RESEARCH PAPER

TRANSFORMATION IN PATIENT-CENTERED CARDIAC REHABILITATION THROUGH ADVANCED MEDICAL-SURGICAL NURSING INTERVENTION

Patel Jyotika Sanjaykumar[1], Ivan Abhishek Prakash[2*], S. Victor Devasirvadam[3], Vrunda Garasiya[4], Patel Neepa Amitkumar[5], Pratiksha Bhasker[6], Mano Priya Vijayan[7]

[1]PhD Scholar, Parul Nursing College, Vadodara, Gujarat

[2*]Professor, Apex College of Nursing, Varanasi, Uttar Pradesh (*Corresponding Author)

[3]Assistant Professor, College of Applied Medical Sciences, Nursing Department, King Faisal University, Al Hofuf, Eastern Region, Saudi Arabia

[4]Tutor, Crystal Institution of Nursing, Lunawada, Gujarat

[5]Principal, Sanjivini Institution of Nursing, Lunawada, Gujarat

[6]Associate Professor, Sugreev Singh Memorial Institute of Nursing and Hospital, Bewar, Mainpuri, Uttar Pradesh

[7]Deputy Dean, Assistant Professor, Faculty of Health Sciences, Villa College, Male', Maldives

***Corresponding author: Ivan Abhishek Prakash, Professor, Apex College of Nursing, Varanasi, Uttar Pradesh**

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ABSTRACT

Cardiac rehabilitation (CR) has evolved into a comprehensive, patient-centered strategy aimed at improving recovery, reducing recurrence, and enhancing quality of life among individuals with cardiovascular diseases. Recent advancements in medical-surgical nursing have significantly transformed CR by integrating evidence-based interventions, individualized care planning, and multidisciplinary collaboration. This article explores the role of advanced nursing interventions in promoting holistic patient care, including physical rehabilitation, psychosocial support, behavioral modification, and long-term disease management. The incorporation of digital health technologies such as telemonitoring, wearable devices, and mobile health applications has further improved accessibility and patient engagement, particularly in underserved populations. Nurse-led rehabilitation programs have demonstrated effectiveness in improving adherence, functional capacity, and emotional well-being through continuous monitoring, patient education, and personalized support. Despite these advancements, challenges such as limited access, low participation rates, and resource constraints persist, necessitating innovative solutions and policy support. Future directions in cardiac rehabilitation emphasize the integration of artificial intelligence, personalized medicine, and expanded nursing roles to optimize outcomes and ensure equitable care delivery.

Keywords: Cardiac Rehabilitation, Patient-Centered Care, Medical-Surgical Nursing, Nurse-Led Interventions, Digital Health, Telemonitoring, Cardiovascular Diseases, Rehabilitation outcomes.

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Introduction

Cardiovascular diseases (CVDs) remain the leading cause of global mortality and a major contributor to disability and healthcare burden, accounting for millions of deaths annually and disproportionately affecting low- and middle-income countries where access to preventive and rehabilitative services is limited, thereby emphasizing the urgent need for comprehensive and sustainable rehabilitation strategies that support long-term recovery and reduce recurrence rates (Roth et al., 2020). Contemporary evidence indicates that cardiac rehabilitation (CR) significantly reduces mortality, improves functional capacity, and lowers hospital readmission rates through a structured combination of exercise training, education, and risk factor modification, highlighting its critical role in secondary prevention and chronic disease management (Anderson et al., 2016). Despite its well-documented benefits, CR remains underutilized globally, with limited program availability and low patient participation rates, thereby necessitating innovative, patient-centered models that enhance accessibility and engagement across diverse populations (Turk-Adawi et al., 2019). In response to these challenges, cardiac rehabilitation has evolved into a comprehensive, patient-centered approach that integrates clinical care with behavioral, psychological, and educational interventions, ensuring that treatment strategies are aligned with individual patient needs, preferences, and socio-cultural contexts (Taylor et al., 2022). This transformation reflects a paradigm shift from traditional hospital-based, exercise-focused programs to holistic care models that

address the physical, emotional, and social dimensions of recovery, thereby improving overall health outcomes and quality of life (Dalal et al., 2015). Medical-surgical nurses play a central and increasingly advanced role in this transformation by conducting comprehensive assessments, developing individualized care plans, and implementing evidence-based interventions that promote self-management and adherence to therapeutic regimens (Zhao et al., 2024). Their contributions extend beyond clinical care to include patient education, counseling, and coordination with multidisciplinary teams, ensuring continuity of care across hospital, community, and home-based settings (McMahon et al., 2017). Furthermore, nurse-led cardiac rehabilitation programs have demonstrated effectiveness in improving patient outcomes by enhancing engagement, providing continuous monitoring, and facilitating early identification of complications, thereby reinforcing the importance of nursing leadership in modern rehabilitation practices (Singh et al., 2025). The integration of digital health technologies, including telemonitoring, wearable devices, and mobile health applications, has further revolutionized cardiac rehabilitation by enabling remote care delivery, real-time data tracking, and personalized feedback, particularly benefiting patients in rural and underserved areas (Frederix et al., 2018). These technological advancements support patient-centered care by promoting self-efficacy, improving adherence, and facilitating timely interventions, ultimately leading to better clinical outcomes and reduced healthcare costs (Maddison et al., 2019). The conceptual framework of patient-centered cardiac rehabilitation, as illustrated in Figure 1, demonstrates the dynamic interaction between patient needs, advanced nursing interventions, multidisciplinary collaboration, and technological integration, forming a robust foundation for delivering high-quality, individualized care that addresses both clinical and psychosocial aspects of recovery (Resurrección et al., 2019).

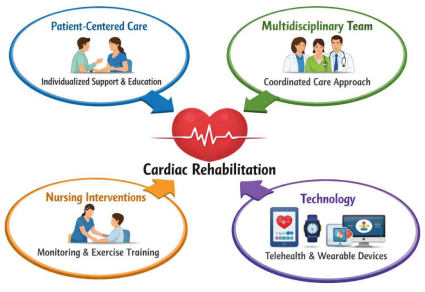

Figure 1.Conceptual framework showing interaction between patient-centered care, nursing interventions, multidisciplinary team, and technology in cardiac rehabilitation

Evolution of Cardiac Rehabilitation

The evolution of cardiac rehabilitation reflects a significant transition from traditional exercise-based recovery models to comprehensive, multidimensional care systems that address the complex and multifactorial nature of cardiovascular diseases, marking a paradigm shift in modern healthcare delivery (Manandi et al., 2025). Early cardiac rehabilitation programs were primarily centered on supervised physical activity, focusing on improving cardiovascular endurance and functional recovery following acute cardiac events, with limited attention to other determinants of health (Li et al., 2024). However, as clinical understanding of cardiovascular disease expanded, it became increasingly evident that effective rehabilitation required a broader approach encompassing lifestyle modification, dietary management, and psychosocial support, thereby transforming CR into a holistic intervention strategy (Chen et al., 2024). The integration of behavioral and educational components into rehabilitation programs reflects a growing recognition of the importance of patient engagement, self-management, and long-term adherence in achieving sustained health outcomes (Zhang et al., 2024). Furthermore, advances in medical science and evidence-based practice have contributed to the refinement of CR models, incorporating risk stratification, individualized care planning, and multidisciplinary collaboration to optimize patient recovery (Zhou et al., 2024). Over time, cardiac rehabilitation has expanded beyond hospital-based settings to include community and home-based programs, thereby increasing accessibility and accommodating diverse patient needs and preferences (Kraal et al., 2017). The shift toward decentralized care delivery has been further accelerated by technological advancements, including telehealth platforms, wearable monitoring devices, and digital health applications, which enable remote supervision and real-time feedback (Cao et al., 2026). These innovations have facilitated the development of hybrid and virtual rehabilitation models, allowing patients to participate in structured programs regardless of geographical constraints and improving overall program adherence (Marzolini et al., 2026). In addition, contemporary CR programs emphasize personalized medicine, tailoring interventions to individual risk profiles, comorbidities, and patient preferences, thereby enhancing the effectiveness and sustainability of rehabilitation outcomes (Santa Mina et al., 2024). The incorporation of psychosocial interventions, including stress management, cognitive behavioral therapy, and emotional support, has further strengthened the multidimensional nature of CR, addressing mental health challenges that often accompany cardiovascular conditions (Hurtado-Borrego et al., 2025). Moreover, the ongoing evolution of CR is

closely linked to a broader shift in healthcare philosophy from disease-centered models to patient-centered care, which prioritizes individualized treatment, shared decision-making, and holistic well-being (Epelde et al., 2024). The progression from hospital-centered care to integrated, technology-enabled rehabilitation is clearly depicted in Figure 2, which highlights the transition toward personalized, accessible, and flexible care models designed to meet the needs of diverse patient populations. This transformation underscores the importance of continuous innovation and adaptation in cardiac rehabilitation, ensuring that programs remain responsive to emerging challenges and advancements in healthcare delivery.

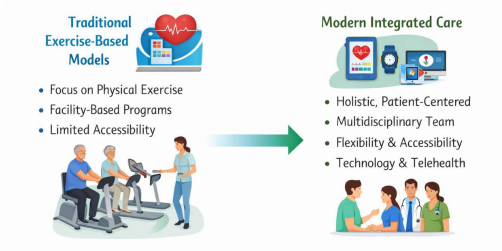

Figure 2.Evolution of cardiac rehabilitation from traditional exercise-based models to modern integrated and technology-supported care

Patient-Centered Care in Cardiac Rehabilitation

Patient-centered care forms the cornerstone of modern cardiac rehabilitation, emphasizing the importance of aligning healthcare interventions with patient preferences, values, and individual health conditions, thereby ensuring that care delivery is both responsive and tailored to the unique needs of each individual recovering from cardiovascular disease (Harzand et al., 2023). This approach represents a significant shift from traditional provider-driven models toward collaborative care frameworks in which patients actively participate in decision-making processes, fostering a sense of ownership and responsibility for their health outcomes (Myneni et al., 2024). Evidence suggests that patient-centered cardiac rehabilitation improves adherence to treatment protocols, enhances lifestyle modification, and reduces the likelihood of recurrent cardiac events by promoting sustained behavioral changes (Chait et al., 2024). Furthermore, the incorporation of individualized care planning allows healthcare professionals to address diverse patient needs, including comorbid conditions, psychological stressors, and socio-economic barriers, thereby improving overall effectiveness and inclusivity of rehabilitation programs (Tessler et al., 2025). Active patient participation is a defining feature of patient-centered care, as it encourages engagement in goal setting, treatment planning, and self-management practices, ultimately leading to improved clinical outcomes and enhanced quality of life (Xia et al., 2024). In addition, shared decision-making strengthens the therapeutic relationship between patients and healthcare providers, fostering trust, communication, and mutual understanding, which are essential for long-term adherence and successful rehabilitation (Myneni et al., 2024). The integration of emotional and social support into cardiac rehabilitation further highlights the holistic nature of patient-centered care, addressing psychological challenges such as anxiety, depression, and stress that frequently accompany cardiovascular conditions (Harzand et al., 2023). Behavioral interventions, including motivational interviewing and counseling, play a crucial role in empowering patients to adopt healthier lifestyles and maintain long-term adherence to prescribed regimens (Myneni et al., 2024). Moreover, advancements in digital health technologies have significantly enhanced patient-centered approaches by enabling continuous monitoring, personalized feedback, and remote access to rehabilitation services, particularly for individuals in remote or underserved areas (Harzand et al., 2023). These technologies support real-time data collection and analysis, allowing healthcare providers to make timely adjustments to treatment plans and improve patient engagement (Tessler et al., 2025). The importance of tailoring rehabilitation programs to patient preferences is further supported by qualitative studies indicating that individualized interventions enhance motivation, reduce barriers to participation, and improve overall satisfaction with care (Janssen et al., 2024). Additionally, structured cardiac rehabilitation programs have demonstrated significant improvements in adherence to dietary and physical activity recommendations, reinforcing the value of patient-centered strategies in promoting sustainable health behaviors (Myneni et al., 2024). The essential components of patient-centered cardiac rehabilitation, including individualized planning, continuous monitoring, patient education, and active engagement, are visually represented in Figure 3, reinforcing the holistic and integrated nature of contemporary rehabilitation practices.

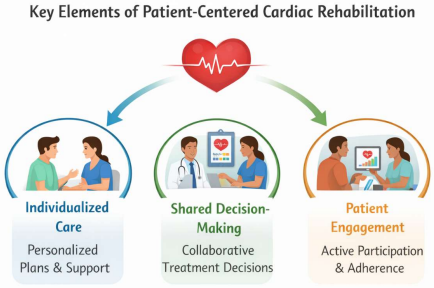

Figure 3.Key elements of patient-centered cardiac rehabilitation including individualized

care, shared decision-making, and patient engagement

Advanced Medical-Surgical Nursing Interventions

Advanced medical-surgical nursing interventions play a critical role in enhancing the effectiveness of cardiac rehabilitation programs by ensuring that care delivery is comprehensive, evidence-based, and tailored to the complex needs of patients with cardiovascular conditions, thereby improving both short-term recovery and long-term health outcomes (Bernier et al., 2026). Nurses are responsible for conducting thorough and systematic assessments that include physical evaluation, risk factor identification, and psychosocial screening, which form the foundation for individualized and patient-centered care planning in cardiac rehabilitation settings (Subih et al., 2024). These assessments enable nurses to identify patient-specific challenges such as comorbidities, functional limitations, and emotional distress, allowing for the development of targeted interventions that address both clinical and psychosocial dimensions of recovery (Garea et al., 2025). The implementation of evidence-based nursing practices, including structured exercise guidance, lifestyle modification counseling, and risk factor management, has been shown to significantly improve patient outcomes and reduce the risk of recurrent cardiac events (Zhang et al., 2025). In addition to direct clinical care, nurses play a vital role in patient education, equipping individuals with the knowledge and skills necessary to manage their condition effectively, adhere to prescribed treatments, and adopt healthier lifestyles (Garea et al., 2025). Medication management is another essential component of nursing interventions, as nurses monitor patient adherence, adjust medications within established protocols, and educate patients about potential side effects and the importance of compliance, thereby minimizing complications and optimizing therapeutic outcomes (Visseren et al., 2021). Furthermore, nurses serve as key coordinators within multidisciplinary teams, facilitating communication among physicians, physiotherapists, dietitians, and other healthcare professionals to ensure integrated and seamless care delivery (Su et al., 2025). The importance of nurse-led and nurse-coordinated rehabilitation programs has been increasingly recognized, with evidence demonstrating their effectiveness in improving physical capacity, mental health, and overall quality of life among cardiac patients (Yan et al., 2025). In home-based and community settings, nurses extend their role by providing follow-up care, monitoring patient progress, and offering ongoing support, which enhances accessibility and continuity of care, particularly for patients who may face barriers to attending hospital-based programs (Li et al., 2023). Technological integration has further expanded the scope of nursing interventions, enabling the use of telemonitoring, mobile health platforms, and remote communication tools to track patient progress, provide real-time feedback, and facilitate timely interventions (Su et al., 2025). These digital solutions support proactive care management by allowing nurses to identify potential complications early and intervene promptly, thereby improving patient safety and outcomes (Bernier et al., 2026). The diverse roles performed by nurses in cardiac rehabilitation, including assessment, monitoring, counseling, education, and coordination, are illustrated in Figure 4, emphasizing their central role in delivering holistic and patient-centered care.

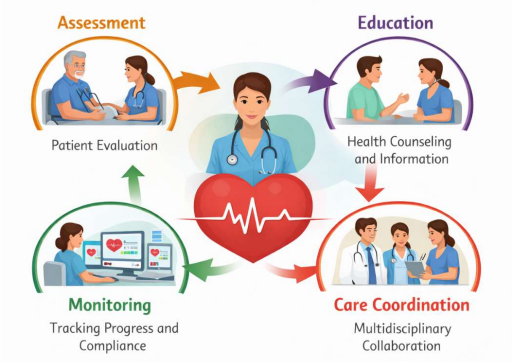

Figure 4.Roles of medical-surgical nurses in cardiac rehabilitation including assessment, education, monitoring, and care coordination

Additionally, the range of core nursing interventions and their associated outcomes, such as improved adherence, enhanced functional capacity, and reduced psychological distress, are summarized in Table 1, providing a structured overview of their impact on patient recovery and long-term disease management. Overall, advanced medical-surgical nursing interventions are integral to the success of modern cardiac rehabilitation programs, as they bridge the gap between clinical treatment and patient self-management, ensuring that care is continuous, personalized, and responsive to the evolving needs of patients with cardiovascular diseases.

Table 1. Core Nursing Interventions in Cardiac Rehabilitation

Intervention	Description	Outcome
Health education	Lifestyle modification guidance	Improved adherence
Exercise supervision	Monitoring physical activity	Enhanced fitness
Psychosocial support	Emotional counseling	Reduced anxiety
Medication management	Ensuring compliance	Reduced complications

Telemonitoring	Remote tracking	Early detection

Nurse-Led Cardiac Rehabilitation Programs

Nurse-led cardiac rehabilitation programs have emerged as highly effective and sustainable models for delivering accessible, patient-centered, and high-quality care, particularly in resource-limited settings where access to multidisciplinary teams may be constrained, thereby addressing critical gaps in traditional rehabilitation services (Dalal et al., 2015). These programs emphasize a holistic approach to recovery by integrating patient education, lifestyle modification, and structured follow-up, enabling individuals to actively participate in their own care and develop the necessary skills for long-term disease management (Taylor et al., 2022). Evidence indicates that nurse-led interventions significantly improve adherence to rehabilitation protocols, enhance functional capacity, and reduce hospital readmissions, demonstrating their effectiveness in optimizing both clinical and psychosocial outcomes (Anderson et al., 2016). A key strength of nurse-led cardiac rehabilitation lies in its focus on patient education, where nurses provide tailored information regarding disease processes, medication adherence, dietary modifications, and physical activity, thereby empowering patients to make informed decisions about their health (Zhao et al., 2024). In addition to education, self-management support is a central component of these programs, as patients are encouraged to set realistic goals, monitor their progress, and adopt sustainable behavioral changes that contribute to improved cardiovascular health (Resurrección et al., 2019). Regular follow-up and continuous monitoring further enhance the effectiveness of nurse-led programs by allowing early identification of potential complications and timely intervention, which is particularly important in preventing disease progression and reducing the risk of recurrent cardiac events (Frederix et al., 2018). Nurses play a pivotal role as coordinators within these programs, facilitating communication among healthcare professionals, organizing care plans, and ensuring that all aspects of rehabilitation are delivered in a consistent and integrated manner (McMahon et al., 2017). Their ability to build strong therapeutic relationships with patients also contributes to increased trust, engagement, and adherence, which are essential for successful rehabilitation outcomes (Poffley et al., 2020). Furthermore, nurse-led cardiac rehabilitation programs are adaptable to various settings, including hospital-based, community-based, and home-based environments, thereby increasing accessibility and accommodating the diverse needs of patients (Kraal et al., 2017). The incorporation of digital health technologies, such as telehealth platforms and mobile applications, has further strengthened these programs by enabling remote monitoring, virtual consultations, and personalized feedback, which enhance patient engagement and continuity of care (Maddison et al., 2019). These innovations are particularly beneficial in rural and underserved areas, where geographical barriers often limit access to traditional rehabilitation services, thereby improving equity in healthcare delivery (Supervia et al., 2021). The structure and workflow of nurse-led cardiac rehabilitation programs, as illustrated in Figure 5, outline the sequential processes of patient assessment, individualized intervention planning, continuous monitoring, and structured follow-up, highlighting their systematic and patient-centered nature. This structured approach ensures that care is delivered efficiently and consistently, while also allowing flexibility to adapt interventions based on patient progress and evolving needs (Ades et al., 2017). Moreover, the cost-effectiveness of nurse-led programs has been widely recognized, as they reduce the burden on healthcare systems while maintaining high standards of care, making them a viable solution for scaling up cardiac rehabilitation services globally (Turk-Adawi et al., 2019).

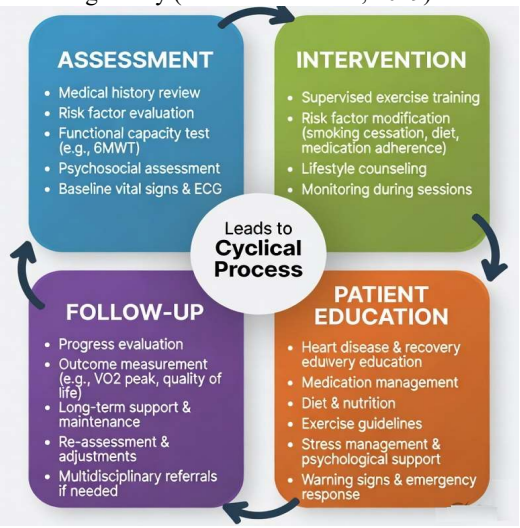

Figure 5.Structure of nurse-led cardiac rehabilitation programs showing assessment, intervention, follow-up, and patient education processes

Integration of Technology in Cardiac Rehabilitation

The integration of technology has significantly enhanced the scope and effectiveness of cardiac rehabilitation by transforming traditional care models into dynamic, accessible, and patient-centered systems that leverage digital innovations to improve outcomes and engagement (Gao et al., 2026). Modern cardiac rehabilitation increasingly incorporates digital tools such as telehealth platforms, wearable devices, and mobile health applications, which enable remote monitoring and facilitate real-time communication between patients and healthcare providers, thereby improving

continuity of care and clinical supervision beyond hospital settings (Alqahtani et al., 2026). Telehealth-based cardiac rehabilitation programs have demonstrated effectiveness comparable to conventional center-based programs, with improvements observed in exercise capacity, quality of life, and adherence rates, highlighting their potential as viable alternatives in contemporary healthcare delivery (Thomas et al., 2019). Wearable technologies, including heart rate monitors, smart sensors, and activity trackers, allow continuous collection of physiological data such as heart rate, physical activity levels, and vital signs, enabling healthcare professionals to make timely and informed decisions regarding patient care (Klein et al., 2026). These devices contribute to enhanced patient engagement by providing feedback and encouraging adherence to prescribed exercise and lifestyle interventions, thereby promoting self-management and accountability (Braver et al., 2025). Mobile health applications further complement these technologies by offering educational resources, reminders, and interactive tools that support behavior modification and reinforce healthy lifestyle practices (Huang et al., 2026). The use of Internet of Things (IoT)-based systems in cardiac rehabilitation has expanded the capabilities of digital health by integrating multiple devices and platforms into a cohesive network, allowing seamless data sharing and personalized care delivery (Klein et al., 2026). Such systems enable continuous monitoring and automated feedback, facilitating early detection of potential complications and reducing the risk of adverse events (Antoniou et al., 2024). Additionally, digital health technologies have played a crucial role in addressing barriers to cardiac rehabilitation, particularly in rural and underserved areas where access to healthcare facilities is limited, by providing remote and flexible care options that overcome geographical and logistical constraints (Supervia et al., 2021). Evidence suggests that telehealth and connected health technologies can reduce healthcare disparities, improve access to rehabilitation services, and enhance patient participation, especially among populations facing socioeconomic and infrastructural challenges (Frederix et al., 2018). Furthermore, advancements in telemedicine infrastructure, including video conferencing, cloud-based data storage, and secure communication systems, have facilitated efficient and scalable delivery of cardiac rehabilitation services (Sadovski et al., 2025). These innovations also support multidisciplinary collaboration by enabling seamless communication among healthcare providers, thereby improving coordination and quality of care (Gao et al., 2026). Despite the numerous benefits, the implementation of digital health technologies in cardiac rehabilitation is not without challenges, including issues related to digital literacy, data privacy, technological accessibility, and the need for standardized protocols to ensure consistent and safe care delivery (Braver et al., 2025). Addressing these challenges requires ongoing research, policy support, and investment in healthcare infrastructure to optimize the integration of technology into rehabilitation programs. The role of digital health in supporting modern rehabilitation practices is illustrated in Figure 6, which demonstrates how technology facilitates continuous monitoring, advanced data analysis, and timely intervention, ultimately enhancing patient outcomes and transforming the delivery of cardiac rehabilitation services.

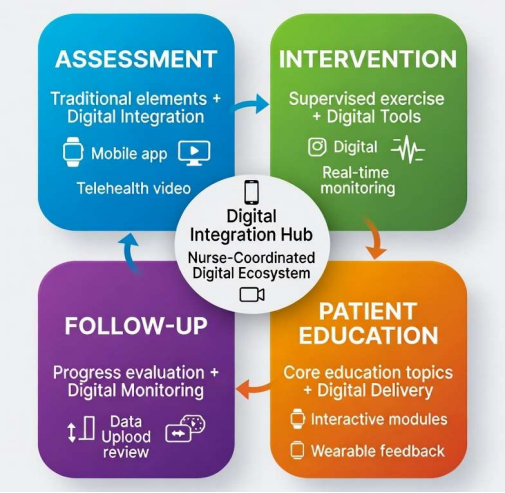

Figure 6.Integration of digital health technologies such as telehealth, wearable devices, and mobile applications in cardiac rehabilitation

Psychosocial and Behavioral Interventions

Psychological and behavioral factors play a crucial role in determining the success of cardiac rehabilitation, as patients frequently experience anxiety, depression, stress, and fear following cardiac events, which can significantly hinder recovery, reduce adherence to treatment, and negatively impact quality of life if not adequately addressed through comprehensive care strategies (Leivaditis et al., 2025). Research indicates that psychological distress is highly prevalent among cardiac patients, with anxiety and depression often leading to avoidance behaviors, reduced participation in rehabilitation programs, and poorer clinical outcomes, thereby emphasizing the need for integrated psychosocial interventions within cardiac care (Farris et al., 2019). The incorporation of advanced nursing interventions, including structured counseling, emotional support, and behavioral therapy, has been shown to effectively address these challenges by promoting coping mechanisms and improving psychological resilience among patients undergoing rehabilitation (Burg et al., 2026). Cognitive behavioral therapy

(CBT), in particular, has emerged as a highly effective intervention for managing depression and anxiety in cardiac patients, as it focuses on modifying negative thought patterns and behaviors that may interfere with recovery and lifestyle changes (Baourda et al., 2025). Evidence from clinical studies demonstrates that combining psychological interventions with physical rehabilitation leads to greater improvements in mental health outcomes compared to exercise-based programs alone, highlighting the importance of integrating psychosocial care into standard cardiac rehabilitation practices (Huh et al., 2025). In addition to CBT, relaxation techniques such as deep breathing exercises, progressive muscle relaxation, and guided imagery have been shown to significantly reduce anxiety and depression levels while improving sleep quality and overall well-being in patients recovering from cardiac procedures (Zakeri et al., 2025). Psychoeducational interventions also play a vital role by helping patients understand their condition, develop realistic expectations, and actively participate in their treatment, thereby enhancing adherence and self-management capabilities (Leivaditis et al., 2025). Furthermore, individual and group counseling sessions provide emotional support and facilitate the sharing of experiences, which can reduce feelings of isolation and improve motivation to engage in rehabilitation activities (Frontiers Study Group et al., 2025). Behavioral modification strategies, including motivational interviewing and goal-setting techniques, are essential components of psychosocial interventions, as they encourage patients to adopt healthier lifestyles, maintain physical activity, and adhere to medication regimens over the long term (Burg et al., 2026). The integration of these interventions into cardiac rehabilitation programs reflects a holistic approach that addresses both physical and psychological aspects of recovery, ensuring more comprehensive and patient-centered care (Leivaditis et al., 2025). The psychosocial support framework presented in Figure 7 highlights the interconnected roles of emotional support, behavioral modification, and patient motivation strategies, demonstrating how these elements collectively contribute to improved rehabilitation outcomes.

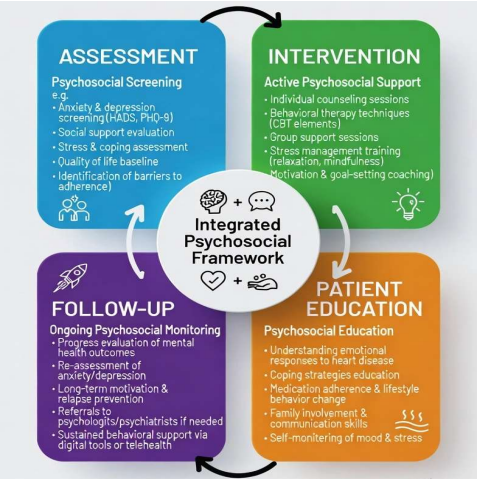

Figure 7.Psychosocial support framework including counseling, behavioral therapy, stress management, and motivation strategies

Additionally, Table 2 provides a detailed overview of key psychosocial interventions and their corresponding outcomes, such as reduced anxiety, improved coping skills, enhanced quality of life, and increased adherence to treatment, emphasizing their importance in optimizing patient well-being. Overall, addressing psychological and behavioral factors through advanced nursing interventions is essential for the success of cardiac rehabilitation, as it not only improves mental health outcomes but also enhances physical recovery, promotes long-term adherence, and supports sustainable lifestyle changes, ultimately contributing to better cardiovascular health and reduced risk of recurrent cardiac events (Burg et al., 2026).

Table 2. Psychosocial Interventions in Cardiac Rehabilitation

Intervention	Purpose	Outcome
Counseling	Emotional support	Reduced depression
CBT	Behavior change	Improved coping
Stress management	Relaxation	Lower stress
Peer support	Social interaction	Increased motivation

Exercise-Based Cardiac Rehabilitation

Exercise training remains a fundamental component of cardiac rehabilitation, contributing significantly to improved cardiovascular function, enhanced physical capacity, and reduced mortality risk among individuals with cardiovascular diseases, thereby forming the cornerstone of evidence-based rehabilitation strategies (Khan et al., 2025). Rehabilitation programs typically incorporate a combination of aerobic exercises, resistance training, and flexibility routines that are

carefully tailored to individual patient needs, ensuring both safety and effectiveness in promoting recovery and long-term health maintenance (Rakhshan et al., 2024). Aerobic exercise, including activities such as walking, cycling, and swimming, is considered the primary modality in cardiac rehabilitation due to its ability to improve cardiovascular endurance, enhance oxygen utilization, and promote favorable hemodynamic adaptations (Mirzai et al., 2025). Research has demonstrated that regular aerobic training leads to significant improvements in endothelial function, cardiac output, and metabolic efficiency, which collectively contribute to reduced cardiovascular risk and improved quality of life (Khan et al., 2025). Resistance training, on the other hand, plays a complementary role by improving muscle strength, endurance, and functional capacity, thereby enabling patients to perform daily activities more efficiently and reducing the burden on the cardiovascular system (Lopes et al., 2023). Evidence suggests that combining aerobic and resistance training yields superior outcomes compared to aerobic exercise alone, as it enhances both cardiorespiratory fitness and muscular strength, leading to more comprehensive rehabilitation benefits (Li et al., 2026). Flexibility and stretching exercises are also integral components of rehabilitation programs, as they improve joint mobility, reduce the risk of injury, and support overall physical function, particularly in older adults and individuals with limited mobility (Rakhshan et al., 2024). Importantly, exercise training in cardiac rehabilitation is conducted under structured and supervised conditions, ensuring that intensity, duration, and progression are appropriately adjusted based on individual patient risk profiles and clinical status, thereby minimizing the risk of adverse events (Rakhshan et al., 2024). Studies have consistently demonstrated that participation in structured exercise-based cardiac rehabilitation programs significantly reduces mortality rates and hospital readmissions, while also improving psychological well-being and overall functional status (Mirzai et al., 2025). Furthermore, exercise training has been shown to positively influence key cardiovascular risk factors, including hypertension, dyslipidemia, and insulin resistance, thereby contributing to comprehensive risk reduction and disease prevention (Khan et al., 2025). The adaptability of exercise programs allows for the inclusion of various training modalities, such as moderate-intensity continuous training and high-intensity interval training, which can be tailored to patient preferences and clinical conditions to maximize adherence and effectiveness (Myneni et al., 2024). Additionally, regular physical activity has been associated with improvements in mental health, including reductions in anxiety and depression, further highlighting the multidimensional benefits of exercise in cardiac rehabilitation (Khan et al., 2025). The different types of exercises incorporated in cardiac rehabilitation are illustrated in Figure 8, which provides a comprehensive overview of structured physical activity within CR programs, emphasizing the integration of aerobic, resistance, and flexibility training in achieving optimal rehabilitation outcomes.

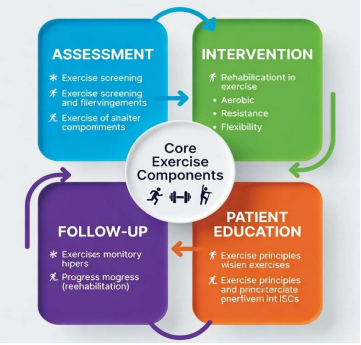

Figure 8.Types of exercise in cardiac rehabilitation including aerobic, resistance, and flexibility training

Challenges in Cardiac Rehabilitation

Despite the significant advancements in cardiac rehabilitation, several challenges continue to hinder its widespread implementation and effectiveness, particularly in terms of accessibility, participation, and healthcare system limitations, which collectively impact patient outcomes and the overall success of rehabilitation programs (Latir et al., 2026). One of the most prominent barriers is limited accessibility to cardiac rehabilitation services, especially in low- and middle-income regions, where healthcare infrastructure and specialized facilities are often inadequate to meet the growing demand for rehabilitation services (Supervia et al., 2021). Geographic constraints, including long travel distances and lack of transportation, further restrict patient access to rehabilitation centers, making it difficult for individuals to attend regular sessions and adhere to prescribed programs (Katz et al., 2025). In addition to accessibility issues, low patient participation rates remain a critical concern, with studies indicating that a substantial proportion of eligible patients either do not enroll in or fail to complete cardiac rehabilitation programs (Anderson et al., 2016). Factors contributing to low participation include lack of awareness, insufficient referral by healthcare providers, and misconceptions about the benefits of rehabilitation, all of which reduce patient engagement and motivation (Sugiharto et al., 2023). Socioeconomic factors such as financial constraints, employment obligations, and lack of insurance coverage also play a significant role in limiting participation, particularly among disadvantaged populations (Katz et al., 2025). Furthermore, psychological barriers, including

anxiety, depression, and low self-efficacy, can negatively influence patient willingness to participate in rehabilitation programs and maintain long-term adherence (Chindhy et al., 2020). Another major challenge is the shortage of trained healthcare professionals, including specialized nurses and rehabilitation experts, which limits the capacity of healthcare systems to deliver high-quality and comprehensive cardiac rehabilitation services (Supervia et al., 2021). This shortage is particularly evident in resource-constrained settings, where healthcare providers are often overburdened and lack access to adequate training and support systems (Latir et al., 2026). Additionally, variations in program quality and lack of standardized protocols can lead to inconsistencies in care delivery, further affecting the effectiveness of rehabilitation interventions (Sugiharto et al., 2023). Technological barriers, such as limited digital literacy and inadequate access to digital health tools, also pose challenges to the implementation of innovative rehabilitation models, particularly among elderly populations and those in rural areas (Chindhy et al., 2020). Addressing these challenges requires a multifaceted approach that includes policy support, increased funding, and the development of infrastructure to expand the availability of cardiac rehabilitation services (Supervia et al., 2021). Enhancing awareness among both patients and healthcare providers is essential to improve referral rates and encourage participation in rehabilitation programs (Anderson et al., 2016). The adoption of innovative care delivery models, such as home-based and telehealth-supported cardiac rehabilitation, offers promising solutions to overcome geographical and logistical barriers while maintaining the quality and effectiveness of care (Latir et al., 2026). Strengthening workforce capacity through training and education programs for healthcare professionals, particularly nurses, can further improve the delivery of patient-centered rehabilitation services (Chindhy et al., 2020). Moreover, integrating digital health technologies into rehabilitation programs can enhance accessibility, enable remote monitoring, and support personalized care, thereby addressing some of the key barriers to participation and adherence (Supervia et al., 2021). The major challenges and their potential solutions are summarized in Table 3, which provides a strategic framework for improving the accessibility, quality, and effectiveness of cardiac rehabilitation services.

Table 3. Challenges and Solutions in Cardiac Rehabilitation

Challenge	Solution
Low participation	Patient education
Geographic barriers	Tele-rehabilitation
Financial issues	Policy support
Limited staff	Training programs

Future Directions in Cardiac Rehabilitation

The future of cardiac rehabilitation lies in the seamless integration of advanced technologies, personalized medicine, and expanded nursing roles, which together are expected to transform rehabilitation into a highly precise, adaptive, and patient-centered model of care that improves both clinical outcomes and patient experience (Gao et al., 2026). Emerging innovations such as artificial intelligence (AI) are poised to revolutionize cardiac rehabilitation by enabling real-time data analysis, predictive modeling, and automated clinical decision support, thereby enhancing the accuracy and efficiency of patient care (Nedadur et al., 2024). AI-driven predictive analytics allow healthcare providers to identify high-risk patients, anticipate complications, and tailor interventions proactively, which significantly improves early detection and prevention strategies in cardiovascular care (Antoniou et al., 2024). Furthermore, machine learning algorithms can process large volumes of patient data, including physiological parameters, lifestyle behaviors, and treatment responses, to generate personalized rehabilitation plans that align with individual patient needs and risk profiles (Gao et al., 2026). The integration of genomics and precision medicine into cardiac rehabilitation represents another major advancement, as genetic profiling enables clinicians to understand individual variations in disease susceptibility, drug response, and recovery patterns, thereby facilitating more targeted and effective interventions (PMC Research Group et al., 2025). These developments support the shift toward precision-based rehabilitation, where treatments are no longer generalized but instead customized according to each patient's biological, environmental, and behavioral characteristics (Frontiers Review et al., 2025). In addition to genomics, emerging technologies such as digital twins and simulation models are being explored to predict patient outcomes and optimize care strategies before implementation, offering a novel approach to personalized rehabilitation planning (Frontiers AI Nursing Study et al., 2025). The role of nurses is also expected to expand significantly in this evolving landscape, as they will increasingly engage in data-driven decision-making, digital health management, and advanced patient education, thereby enhancing the quality and continuity of care (Frontiers Nursing Review et al., 2025). Nurses will play a critical role in interpreting complex data generated by AI systems,

translating these insights into practical interventions, and ensuring that care remains patient-centered despite increasing technological complexity (Nedadur et al., 2024). Moreover, the integration of wearable technologies and remote monitoring systems will enable continuous tracking of patient health metrics, allowing nurses and healthcare providers to deliver timely interventions and maintain close supervision even in home-based settings (Antoniou et al., 2024). These advancements will significantly improve patient engagement and adherence by providing real-time feedback, personalized recommendations, and ongoing support throughout the rehabilitation process (Gao et al., 2026). The adoption of virtual and hybrid rehabilitation models further enhances accessibility, particularly for patients in remote or underserved areas, thereby addressing longstanding disparities in cardiac rehabilitation services (American College of Cardiology Report et al., 2024). However, the successful implementation of these innovations will require addressing challenges related to data privacy, ethical considerations, technological infrastructure, and workforce training to ensure safe and effective integration into clinical practice (Frontiers Review et al., 2025). Additionally, interdisciplinary collaboration will become increasingly important, as healthcare professionals from various fields work together to leverage advanced technologies and deliver comprehensive care (PMC Research Group et al., 2025).

Conclusion

The transformation of cardiac rehabilitation through advanced medical-surgical nursing interventions has significantly improved the quality and effectiveness of patient-centered care. Modern rehabilitation approaches now extend beyond traditional exercise-based models to include comprehensive strategies that address physical, psychological, and social dimensions of health. The integration of personalized care plans ensures that interventions are tailored to individual patient needs, preferences, and risk profiles, thereby enhancing engagement and adherence to treatment.Technological innovations such as telehealth, wearable devices, and mobile health applications have further strengthened rehabilitation programs by enabling continuous monitoring, real-time feedback, and remote access to care. These advancements have made cardiac rehabilitation more accessible, especially for patients in remote or underserved areas, while also improving efficiency and continuity of care. In addition, nurse-led programs have played a crucial role in coordinating multidisciplinary efforts, providing education, and supporting patients throughout their recovery journey.Together, these developments have led to improved clinical outcomes, increased patient satisfaction, and better long-term management of cardiovascular conditions. Continued investment in research, healthcare infrastructure, and workforce development will be essential to sustain these advancements and overcome existing barriers.

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