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Research Progress of Mobile Medical Technology in Home Cardiac Rehabilitation Nursing

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ABSTRACT

In recent years, due to the increasing incidence of cardiovascular diseases and the lack of medical resources, the traditional hospital based cardiac rehabilitation is difficult to meet the needs of patients. Mobile medicine has the characteristics of being anytime, anywhere, convenient and fast, which can better expand cardiac rehabilitation to the home. This article provides a review of the relevant research on the application of mobile medicine in home cardiac rehabilitation nursing: summarizing its core carrier role, main application methods, and further improvement directions. In summary, mobile healthcare can provide assistance for remote follow-up, personalized management, health education, and psychological counseling, playing a positive role in improving rehabilitation rates, compliance, and prognosis. The next step should start with technology integration, precision services, cross disciplinary cooperation, and the establishment of relevant systems, aiming to promote the standardization and sustainability of home-based cardiac rehabilitation.

KEYWORDS

Mobile health; Telehomecare; Cardiac rehabilitation; Remote patient monitoring; e-health; Chronic illness

1. INTRODUCTION

Cardiovascular disease is one of the leading causes of death and disability worldwide with a huge medical burden.Cardiac rehabilitation is an integral collection of secondary prevention and rehabilitation measures for cardiovascular disease [1]. There are abundant medical evidence-based evidence to show that it can reduce the risk of readmission, death and improve the quality of life and functional level of patients. However, participation and completion rates for CR in all countries are relatively low, and conventional centralized rehabilitation has many barriers such as a long distance, time conflicts, high cost, and unbalanced distribution of medical resources. In the past decade, along with the development of information technology, especially smartphones, wearable devices, Internet of Things (IoT), and artificial intelligence, mHealth has quickly become a new research area. Mobile medical (MH) is a medical and health service provided by mobile communication tools, which brings a new opportunity to solve the problem of difficult landing of cardiac rehabilitation. The application of mobile Internet technology in home cardiac rehabilitation care can dynamically monitor patients and provide timely guidance and help, thus expanding coverage and improving results. This article will systematically elaborate on the research progress of mobile medical technology in home cardiac rehabilitation nursing from the aspects of its importance, core application types, and future development strategies.

2. THE IMPORTANCE OF MOBILE MEDICAL TECHNOLOGY AS A KEY CARRIER AND EFFICIENCY ENHANCEMENT FOR HOME CARDIAC REHABILITATION

Cardiac rehabilitation is a long-term systematic process that includes medical assessment, exercise prescription, health promotion, psychological intervention, and risk factor control. And whether patients can continue to participate and actively implement the cardiac rehabilitation plan is a key factor affecting the success or failure of cardiac rehabilitation treatment. Home style cardiac rehabilitation refers to cardiac rehabilitation performed at home, which is more convenient and accessible compared to in-hospital cardiac rehabilitation. However, the fragmentation and non specialization of family environments can also lead to issues such as lack of supervision, guidance, and data feedback [2]. Mobile healthcare can supplement this deficiency and play an important role as a link and medium between medical professionals and family patients.

The application of intelligent medical technology makes rehabilitation more coherent and real-time. With the help of smart wristbands and APP software, patients' physical signs, activity levels, pain sensations, and other information are recorded and uploaded to cloud servers. They can be viewed at any time on the doctor's end. If any discomfort occurs, doctors can detect it in the first time and provide advice, which significantly improves safety from passive to active. Mobile medical technology improves the participation and compliance behavior of rehabilitation interventions, relying on mobile device apps to provide patients with multimedia health education, personalized exercise prescriptions, medication reminders, and two-way communication functions, enhancing patients' acceptance and initiative in terms of fun and imagery; The use of game mechanics, settings, and feedback tools for behavior modification is beneficial for forming good self-management behaviors among patients; Promote precision and big data based rehabilitation management. Long term collected data can be used to analyze patients' rehabilitation status, and big data can be used for risk factor warning and treatment plan formulation, thereby better implementing precision rehabilitation [3]. Therefore, mobile healthcare technology is not only a tool level innovation, but also an important driving force for promoting the efficient, safe, and personalized home cardiac rehabilitation model.

3. THE MAIN APPLICATION TYPES OF MOBILE MEDICAL TECHNOLOGY IN HOME CARDIAC REHABILITATION NURSING

Currently, the application of mobile medical technology in home cardiac rehabilitation nursing is showing a trend of diversification and integration, mainly covering the following core types.

3.1. Remote Vital Sign Monitoring And Early Warning Technology

Remote monitoring is the simplest and most widely used mobile medical method for cardiac rehabilitation. It mainly refers to collecting real-time or periodic data of patients through sensors installed in mobile phones, wearable devices, or clothing, usually including heart rate, heartbeat, blood pressure, blood oxygen, body mass, exercise volume, electrocardiogram segments, and other information [4]. The above information is automatically uploaded to the APP or cloud platform through Bluetooth, WIFI, and other methods.

On the one hand, patients can directly see their curve changes on the APP and understand their physical condition; On the other hand, pre-set models can be used to intelligently process data, detect conditions such as rapid or slow heartbeat, high blood pressure, and insufficient exercise, and provide patient reminders while notifying the doctor's backend. Facilitating remote assessment and timely intervention, such as adjusting medication, providing consultation or guidance for emergency medical

treatment. Research has shown that remote monitoring can detect complications early and reduce unnecessary outpatient visits, while increasing a sense of security and confidence in recovery.

3.2. Personalized Rehabilitation Plan and Guidance Based on Mobile Terminals

Exercise is an important part of mental health. Mobile healthcare can help patients transform standardized treatment into individualized treatment strategies implemented at home. The APP can develop personalized exercise patterns, intensities, durations, frequencies, and other exercise prescriptions based on the patient's previous evaluation, disease progression, patient preferences, and patient feedback [5].

The application can monitor the heart rate during exercise in real-time through internal sensors or external devices, ensuring that the patient is within an effective and safe target heart rate range; Provide correct movement posture in the form of videos or animations to avoid sports injuries; Record the progress of each exercise session, follow up on the progress, and adjust the plan according to the patient's acceptance of the exercise at any time. In addition, some high-end devices also provide personalized real-time advice on whether outdoor activities are suitable based on climate conditions and air quality index. This is equivalent to having professionals supervise and guide on the side, making exercise more scientific and reasonable.

3.3. Application of Patient Education and Medication Compliance Management

Repetitive health education is a prerequisite for improving patients' unhealthy lifestyle habits and maintaining rehabilitation effects. Mobile medical apps can provide massive, easily accessible, and repeatedly accessed educational resources in the form of graphics, images, and audiovisuals for various forms of health education, including disease-related knowledge, dietary nutrition, smoking cessation and alcohol restriction, psychological stress relief, medication knowledge, and adverse reactions. Content can be pushed in stages, synchronized with the patient's rehabilitation process, to avoid excessive information.

Medication management is an important component of cardiac rehabilitation, but compliance is often unsatisfactory. The application can assist patients in forming a good medication behavior pattern by setting medication prompts, recording medication status, and viewing medication instructions. More advanced programs can also use photo recognition to confirm whether the patient is taking medication, or detect whether the medication box is opened through the built-in Bluetooth sensor [6]. In addition, for complex medication plans, the application can also provide reminders of potential drug interactions, greatly reducing the incidence of missed or incorrect medication and ensuring the effectiveness of secondary prevention.

3.4. Social Support and Psychological Health Intervention Platform

Cardiovascular disease patients are prone to comorbidities such as anxiety and depression, and social support is crucial for their recovery. Mobile health can establish a virtual social support network. Patients can anonymously or with their real names share their experiences, express their troubles, and encourage each other in the community to alleviate their sense of shame and loneliness. At the same time, professional doctors or psychological counselors can also join the community to provide online collective psychological counseling or one-on-one psychological counseling [7]. At the same time, some apps also include functional modules such as mindfulness meditation, relaxation training, and cognitive-behavioral therapy, which guide patients to engage in self psychological regulation and assist patients in identifying and coping with negative emotions through methods such as emotional log recording and subjective evaluation of stress levels. Psychological health interventions are organically embedded into daily rehabilitation management, fully reflecting the concept of mind body

integration in cardiac rehabilitation and having positive significance for patients' comprehensive prognosis.

4. OPTIMIZATION AND DEVELOPMENT STRATEGIES OF MOBILE MEDICAL TECHNOLOGY IN HOME CARDIAC REHABILITATION NURSING

In summary, although mobile healthcare technology has broad prospects in the field of home heart failure management, there are still many technological, clinical, social, and policy factors that hinder its large-scale and deep level application. In the future, improvements and developments should be made in the following aspects.

4.1. Technology Integration And Intelligent Upgrading

At present, the number of mobile medical devices and software products used for home center dirty rehabilitation scenarios is gradually increasing, but there are problems such as incompatible data formats and serious information silos. For example, the same patient can wear smartwatches, smart blood pressure monitors, specialized electrocardiogram patches from different manufacturers, and installdifferent rehabilitation training apps. The data in these hardware and apps often cannot be fused and analyzed, and clinical doctors and nurses have to repeatedly search through multiple pages.The collection of information is always manual, which takes more time, labor-intensive, easy to omit, so that there are huge information barriers. Not only will it increase the workload,but it prevents from a global and continual monitoring of the patient’s healing state.The most important thing is the establishment of one single general-purpose and high-interoperability database. This platform needs to be able to connect several widely-used health terminals together and integrate and gather essential information from various resources, including the information about the vital signs, exercise status, medications and so on., and standardize and organize this information [8]. At the same time, based on this, complete the functional chain of data collection, data analysis, information push, and intervention guidance. If the platform detects thatthe patient has a high heart rate during the activity period and the patient complains of mild dizziness and discomfort, it can promptly remind the patient to rest and push the warning information and corresponding data to the responsible rehabilitation therapist for remote judgment and analysis. Additional use of big data analytics and datamining approaches could help move AML from passive observersto active players, for example, using machine learning to build up a risk evaluation model for predicting the possibility of adverse event occurrence among patients ahead, and delivering customized treatments depending upon patients’ physical conditions, daily activity routines, and preferences. Dynamically vary push exercise’s frequency and forme prescriptions and educational content; Simultaneously studying the application of natural language processing to analyze textual information during patient interactions, automatically generating the patient's emotional state and potentialquestions as a reference for timely psychological intervention.

4.2. Personalization and Precision

Although traditional rehabilitation treatment plans have certain models, they are difficult to meet the huge differences in physiological, psychological, and social needs of patients. One of the development trends of mobile health is the shift from homogeneous treatment plans to highly personalized and precise treatments. The highly personalized implementation depends on the highly integrated information [9]. In addition to common clinical and monitoring information, this information should also gradually include biomarker data such as genomics and metabolomics that can reflect individual physiological characteristics, in order to reveal potential differences in drug effects and exercise benefits;And an individual's schedule activity patterns, personality psychological

traits, social support background, etc. constitute their digital persona, which is also very important. By integrating different types of omics data and digital portrait, it has a chance to create individualized digital twin of patients, simulating and predicting effects of various interventions (e.g., change in intensity of exercises, medications) in the virtual world, thus offering patients the best and most current recovery plans that exist in the real world. The working interface and mode of the app need to consider different user requirements, for elderly persons or users with poor computer skills, it should be considered the use of large fonts layout, simple and user-friendly features, speech interaction, click on buttons and so on for aging adaptation; Content display format should consider more inclusive ways of displaying content for users in other countries. At the same time, the system should have a certain customizable setting function, giving patients a certain degree of autonomy in setting rehabilitation training goals while ensuring safety, in order to enhance patients' sense of control and compliance.

4.3. Multidisciplinary Collaboration and Standardized Construction

Home rehabilitation is a systematic project that can only be completed through close collaboration between cardiologists, rehabilitation therapists, nursing staff, nutritionists, psychological counselors, and other related disciplines. The mobile Internet platform should be one of the main means of communication among relevant disciplines, not only limited to the patients' APP applications. A reasonable cross-discipline cooperation platform should be able to clarify the permission of each role, so that each role can obtain the corresponding data and function. Including secure team communication, task assignment, and case study capabilities to assist workflow implementation, promote alignment and unity of treatment plans, and track critical work flow and communication for safe patient care and team productivity. But all of this relies on strong standardized foundational support. Currently, however, no consensus exists with respect to quality requirements and how data outliers are determined or alarms processed, and lack of standardization in home monitoring equipment itself as well as its use (e.g., remote supervisor training), creating risk to quality and patient safety and preventing standardized service development. Therefore, it is recommended that the society, industry associations, and management departments develop corresponding guidelines and standards as soon as possible. Thirdly, we need to carry out large-scale and high-quality clinical research to produce a large amount of high quality evidence on the efficacy of, safety, and economy of mobile health care interventions by offering evidencebased medical support in developing and updating clinical guidelines, ensuring scientific-effective and reasonable application of mobile medical care in home mental health, so as to promote its promotion and implementation as a reliable and feasible daily practice.

4.4. Policy Support and Sustainable Development Path

The large-scale development of mobile healthcare requires strong policy support and clear payment mechanisms. The health administrative department should promptly introduce relevant regulations on the admission and certification of remote medical and digital therapy products, as well as network security and confidentiality [10]. Attempt to include verified and safe digital rehabilitation technologies in the medical or commercial insurance directory, therefore, we need reasonable payment methods to encourage hospitals and suppliers to join; We also need to consider the issue of the digital divide and ensure that we do not deprive certain populations of their right to health due to a lack of devices and networks; Finally, we need a sustainable ecosystem driven by government agencies, hospitals, businesses, patients, and communities to promote the transition of mobile healthcare home heart failure rehabilitation models from experimental to normalized.

5. CONCLUSION

MHRT is changing the model of home CR and improving its accessibility, compliance, and management through remote monitoring, counseling, education, and psychological counseling, providing a solution to the global burden of chronic CVD disease. Previous studies have shown initial success and high acceptance of mHRT. However, in order to achieve the maximum application of deep integration of all elements, there are still many obstacles such as technological integration degree, clinical evidence support, standardization construction, and payment mechanism. In the future, there is a need for collaborative efforts between industry, academia, research, medicine, and government to promote technological intelligence, precision, and humanization upgrades, improve relevant standards, regulations, and policy systems, establish a data-driven, multidisciplinary team collaboration smart home style cardiac rehabilitation new paradigm that meets patient needs, and improve the long-term prognosis and quality of life of a large number of heart disease patients.

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