

Applications and Prospects of Digital Health Technologies in Cardiovascular Nursing: Smart Devices, Remote Monitoring, and Personalized Care

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Abstract: Cardiovascular disease (CVD), the leading cause of death among non-communicable diseases worldwide, demands innovative approaches in prevention and nursing care. With the rapid advancement of digital health technologies, cardiovascular nursing is undergoing an unprecedented transformation. Core applications include wearable devices for continuous heart rate and rhythm monitoring, implantable devices such as pacemakers and smart stents for real-time physiological assessment, remote monitoring platforms for early warning and intervention in heart failure, and big-data-driven personalized care strategies supported by artificial intelligence. Evidence shows that these technologies can reduce readmission rates, improve treatment adherence, and enable up to 82% of patients to self-manage blood pressure and glucose. This review summarized current applications of digital health technologies in cardiovascular nursing and discussed their future prospects, aiming to provide a theoretical foundation for their further integration into clinical practice.

Keywords: cardiovascular disease, digital health, smart device, personalized care

Introduction

Current Status and Challenges of Cardiovascular Disease

Cardiovascular disease (CVD) is the leading cause of death among non-communicable diseases worldwide, accounting for approximately 17.9 million deaths annually, which represents 31% of all global deaths. According to data from the World Health Organization (WHO), CVD has become a major public health challenge globally.^{1,2} Despite significant progress in prevention and treatment over the past decades, the burden of CVD continues to rise, particularly in developing countries. CVDs, including coronary heart disease, heart failure, arrhythmias, and hypertension, are associated with high morbidity and mortality, making them the leading global health threat.^{3–5} In 2021, the global number of patients with CVD reached 612 million, accounting for 26.8% of all deaths worldwide. Ischemic heart disease and stroke were the leading causes of CVD-related mortality. Although cardiovascular mortality has declined in some developed countries, the global burden of CVD continues to increase, particularly in low- and middle-income countries.⁶ CVD is likewise a major cause of death in China. The accelerating aging population and shifts in lifestyle have contributed to a sustained increase in both the incidence and mortality of CVD in recent years. According to statistics, the number of patients with CVD in China has surpassed 120 million, and the annual death toll exceeds 4.5 million. Hypertension, diabetes, and dyslipidemia are becoming increasingly prevalent, yet the awareness, treatment, and control rates remain inadequate, presenting considerable obstacles for the prevention and management of CVD.^{7–9} Recent evidence also suggests that poor control of cardiovascular risk factors contributes substantially to premature mortality and readmission rates, further underscoring the need for new models of care.

Limitations of the Traditional Cardiovascular Nursing Model

The traditional cardiovascular nursing model refers to a hospital-centered and disease-oriented approach, in which nursing care is primarily delivered through face-to-face interactions within clinical settings and is largely guided by physicians' medical orders.¹⁰ Its typical characteristics include reliance on physiological monitoring and medical treatment, limited emphasis on patient self-management, and insufficient integration of psychosocial support or long-term rehabilitation guidance.¹¹

Although this conventional model has contributed to disease management, it presents several limitations. Conceptually, it prioritizes physiological indicators and treatment adherence, while paying limited attention to patients' psychological and social needs. Such an approach often results in insufficient attention to patients' emotional well-being, which may adversely affect both recovery and overall quality of life.¹² For instance, anxiety and depression are common among patients undergoing treatment, yet conventional nursing models may lack the mechanisms to promptly identify and manage these psychological concerns.¹³

Another limitation concerns the content of nursing care. Conventional nursing models tend to focus largely on physiological interventions, such as drug administration and condition monitoring, with insufficient emphasis on health education, psychological care, and rehabilitation counseling. Such a limited scope of nursing care fails to meet the diverse needs of patients in disease prevention, rehabilitation, and self-management. For example, a patient discharged after myocardial infarction may not receive structured education on lifestyle modification or stress management, increasing the risk of hospital readmission.¹⁴

In terms of methods, traditional nursing models lack personalization and flexibility, with relatively rigid approaches that are difficult to adapt to individual patient conditions and needs.¹⁵ As a result, patients may not receive the most appropriate care plans, thereby compromising the effectiveness of nursing interventions. For example, traditional nursing approaches may fail to meet the individualized needs of patients from different age groups and cultural backgrounds, leading to reduced satisfaction with nursing services.

Finally, there are limitations in the evaluation of nursing outcomes. Traditional nursing models often focus on short-term improvements in physiological indicators, while lacking assessment of long-term rehabilitation outcomes and quality of life. Such evaluation methods fail to fully reflect the effectiveness of nursing care and hinder continuous quality improvement.¹⁶ Taken together, the traditional cardiovascular nursing model can be described as disease-centered, hospital-dependent, and short-term outcome-oriented, which contrasts with emerging digital health models that emphasize patient-centeredness, continuity of care, and personalized interventions.

Emergence of Digital Health Technologies

The rise of digital health is a product of the integration of digital technologies with medical and healthcare systems. Driven by advancements in artificial intelligence (AI), big data, internet technologies, and cloud computing, digital health technologies are increasingly regarded as effective tools for enhancing the quality and efficiency of medical services.¹⁷ In recent years, global interest in digital health technologies has been steadily increasing, with governments and healthcare institutions worldwide introducing policies and initiatives to promote their widespread application in the medical field. According to the WHO, digital health technologies were defined as: "the field of knowledge and practice associated with the development and use of digital technologies to improve health".¹⁸ This field involves various technologies, such as the Internet of Things, AI, big data, and blockchain, with the goal of enhancing the allocation of healthcare resources and improving the quality and efficiency of medical services through digital solutions.¹⁹

As reported, the rapid advancement of digital health in the medical field has significant implications for cardiovascular nursing. Briefly, digital health increases nursing efficiency by reducing the workload of nursing staff, allowing them to devote more time and attention to personalized patient care. Remote healthcare and Internet of Things contribute to better resource allocation, particularly in remote and underserved areas. Additionally, digital health improves nursing quality by enabling continuous health monitoring and the delivery of accurate nursing interventions. Furthermore, patient engagement is enhanced through mobile health applications and wearable devices, enabling patients to better understand

their health status, actively participate in health management, and ultimately improve the effectiveness of nursing care.^{17,20–27}

Recent international guidelines, such as the 2021 European Society of Cardiology (ESC) Guidelines on cardiovascular disease prevention²⁸ and the American Heart Association (AHA) scientific statement on digital transformation in healthcare,²⁹ have emphasized the critical role of digital health technologies in modern cardiovascular care. These consensus statements further highlight the importance of interdisciplinary collaboration, evidence-based practice, and policy support in the integration of digital health into nursing practice.

This review aims to summarize the current applications of digital health technologies in cardiovascular nursing, critically evaluate their advantages and challenges, and explore future directions for clinical integration, with the ultimate goal of advancing patient-centered and evidence-based cardiovascular care.

Application of Digital Health Technologies in Cardiovascular Nursing

Application of Smart Devices

Wearable Devices

Wearable devices represent a critical component of digital health technologies in cardiovascular nursing. By continuously monitoring patients' physiological parameters in real time, wearable devices not only provide healthcare professionals with accurate health information but also empower patients to actively participate in their own health management. Increasing evidence demonstrates that wearable devices improve early disease detection, treatment adherence, and long-term outcomes in cardiovascular populations.

Real-Time Heart Rate Monitoring for Health Management

Smartwatches and fitness bands equipped with photoplethysmography or electrocardiogram (ECG) sensors allow continuous rhythm assessment and can facilitate early identification of atrial fibrillation (AF). The Apple Heart Study, which enrolled over 400,000 participants, showed that smartwatch-based irregular pulse detection could successfully identify AF, with subsequent ECG confirmation.³⁰ Similarly, the mAFA-II randomized trial demonstrated that integrating wearable-based AF screening with mobile health platforms significantly reduced stroke and rehospitalization compared with usual care.³¹ These findings highlight the potential of wearables to complement traditional arrhythmia monitoring and provide timely opportunities for intervention.

Monitoring of Blood Pressure

Several wearable devices are capable of continuous or intermittent blood pressure monitoring through cuffless technologies. A systematic review and meta-analysis confirmed that wearable-based blood pressure interventions improved hypertension control and medication adherence compared with standard care.³² Such tools enable earlier detection of blood pressure fluctuations and support individualized nursing interventions, particularly in patients with poorly controlled hypertension or multiple comorbidities.

Activity Monitoring

Activity monitoring, including step count, exercise duration, and energy expenditure, provides objective data for rehabilitation planning. Recent randomized and pilot studies in post-myocardial infarction patients indicate that rehabilitation programs incorporating wearable devices (eg step-count monitors, accelerometers) are associated with improved functional capacity (eg increased daily steps, walking distance) compared with traditional gym-based or standard care routines.³³ Furthermore, mobile health-supported cardiac rehabilitation programs that integrate wearable devices have been associated with enhanced quality of life and reduced hospital readmissions.³⁴

Overall, wearable devices have demonstrated measurable benefits, including early arrhythmia detection, better blood pressure control, improved rehabilitation adherence, and enhanced self-management skills. These outcomes are particularly valuable in the post-discharge phase, where traditional nursing models may fail to provide continuous support. Nevertheless, limitations remain. Device accuracy can be affected by motion artifacts or skin tone, long-term adherence

often declines, and data security or privacy concerns persist. Addressing these challenges is essential for ensuring the safe and effective integration of wearables into cardiovascular nursing practice.

Implantable Devices

Implantable devices represent a critical component of digital health technologies in cardiovascular nursing. Utilizing advanced sensors and communication technologies, these devices allow real-time monitoring of physiological parameters, thereby providing healthcare professionals with accurate health data and supporting patients in managing their own health.³⁵ In clinical cardiovascular nursing, the most commonly used implantable devices include cardiac pacemaker, implantable cardioverter defibrillator (ICD), implantable loop recorder (ILR), implantable hemodynamic monitor, and smart stent.

Cardiac Pacemaker

Cardiac pacemaker is designed to treat bradycardia by delivering electrical impulses to regulate the heart rate and maintain normal cardiac rhythm. Modern pacemakers are equipped with advanced sensors capable of monitoring patient activity levels and respiratory rates, allowing for automatic heart rate adjustment based on these parameters to meet individual physiological demands. For example, the Reveal LINQ, an implantable cardiac monitor launched by Medtronic, is a compact device inserted into the chest through minimally invasive surgery, enabling continuous electrocardiographic monitoring and aiding in the early diagnosis of arrhythmias.

Implantable Cardioverter Defibrillator

ICD is a device used to prevent sudden cardiac arrest by continuously monitoring cardiac rhythm and automatically delivering electrical shocks to restore normal rhythm when life-threatening arrhythmias are detected. ICD is an essential intervention for preventing sudden cardiac death, especially in patients with heart failure or a prior episode of ventricular fibrillation.

Implantable Loop Recorder

ILR is a small device designed for long-term electrocardiographic monitoring, particularly useful for diagnosing intermittent arrhythmias. Compared with conventional Holter monitors, ILRs provide extended continuous recording, improving the detection of infrequent arrhythmic events.

Implantable Hemodynamic Monitor

Implantable hemodynamic monitors are used to monitor the hemodynamic parameters of the heart, such as ventricular pressure and oxygen saturation. Real-time monitoring of these parameters enables early detection of heart failure and allows for timely therapeutic adjustments to prevent disease progression.

Smart Stent

Smart stents are novel implantable devices equipped with embedded sensors capable of monitoring intravascular pressure and blood flow. Real-time monitoring of these data enables healthcare professionals to detect in-stent restenosis or other complications at an early stage and implement timely interventions.

Application of Remote Monitoring Technologies

Remote monitoring technologies are essential components of digital health in cardiovascular nursing. They utilize wireless communication to collect real-time physiological data, providing healthcare professionals with accurate health information while enabling patients to better manage their own health.^{36–47} Specifically, wearable devices (such as smartwatches and fitness bands) and implantable devices (such as cardiac pacemakers and ICD) enable real-time monitoring of heart rate and rhythm. These devices can detect abnormalities such as arrhythmias and promptly alert healthcare professionals. Furthermore, certain remote monitoring devices allow for continuous assessment of blood pressure and oxygen saturation, enabling timely detection of hypertension or hypotension and supporting the optimization of treatment strategies. In addition, by monitoring data such as step count and duration of physical activity, clinicians

can assess patients' physical activity levels and inform rehabilitation and physical training strategies. As for early warning and intervention, remote monitoring technologies enable real-time detection of hemodynamic changes in heart failure patients, such as pulmonary artery pressure and ventricular pressure. These data allow for the early identification of disease progression, facilitating timely clinical intervention and helping to avoid unnecessary hospitalizations. Moreover, remote monitoring systems support real-time cardiac rhythm tracking, allowing for the timely identification of arrhythmias, including atrial fibrillation, and aiding clinicians in developing individualized management plans. Besides, remote monitoring devices allow patients to access their health status at any time, thereby enhancing self-management capabilities. For example, patients can use mobile applications to record data such as heart rate and blood pressure, visualize trends, and identify abnormalities promptly. Remote monitoring technologies can also deliver health-related recommendations and reminders to support lifestyle modifications, such as medication adherence and dietary control. Additionally, these technologies assist healthcare providers in identifying high-risk patients and optimizing resource allocation. For instance, by monitoring patients' health data, medical staff can promptly identify situations requiring urgent intervention and prevent unnecessary resource utilization.

Personalized Care Strategies Based on Big Data

Personalized care is one of the key applications of digital health in cardiovascular care. By analyzing patients' medical history, physiological data, and lifestyle patterns through big data technologies, individualized nursing plans can be developed. Tailored interventions can then be implemented based on specific risk factors and disease characteristics.

In routine nursing care, AI systems can integrate medical history, genetic information, and lifestyle habits to comprehensively assess patient's physical condition, disease characteristics, and psychological needs, thereby supporting the development of individualized nursing plan. Importantly, current AI applications function primarily as clinical decision-support tools, rather than as independent treatment systems. For example, AI can generate recommendations on medication adjustment or rehabilitation intensity based on patient data; however, the final decision must be made by physicians in accordance with clinical guidelines and local regulations.^{48,49} Indeed, regulatory agencies such as the US Food and Drug Administration (FDA) have approved certain AI-based tools for arrhythmia detection and treatment optimization, but none are authorized to autonomously modify prescriptions without physician oversight.⁵⁰

Clinical studies in chronic disease management further suggest that AI-assisted systems may improve adherence and help personalize care pathways,⁵¹ but their effectiveness in dynamically adjusting therapy remains under investigation. In postoperative patients, AI can, under physician supervision, assist in modifying the intensity and duration of rehabilitation training according to recovery status. Similarly, natural language processing (NLP) techniques enable nursing staff to interact with patients and identify emotional fluctuations, providing opportunities for personalized psychological support.

In addition, wearable devices allow real-time monitoring of vital signs such as heart rate and blood pressure, and AI algorithms can identify abnormal patterns and issue early alerts to clinicians. These tools enhance precision and support timely interventions, but it should be emphasized that the performance of AI models varies across populations. For instance, the sensitivity of atrial fibrillation detection algorithms may differ by over 30% between elderly and non-elderly groups (Table 1). Taken together, AI holds promise in supporting personalized care strategies, yet further large-scale trials and robust regulatory frameworks are needed to ensure safety, efficacy, and ethical implementation.

Table 1 Functions of Different Smart Devices

Technology Category	Device Type	Function/Application
Wearable devices	Smartwatches, fitness bands	Real-time monitoring of physiological parameters such as heart rate, blood pressure, and physical activity
Smart blood pressure monitors	Continuous blood pressure monitoring devices	Early detection and management of hypertension or hypotension
Implantable devices	Cardiac pacemaker	Regulation of heart rate via electrical impulses; monitoring of activity level and respiratory rate

(Continued)

Table 1 (Continued).

Technology Category	Device Type	Function/Application
Implantable cardioverter defibrillator (ICD)	Real-time monitoring of cardiac rhythm and automatic delivery of electrical shocks to restore normal rhythm	Prevention of sudden cardiac arrest in high-risk patients
Implantable loop recorder (ILR)	Long-term monitoring of electrocardiographic activity	Early detection of arrhythmias and prevention of sudden cardiac arrest in high-risk individuals
Implantable hemodynamic monitor	Continuous measurement of ventricular pressure and oxygen saturation	Early detection and management of heart failure
Smart stent	Continuous monitoring of intravascular pressure and blood flow	Early detection of in-stent restenosis or other vascular complications
Remote monitoring technologies	Wearable or implantable devices (eg, smartwatches, fitness bands, pacemakers, ICDs)	Real-time monitoring of heart rate, rhythm, blood pressure, oxygen saturation, and physical activity
Remote monitoring platforms	Hemodynamic pattern recognition, early warning, and timely intervention	Prediction of disease exacerbation in heart failure patients
Big data-based personalized care	Artificial intelligence (AI) systems and natural language processing technologies	Analysis of electronic health records, genetic data, and lifestyle information for the development of individualized nursing plans
AI-integrated smart devices	Real-time monitoring of vital signs, detection of abnormal patterns, and alert generation	Optimization of clinical decision-making and personalization of nursing strategies

Advantages of Digital Health Technologies in Cardiovascular Nursing Enhancing Nursing Efficiency and Precision

Automated data collection and analysis reduce manual operation errors. Real-time monitoring and alerting systems enable rapid response to patient needs. For example, wearable devices and mobile applications can continuously monitor and integrate vital signs such as heart rate, blood pressure, and physical activity, transmitting the data directly to healthcare systems.^{48,49} This real-time monitoring reduces the time and workload associated with manual data entry and improves nursing efficiency. Data integration technologies aggregate information from multiple devices into a single platform, enabling nursing staff to quickly access comprehensive patient health data and make more accurate nursing decisions. In addition, telemedicine and virtual nursing technologies enable nursing staff to interact remotely with patients through video calls and mobile applications. This approach not only reduces the time and cost associated with hospital visits but also allows for more frequent communication, timely issue identification, and improved nursing efficiency.^{52–54} Remote nursing can also support patient self-management through automated health reminders and interventions, such as medication alerts and health education notifications. From a clinical nursing perspective, reducing nursing workload through automated medication dispensing systems and smart reminder tools can alleviate repetitive tasks, allowing nursing staff to dedicate more time to direct patient care. AI technologies can further reduce the nursing burden by assisting with documentation and patient education.

Improving Patients' Quality of Life and Prognosis

The application of digital health technologies in cardiovascular nursing is rapidly transforming traditional healthcare models, significantly enhancing patients' quality of life and prognosis. By employing innovative intervention strategies, digital health technologies effectively shorten hospitalization periods, optimize healthcare processes, improve medical efficiency, and reduce both hospital stays and healthcare costs. Moreover, these technologies also contribute to improving patients' autonomy and health levels.^{55–57} Remote monitoring systems continuously track cardiac function parameters and, using AI-driven alert algorithms, identify early signs of disease fluctuation. This proactive approach helps decrease readmission rates and reduce patient burden.⁵⁸ Mobile applications can provide patients with medication reminders, health education, and personalized advice, helping them better adhere to treatment plans and improve compliance. This not only enhances patient adherence but also reduces the risk of treatment failure or disease deterioration due to non-compliance. The mobile health management system integrates functions such as dietary guidance and symptom self-

assessment, combined with feedback from wearable device data, enabling 82% of patients to independently manage their blood pressure and blood glucose levels. Additionally, the Hospital Anxiety and Depression Scale has exhibited a dropped score (Table 2). These technological innovations not only alleviate patients' financial burden but also reshape their health behavior, facilitate the restoration of social roles, and ultimately optimize both healthcare costs and quality of life.^{59,60}

Challenges Faced by Digital Health Technologies in Cardiovascular Nursing

The application of digital health technologies in cardiovascular nursing faces multiple practical challenges. Technically, wearable device data is susceptible to interference (eg, with monitoring error rates of 15%–20% during nighttime), data formats from various devices are incompatible, creating “information silos”, AI models exhibit lower generalizability in elderly or obese patients (with sensitivity differences in atrial fibrillation detection exceeding 30%), and implantable devices face cybersecurity risks.⁶¹ Clinical integration faces challenges such as the excessive volume of alert notifications leading to “alarm fatigue” among healthcare workers, the absence of standardized interfaces between electronic health records and health applications, 83% of digital therapies lacking robust evidence, insufficient insurance coverage increasing the financial burden on patients, and an insufficient evidence foundation. Although many studies indicate the potential benefits of digital health technologies, high-quality randomized controlled trials remain limited, requiring further research to verify the long-term effects and cost-effectiveness of these technologies. Regarding technology acceptance and usage barriers, some patients, particularly the elderly, low-income populations, and ethnic minorities,

Table 2 Advantages of Digital Health Technologies in Cardiovascular Nursing

Technologies/Measures	Enhancing Nursing Efficiency and Precision	Improving Patients' Quality Of Life and Prognosis
Real-time monitoring and data integration	<ul style="list-style-type: none"> - Wearable devices and mobile applications monitor vital signs (heart rate, blood pressure, activity level) in real time, reducing manual recording time and improving nursing efficiency. - Data integration technologies centralize data from multiple devices, allowing nursing staff to quickly access comprehensive health information and make accurate nursing decisions. 	<ul style="list-style-type: none"> - Real-time monitoring and data integration optimize medical workflows, improve healthcare efficiency, and reduce hospital admissions and medical costs. - Remote monitoring systems, combined with artificial intelligence (AI)-based warning algorithms, enable the early identification of condition fluctuations, which helps reduce readmission rates and ease the burden on patients.
Telemedicine and virtual nursing	<ul style="list-style-type: none"> - Remote interaction with patients via video calls, mobile applications, etc., reduces patient travel time and costs, improving nursing efficiency. - Remote nursing, with automated health reminders and interventions, helps patients manage their health more effectively. 	<ul style="list-style-type: none"> - Telemedicine and virtual nursing improve access to healthcare services, especially in remote areas. - Mobile applications offer medication reminders, health education, and personalized advice, improving patient adherence and reducing care failure or disease exacerbation.
AI assistance and automation	<ul style="list-style-type: none"> - AI technologies assist in completing documentation, patient education, and other tasks, reducing nursing workload. - Automated health reminders and interventions help patients better manage their health conditions. 	<ul style="list-style-type: none"> - AI warning algorithms identify early fluctuations in patient conditions, helping patients better adhere to treatment plans. - Mobile health management systems integrate dietary guidance, symptom self-assessment, and wearable device feedback, enhancing patient autonomy and health outcomes.
Innovative intervention models	<ul style="list-style-type: none"> - Automated data collection and analysis reduce human error, improving nursing precision. - Telemedicine and virtual nursing technologies enable more frequent communication between healthcare providers and patients, facilitating timely identification and resolution of issues. 	<ul style="list-style-type: none"> - Innovative intervention models shorten patient hospitalization periods, optimize medical workflows, and increase healthcare efficiency. - Mobile health management systems enable 82% of patients to independently manage their blood pressure and blood glucose, reduce anxiety (measured by the Hospital Anxiety and Depression Scale), and reshape health behavior patterns.

may face obstacles in accessing and using digital health technologies. These barriers may include the availability of technological devices, the complexity of operation, and a lack of technical support. The liability for AI misdiagnosis remains unclear, and the misuse of cardiovascular data may lead to insurance discrimination or privacy breaches. Addressing these issues requires the combined advancement of technological innovation (eg, anti-interference biosensors), institutional reform (eg, reform of medical insurance payments), and ethical governance (eg, data ownership legislation), to achieve the effective translation of technological potential into clinical value.^{62,63}

Future Prospects of Digital Health Technologies in Cardiovascular Nursing

Technological Innovation and Intelligence

Wearable Devices and Mobile Applications

As technology continues to advance, wearable devices and mobile applications will become more intelligent and accurate, enabling real-time monitoring of various cardiovascular-related data, such as heart rate, blood pressure, activity levels, and sleep quality. Such data will offer nursing staff more comprehensive and continuous insights into patient health, facilitating earlier identification and intervention of potential problems.

Artificial Intelligence and Machine Learning

AI and machine learning (ML) algorithms are expected to play an increasingly important role in cardiovascular nursing by enabling more precise risk prediction, diagnosis, and individualized care. Recent studies using electronic health records (EHRs) and multi-modal patient data have demonstrated that ML models can predict major adverse cardiovascular events (MACE) and coronary artery disease (CAD) outcomes with higher accuracy than conventional risk scores. For example, a systematic review and meta-analysis found that ML models offer high discriminative performance in predicting mortality risk among acute coronary syndrome (ACS) patients at multiple time points compared with traditional methods.⁶⁴ Similarly, ML models trained on diverse, multi-ethnic cohorts using EHR data improved ASCVD risk prediction beyond established risk scores such as the Pooled Cohort Equations, especially in populations underrepresented by traditional tools.⁶⁵ Natural language processing (NLP) approaches have also been developed to extract unstructured information from clinical notes, showing high accuracy and improving the identification of hidden risk factors relevant to CAD outcome prediction.⁶⁶ These applications highlight the potential of AI and ML to support personalized risk stratification, early intervention, and individualized nursing pathways. Nevertheless, while current evidence is promising, most applications remain investigational, and their effectiveness in dynamically adjusting therapy in real-world clinical practice is still under evaluation.

Large Language Models

The application of large language models (LLMs) in cardiovascular nursing is also expected to expand. Recent studies show that LLMs such as Med-PaLM 2 and GPT-4 can assist with repetitive documentation tasks, generate clinical summaries, and provide patient-friendly explanations of complex medical concepts.^{67,68} They may also enhance patient self-management through interactive health education and psychological support. However, concerns about accuracy, reliability, and “hallucinations” remain, and their clinical use in nursing practice requires further validation before widespread adoption.

Telemedicine and Virtual Nursing

Remote Monitoring and Follow-Up

Telemedicine and virtual nursing are expected to become essential components of cardiovascular nursing, enabling patients to receive continuous medical monitoring and follow-up care from home. Through video consultations, mobile applications, and other digital tools, nursing staff can monitor changes in patients' conditions in real time, adjust treatment plans accordingly, and reduce the frequency of hospital visits and associated medical costs.

Remote Diagnosis and Treatment

With technological advancements, remote diagnosis and treatment are becoming increasingly feasible. For example,

through high-definition video, remote auscultation, and remote electrocardiogram monitoring, physicians can diagnose patients at a distance and issue prescriptions or provide treatment recommendations accordingly. This approach is particularly beneficial for patients in remote or underserved areas, enhancing the accessibility of healthcare services.^{63,69,70}

Data Integration and Interoperability

Integration of Medical Data

In the future, medical data from various sources, such as electronic health records, wearable devices, and laboratory test results, will be more seamlessly integrated into a comprehensive patient health data platform. This will enable healthcare professionals to gain a more holistic understanding of patients' health status and make more accurate diagnostic and therapeutic decisions.

Establishment of Interoperability Standards

To achieve interoperability among different digital health technologies, relevant standards and protocols will be continuously refined. This will promote the sharing and exchange of medical data, thereby enhancing the overall efficiency and coordination of healthcare systems.^{63,69–73}

Medical Insurance Policies and Healthcare Equity

Support from Medical Insurance Policies

As digital health technologies are more widely applied in cardiovascular nursing, medical insurance support will be gradually introduced, reducing out-of-pocket costs for patients and improving the availability and uptake of such technologies.

Bridging the Digital Divide

To ensure that digital health technologies benefit a broader patient population, particularly socioeconomically disadvantaged groups, governments and relevant institutions need to implement measures to bridge the digital divide. These efforts include providing financial assistance, improving internet infrastructure, and promoting digital literacy education, thereby ensuring equitable access to and use of such technologies by all individuals.^{63,69–73}

Implementation Strategies in Low-Resource Settings

In low-resource settings, where healthcare infrastructure and internet connectivity may be limited, tailored implementation strategies are required. Mobile phone-based health (mHealth) interventions, such as SMS reminders for medication adherence or remote follow-up, have proven to be cost-effective and scalable. Training community health workers and nurses to deliver digital health interventions can extend the reach of cardiovascular care beyond hospitals. Public-private partnerships and international collaborations can also play a crucial role by providing affordable devices, subsidizing connectivity, and ensuring sustainable funding models. By focusing on simplicity, affordability, and local adaptability, these strategies make it possible to integrate digital health into cardiovascular nursing even in resource-constrained environments.

Conclusion

CVD, the leading cause of death among non-communicable diseases globally, necessitates a breakthrough in its prevention and nursing approaches. Our review highlights how the rapid development of digital health technologies—particularly wearable devices, implantable sensors, telemedicine platforms, and AI-assisted systems—has already shown measurable benefits in cardiovascular nursing. Evidence from recent randomized controlled trials and meta-analyses demonstrates that wearable devices can improve arrhythmia detection and enhance self-management, remote monitoring can reduce readmission rates and support continuity of care, and AI-driven models can improve risk prediction for major adverse cardiovascular events compared with traditional scores. These advances collectively suggest a paradigm shift from conventional disease management toward personalized and preventive nursing models.

Nevertheless, challenges remain in terms of data quality, interoperability, equitable access, and the lack of large-scale clinical validation. Future breakthroughs will depend not only on technological innovation (eg, biosensors, edge computing), but also on institutional reform (eg, reimbursement mechanisms, certification of digital therapeutics) and ethical governance (eg, data ownership and privacy protection). With the ongoing progress of flexible electronics, biological digital twins, and biodegradable monitoring devices, digital health is poised to further transform cardiovascular nursing. To realize this vision, strengthened interdisciplinary collaboration, robust clinical evidence chains, and supportive policy frameworks are essential to ensure that digital health technologies are implemented in a patient-centered, safe, and inclusive manner.

Data Sharing Statement

The data used to support the findings of this study are available from the corresponding author upon request.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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