations studied may affect the generalizability of findings. Furthermore, while intelligent technologies have shown promise, their integration into diverse healthcare settings

remains a significant challenge, particularly in resource-constrained environments. These technologies offer substantial promise in addressing many of the existing challenges in chronic disease care. For example, wearable devices, such as continuous glucose monitors, allow real-time tracking of blood sugar levels, enabling timely adjustments to treatment plans and improving patient outcomes. Similarly, AI algorithms are used to predict disease progression in conditions like diabetes, helping clinicians personalize treatment and prevent complications. Moreover, telemedicine platforms have facilitated remote consultations, ensuring continuous care for patients in underserved areas and improving treatment adherence.

## **5. Application of intelligent technology in chronic disease management**

This section focuses on the practical application of smart technologies in chronic disease management, discussing the implementation outcomes, clinical value, and challenges of each technology in clinical practice. In chronic disease management, intelligent technologies demonstrate significant application value by enhancing care quality, reducing healthcare costs, optimizing resource allocation, and assisting patients in better self-managing their conditions.

### **5.1. Remote monitoring and real-time health data tracking**

Remote monitoring technology has demonstrated significant efficacy in the management of chronic conditions such as type 2 diabetes and hypertension. Through smart wearable devices and sensors, patients' physiological data—including blood glucose and blood pressure—can be transmitted in real time to healthcare professionals, enabling personalized interventions. Research indicates that remote monitoring enhances self-management capabilities among chronic disease patients and improves disease control. For instance, Dempsey et al. evaluated the impact of remote rehabilitation on type 2 diabetes patients, finding that interventions combining remote monitoring with exercise prescriptions significantly improved glycemic control and quality of life<sup>[13]</sup>. These studies demonstrate that remote monitoring technology not only enhances care efficiency but also provides patients with convenient, personalized health management solutions.

### **5.2. Artificial intelligence-assisted decision-making and personalized care**

The application of artificial intelligence in chronic disease management, particularly in decision support and personalized care, has become a key research focus. By processing patients' health data, AI provides clinicians with precise diagnostic support and treatment recommendations, thereby optimizing therapeutic options. In recent years, AI has made significant strides in predicting and managing chronic conditions such as diabetes and hypertension. It can analyze vast datasets to generate personalized treatment plans<sup>[14]</sup>, thereby enhancing therapeutic outcomes and patient quality of life. Furthermore, AI supports clinical decision-making, enabling healthcare professionals to make more efficient and accurate judgments amidst demanding workloads, ultimately elevating the overall quality of care services<sup>[15]</sup>.

### **5.3. Virtual reality and disease rehabilitation**

Virtual reality technology demonstrates significant potential in the rehabilitation of chronic disease patients, particularly within the domains of mental health and rehabilitation training. Virtual reality can provide patients with immersive rehabilitation training environments, alleviating pain whilst enhancing motor function. For instance, research by Lin *et al.* demonstrated that virtual reality technology effectively mitigates pain in burn

patients, positively influencing both rehabilitation outcomes and emotional states <sup>[16]</sup>. Furthermore, virtual reality facilitates interactive health education and psychological support, proving particularly valuable for addressing psychological distress encountered during prolonged rehabilitation or chronic disease management.

## **6. Innovative exploration of intelligent nursing models**

The intelligent nursing model has emerged in response to the rapid advancement of information technology, particularly AI, the Internet of Things (IoT), big data, and cloud computing. Its core objective is to enhance the quality, efficiency, and precision of nursing services through technological means, thereby promoting personalized care, supporting patient self-management, and alleviating the burden on healthcare systems. As healthcare demands become increasingly diverse and nursing resources grow ever more constrained, the innovative exploration of intelligent nursing models assumes particular significance.

### **6.1. Artificial intelligence-based personalized care**

The care requirements for chronic conditions are highly personalized, with variations in patient conditions, lifestyle habits, and medication responses demanding care plans that are exceptionally adaptable and flexible. AI, through deep analysis of big data, can provide bespoke care plans for each patient <sup>[17]</sup> whilst offering decision support to nursing staff. Traditional care models typically rely on standardized procedures and clinical experience, whereas intelligent care systems integrate AI, big data analytics, and IoT technology to achieve personalized nursing interventions. These systems account for patients' medical conditions, physical states, lifestyles, and emotional needs, thereby delivering more precise care.

The application of AI in personalized care, such as tailored treatment plans for chronic conditions including diabetes and hypertension, has yielded tangible results. By analyzing historical patient data alongside real-time monitoring metrics <sup>[18]</sup>, AI delivers bespoke intervention strategies that markedly enhance therapeutic outcomes and patient quality of life.

However, the application of AI decision support systems in clinical practice still faces numerous challenges. Firstly, AI systems require substantial volumes of high-quality data for training and optimization. In real-world clinical settings, however, data often suffers from incompleteness, bias, or privacy protection concerns, which may compromise the system's accuracy and reliability. Secondly, the "black box" nature of AI models means healthcare professionals may lack transparency regarding the specific decision-making process when relying on these outputs, presenting barriers to clinicians' trust and acceptance. Inconsistencies across research findings present another concern, with some studies indicating that AI systems may fail to deliver expected outcomes in specific scenarios, potentially leading to misdiagnoses or missed diagnoses. Consequently, while the application of AI in chronic disease management holds considerable promise, it warrants cautious implementation and further refinement.

### **6.2. Deep integration of the Internet of Things (IoT) with remote health monitoring systems**

Utilizing smart sensors and wearable devices, patients' health conditions can be monitored in real time around the clock. Data is transmitted to the care team via IoT technology, enabling continuous health management. The introduction of IoT technology empowers healthcare professionals to deliver remote care services such as online consultations, video communication, and health guidance. For chronic disease patients, remote care platforms employ intelligent systems to automatically remind patients to take medication on schedule, adjust treatment

plans, and provide personalized health management advice. The integration of IoT technology with remote health monitoring systems holds significant potential in chronic disease management, both expanding the reach of care services and substantially enhancing the efficiency of nursing operations.

The application of Internet of Things technology in chronic disease management has yielded significant results. For instance, through IoT devices, real-time blood glucose monitoring is conducted for diabetic patients, with data transmitted to clinicians via cloud platforms. Physicians can then adjust treatment regimens based on data fluctuations<sup>[19]</sup>, thereby substantially reducing the incidence of complications.

Despite initial successes in applying the Internet of Things to chronic disease management, certain technical and operational bottlenecks persist. Firstly, device adoption rates and ease of use remain key constraints to widespread IoT implementation. For some elderly patients, operating complex devices may present barriers to technological uptake. Secondly, data transmission security and privacy protection warrant particular attention. Whilst most IoT devices employ encryption to safeguard patient data, risks of information leakage during transmission remain. Moreover, while IoT technology enables continuous monitoring, devices may struggle to manage sudden incidents or assess complex conditions without human intervention. Consequently, clinicians and care staff must remain integral to patients' health management.

### **6.3. Application of intelligent care robots in chronic disease management**

Intelligent care robots assist nursing staff in performing routine tasks such as patient transfers, feeding, and vital signs monitoring. By alleviating the burden of foundational duties, these robots enable carers to focus on more complex nursing responsibilities, thereby enhancing overall care efficiency. For chronic patients undergoing long-term hospitalization or receiving home care, care robots also provide emotional companionship, alleviating feelings of loneliness and anxiety. Through interaction with patients, these robots not only fulfil daily needs but also offer psychological support.

Intelligent care robots demonstrate promising applications in enhancing nursing efficiency and improving emotional support for patients. For instance, certain robots have been successfully deployed in the care of dementia patients<sup>[20]</sup>, significantly improving their emotional state and cognitive abilities through companionship and emotional interaction.

Despite their capacity to substantially boost care efficiency and patient emotional support, nursing robots face several implementation challenges. Firstly, intelligent nursing robots are often prohibitively expensive and require regular maintenance and updates, potentially limiting their adoption in economically underdeveloped regions. Secondly, the limitations of robotic technology cannot be overlooked. Most current care robots can only perform simple, repetitive tasks and demonstrate poor adaptability to complex care requirements. Furthermore, patients may develop emotional resistance towards interacting with care robots rather than human carers, particularly among chronic patients with heightened emotional needs, where robots struggle to fully replicate human-to-human emotional exchange.

### **6.4. Disease prediction and health management based on big data**

Through analysis of large-scale health data, healthcare professionals can predict the progression of patients' conditions, enabling early intervention based on historical and real-time monitoring data to reduce the incidence of chronic disease complications<sup>[21]</sup>. Intelligent rehabilitation information systems collect patient data and utilize adaptive feedback mechanisms to optimize rehabilitation programs. Combined with clinical testing, comprehensive quantitative assessment techniques have been developed to effectively diagnose functional impairments, select

appropriate rehabilitation treatment plans, and predict patients' recovery of motor function.

The application of big data technology in chronic disease management enhances the scientific rigor and precision of care processes. For instance, by analyzing patients' health data to predict disease progression and the onset of complications, interventions can be initiated proactively to avert severe conditions, thereby improving patients' quality of life.

Nevertheless, despite the immense potential of big data in chronic disease management, significant practical challenges persist. Firstly, big data analysis often relies on extensive, high-quality medical datasets, yet data quality and completeness remain widespread issues. Particularly in resource-constrained regions, standardization and interoperability of data require further improvement. Secondly, while big data offers valuable predictive insights, over-reliance on analytical outputs risks overlooking patients' subjective experiences and emotional needs. Finally, data privacy concerns present another significant challenge. How to leverage big data for health management while safeguarding patient privacy remains an urgent issue requiring resolution.

## **7. Discussion and outlook**

### **7.1. Challenges in intelligent nursing technology**

Although intelligent nursing models demonstrate significant potential in enhancing care efficiency, delivering personalized care plans, predicting illnesses, and managing chronic conditions, they still encounter a series of challenges during practical implementation.

#### **7.1.1. Technology acceptance and adaptability issues**

For individuals with chronic conditions, especially the elderly, the use of smart devices presents significant challenges. Many elderly individuals lack familiarity with technology and the necessary operational skills, often finding these devices overly complex. This can lead to resistance towards the adoption and use of such technology [22,23]. Particularly within home care settings, patients' capacity for independent operation may be constrained, thereby impacting the effectiveness of technological applications. This issue underscores the necessity for smart care technologies to consider the specific requirements of user groups during implementation, with particular emphasis on designing for technological adaptability and user-friendliness tailored to elderly patients.

#### **7.1.2. Data privacy and security issues**

With the proliferation of intelligent nursing models, vast quantities of patient health data—including sensitive information such as personal medical histories, vital signs, and genetic information—are being collected, stored, and transmitted. This undeniably heightens the complexity of data privacy and security management. According to the WHO 2024 World Health Statistics Report, between 2009 and 2023, there were 5,887 healthcare data breaches globally, affecting over 510 million medical records [24]. Such breaches may lead to the unlawful acquisition and misuse of patients' private information, potentially causing multifaceted adverse consequences ranging from social discrimination to threats to life safety [24]. Consequently, ensuring data security, preventing breaches, and curbing improper use within multi-stakeholder environments have emerged as significant challenges in the implementation of intelligent nursing technologies.

#### **7.1.3. The balance between technology and quality of care**

Overreliance on intelligent technologies may lead to emotional detachment between care providers and patients,

thereby impacting patient satisfaction and treatment adherence. Particularly for elderly patients and those with chronic conditions, emotional support often constitutes a vital component of care services. Whilst artificial intelligence technologies can alleviate cognitive burdens on care staff and enhance operational efficiency, can they genuinely assist in maintaining emotional connections and humanistic care with patients <sup>[25]</sup>? Furthermore, while AI systems offer highly accurate care recommendations and diagnostic support, complete reliance on such systems warrants careful consideration. Particularly in chronic disease management, care decisions should holistically account for individual patient needs, social support networks, and cultural contexts. Overdependence on technology risks overlooking these non-quantifiable factors, thereby compromising the comprehensiveness and personalization of care services. Consequently, striking a balance between enhancing care efficiency and preserving humanized care represents a pivotal challenge in the development of intelligent nursing models.

#### **7.1.4. Legal and ethical issues**

The introduction of intelligent nursing systems has increasingly shifted nursing decision-making towards reliance on technological systems, rendering the allocation of responsibility increasingly complex when system failures occur. Further research and standardization are required to clarify the division of responsibility and accountability between robots and humans in cases where nursing errors result from system malfunctions or algorithmic errors <sup>[26]</sup>. This encompasses issues such as robotic conduct standards, attribution of responsibility, and legal liability <sup>[27]</sup>. Moreover, the collection, storage, and transmission of substantial patient privacy data within intelligent nursing models raises ethical concerns due to legal uncertainties surrounding data protection <sup>[28]</sup>. Consequently, ensuring effective safeguarding of patient privacy has become a critical ethical challenge in the rollout of such systems. Simultaneously, the potential for artificial intelligence to make decisions regarding patient care and treatment in certain scenarios has sparked discussions on ethical decision-making <sup>[29]</sup>. Ensuring that artificial intelligence adheres to ethical norms and makes reasonable decisions while safeguarding patients' best interests represents a major issue in the development of intelligent nursing systems.

#### **7.2. Future development direction**

In the future, intelligent nursing will evolve from being a mere auxiliary tool to becoming the cornerstone of comprehensive health management for chronic disease patients. With the continuous advancements in the IoT, 5G communication, and AI, intelligent nursing systems will enable more precise and real-time monitoring of patient health. This will expand beyond traditional vital signs to include more detailed indicators such as blood oxygen levels, metabolic rates, dietary intake, and emotional fluctuations, facilitating a holistic approach to health data collection and analysis. The establishment of 5G-enabled smart hospitals, coupled with innovations in biomedicine, robotics, communications, and medical informatics, will foster true interoperability between healthcare and information technologies. This synergy will create optimized conditions for diagnosis, treatment, and care <sup>[30]</sup>.

Furthermore, AI and 5G technologies hold great potential for integration with robotic surgical systems, enabling remote surgeries that will enhance healthcare accessibility, reduce costs, and extend the benefits of advanced care to a broader patient population <sup>[31]</sup>. Looking ahead, intelligent multimodal monitoring systems will play a pivotal role in disease modeling, drug development, and personalized medicine <sup>[32]</sup>. As these technologies continue to mature, they will permeate every aspect of chronic disease management, driving nursing models toward greater precision, personalization, and intelligence.

Through continuous technological refinement, policy optimization, and enhanced interdisciplinary collaboration, intelligent nursing models will become an indispensable component of chronic disease management, delivering more efficient and tailored care services to patients worldwide.

## 8. Conclusion

With the rapid advancement of technology, intelligent nursing models have progressively emerged as a pivotal innovation in chronic disease management. By integrating cutting-edge technologies such as artificial intelligence, big data, the Internet of Things, and smart devices, these models are reshaping traditional frameworks for chronic disease care. This approach not only significantly enhances nursing efficiency but also demonstrates immense potential in improving care quality and elevating the effectiveness of patient health management. In summary, the intelligent nursing model not only heralds a technological revolution in chronic disease management but also offers fresh perspectives and directions for the future development of the nursing discipline. It plays a vital role in enhancing care quality, optimizing patient health management, and improving the allocation of nursing resources, establishing itself as a significant trend for the future advancement of the nursing field.

While intelligent nursing models hold great potential, there is a pressing need for innovative research to explore the cross-disciplinary integration of AI, IoT, and healthcare systems. Future studies should focus on developing more robust, interdisciplinary frameworks that address the technical, ethical, and practical barriers to implementation. Additionally, greater emphasis should be placed on the impact of these technologies on patient-centered care, including emotional support, self-management, and long-term health outcomes. As intelligent technologies become increasingly prevalent in chronic disease care, future research will focus on clinically validating and evaluating the efficacy of intelligent nursing technologies, exploring multidisciplinary collaboration models, and addressing data privacy and security concerns. Such research will provide a robust foundation for advancing the sustainable development of intelligent nursing models, ultimately achieving the goal of delivering more precise and efficient care services to chronic disease patients.

## Disclosure statement

The authors declare no conflict of interest.

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