



REVIEW

Technological innovations in cardiac rehabilitation: effectiveness and impact on patient's quality of life

Innovaciones tecnológicas en rehabilitación cardíaca: eficacia e impacto en la calidad de vida del paciente

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ABSTRACT

Introduction: today, the issue of effective rehabilitation of patients after ischemic damage to the heart muscle is relevant in connection with the annual increase in the number of patients with chronic cardiovascular pathology.

Objective: to establish modern effective methods of cardiorehabilitation through a literature search.

Methods: a review of the literature on the topic of innovations in cardiorehabilitation using databases: GoogleScholar, PubMed, Web of Science, Scopus was carried out using the survey and system analysis method. These methods provide the possibility of remote monitoring of patients with chronic cardiovascular diseases using telemonitoring, which encourages patients to monitor the state of the cardiovascular system based on ECG, blood pressure, and oximetry. Telecardiorehabilitation is a modern method that has been widely implemented in the last 10 years, and especially during the outbreak of the COVID-19 pandemic. Taking into account that after discharge from the hospital, elderly people sometimes find it difficult to get to rehabilitation centers or work in groups.

Development: as an alternative, specialists found the possibility of physical rehabilitation with a set of exercises at home and constant monitoring with the help of smart technologies. The introduction of modern techniques increased the percentage of patients who were involved in cardiorehabilitation, which reduced mortality rates and positively affected the quality of life of patients.

Conclusions: the implementation of telemonitoring and telecardiorehabilitation in the conditions of aging population and increasing share of patients with chronic course is a very promising direction of modern rehabilitation.

Keywords: Cardiovascular Diseases; Physical Activity; Rehabilitation Program; Heart Health; Medical Innovations; Cardiac Therapy.

RESUMEN

Introducción: hoy en día, la cuestión de la rehabilitación eficaz de los pacientes después de una lesión isquémica del músculo cardíaco es relevante en relación con el aumento anual del número de pacientes con patología cardiovascular crónica. El objetivo de nuestro estudio fue establecer métodos modernos y eficaces de cardiorrehabilitación mediante una búsqueda bibliográfica.

Métodos: se realizó una revisión de la literatura sobre el tema de innovaciones en cardiorehabilitación utilizando bases de datos: GoogleScholar, PubMed, Web of Science, Scopus mediante el método de encuesta y análisis de sistemas. Estos métodos brindan la posibilidad de realizar un seguimiento remoto de pacientes con enfermedades cardiovasculares crónicas mediante telemonitorización, que anima a los pacientes a controlar el estado del sistema cardiovascular basándose en ECG, presión arterial y oximetría. La telecardiorrehabilitación es un método moderno que se ha implementado ampliamente en los últimos 10 años, y especialmente durante el estallido de la pandemia de COVID-19. Teniendo en cuenta que, tras el alta hospitalaria, las personas mayores en ocasiones tienen dificultades para llegar a los centros de rehabilitación o trabajar en grupo.

Desarrollo: como alternativa, los especialistas encontraron la posibilidad de la rehabilitación física con una serie de ejercicios en casa y un seguimiento constante con la ayuda de tecnologías inteligentes. Los estudios clínicos realizados han establecido un efecto positivo en los indicadores de salud física y mental en comparación con los pacientes que no pasaron por la fase ambulatoria de rehabilitación física.

Conclusiones: La implementación de la telemonitorización y la telecardiorrehabilitación en condiciones de envejecimiento de la población y una proporción cada vez mayor de pacientes con un curso crónico es una dirección muy prometedora de la rehabilitación moderna.

Palabras clave: Enfermedades Cardiovasculares; Actividad Física; Programa de Rehabilitación; Salud del Corazón; Innovaciones Médicas; Terapia Cardíaca.

INTRODUCTION

According to WHO data, cardiac disease (CVD) ranks first among the world's leading causes of mortality. The nosologies that are most often diagnosed include ischemic heart disease (IHD) and stroke. Among the population of Ukraine and Europe, CVD remains the first cause of mortality (about 60.2 %).⁽¹⁾ The key is to lose preventive nutrition before the recurrence of myocardial infarction (MI) after successful cardiac resuscitation, since the risk of developing a recurrent episode of MI is approximately 25 % in patients, that is already looming in the anamnesis of IM. In this case, the level of respect for secondary prevention of IM increases.⁽²⁾ The growth of the world's population, of which 25 % are people aged 0-14, 65 % are aged 15-64 and 10 % are aged 65+ requires investment in health care, support and specialized care for the elderly people.⁽³⁾

Although theoretical approaches are described in detail in protocols and clinical settings, they are insufficient for practical treatment, due to insufficient understanding of the pathophysiological processes, the cascade of which is launched as a result of changes in the architectonics of the heart meat during the period between the first troubling episode of hypoxia and the formation of a connective tissue scar.⁽⁴⁾ Other risk factors for the development of recurrent myocardial infarction include low patient compliance, lack of awareness of the possible risks of recurrent myocardial infarction, calling the patient to pain symptoms and the threshold of sensitivity to pain, psychological reasons – depression after an episode of myocardial infarction, depending on the probability and inevitability strike again.⁽⁵⁾ Stressful factors create psychotraumatic situations and negatively affect the assimilation of information and recovery processes.⁽⁶⁾

Looking at the most important factors, there is a need to formulate advanced respect before post-factual rehabilitation, actively training the patient before the program for updating the functions of the body, in cooperation with cardiologists, family doctors, psychologists, etc.⁽⁷⁾ At the center of the respect of doctors and successors is the lack of effective integration of physical rights with modern digital technologies.⁽⁸⁾ Cardiorehabilitation itself after treatment of patients with cardiovascular pathology is an important factor that can reduce mortality, disability and return patients to valuable life.^(9,10)

METHODS

A review of scientific publications over the past 5 years on the topic of this study was conducted. To search for literature sources, databases and search engines were used: Web of Science, Scopus, PubMed and Google Scholar using key words on the research topic: medical technologies, cardiovascular diseases, motor activity, rehabilitation program, heart health, medical innovations, cardiotherapy, patient rehabilitation, functional diagnostics. Relevant articles were selected for the review, which corresponded to the content and had full texts freely available in English: review articles, meta-analyses, experimental studies. Generalization and systematization of the obtained data was carried out using the survey method and the system analysis method.

DEVELOPMENT

The complex of rehabilitation approaches includes drug therapy, surgical assistance if necessary, and

consultation with specialists to change the way of life and improve physical and psychological health. Social factors can be the cause of psychoemotional instability, which is important for effective rehabilitation.⁽¹¹⁾ Physical rehabilitation is one of the key factors in a successful postoperative period in patients with CVD.⁽¹²⁾ In cardiac patients, physical activity is increased, which begins in the early postoperative period.⁽¹³⁾

This is a complex of physical exercises that begins with the upper ends of the legs in a sitting position on a bed with walking movements in the appearance of stepping with gatherings up to a lasting walk of 500 m 3-4 times per day in the postoperative period.⁽¹⁴⁾ Physical exercise leads to increased hemodynamics and decreased myocardial velocity.⁽¹⁵⁾ It is important to activate extracardial mechanisms, such as enhancing the short-term function of the lower end muscles, which increases venous flow to the right half of the heart; strengthening the role of the diaphragm in the regulation of blood flow, for the restoration of respiratory rights.⁽¹⁶⁾ One of the current methods that has become popular among a large number of patients around the world is the Scandinavian walk, which has a painless effect.⁽¹⁷⁾ This method is accessible, not expensive, when walking, all groups of muscles are treated, while squeezing sticks at the muscles of the shoulder girdle and upper ends, shortening is achieved, which ensures the flow of lymph and changes stagnation and heart load.

At the current stage of rehabilitation, patients are trained to perform basic physical exercises in order to prevent possible complications.⁽¹⁸⁾ At the international forum on preventive cardiology EuroPrevent 2019, which took place in Lisbon, the British representatives emphasized their respect that their research revealed greater effectiveness of physical rehabilitation over medication by 80 %. Data from the University of California show that rehabilitation of people who have suffered a heart attack reduces mortality by 25 %. Mechanotherapy on simulators remains quite effective.

For example, rehabilitation The Ergo Watch system is equipped with a cycling ergometry system for monitoring CV indicators: ECG recording, AT monitoring, heart rate readings. The simulators allow you to apply pressure individually to a specific group of muscles. The treadmills with advanced monitoring systems and recording test history data are also kept up to date.⁽¹⁹⁾ In the facilities of the equipped physiotherapeutic department, it is possible to carry out physiotherapeutic procedures: galvanization and electrophoresis, electrical stimulation, inductothermy, hydrolysis.^(20,21) The number of patients in the complex of rehabilitation visits is low in Ukraine and some European countries: so in Germany and Great Britain, only 13-40 % of patients, which is connected with reluctance to visit distant rehabilitation centers, or to work out in a group.⁽²²⁾

This prompted foreign specialists to implement telemonitoring of patients and enroll them in telecardiorehabilitation. Based on further studies, a program of regular physical exercises has eliminated regressions of left ventricle hypertrophy in post-existing patients, both from the saved and significantly changed fraction of the left ventricle (LV). As part of the visualization method, cardiac magnetic resonance is used. This method has the advantage of accuracy and the possibility of frequent errors through the risk of exchange of interest in the investigation. It is also indicated that effective cardiac output is not a residual criterion for assessing local myocardial ischemia.

The compensatory function of myocardiocytes in healthy heart parts is not turned off, which can be reflected in the indicators of effective cardiac dysfunction, when the ischemic part is often caused by the process of cardiac shortening. In addition to this fact, it is necessary to note that cardiac shortening occurs in different areas, through which visualization techniques quickly improve the epicardium and endocardium. Using a randomized follow-up study, the effectiveness of treatment was used to compare the effectiveness of treatment of patients who took part in the physical training program and compared with the standard of treatment with drugs and patients who did not take part in the physical rehabilitation program.⁽²³⁾

The basis of the physical rehabilitation program is a gentle position on the running path with advanced preparation before their execution (walking and short warm-up). The right ones were performed under the supervision of a nurse. The diagnostic criteria included indicators of the index of impairment of local myocardial velocity, as well as indicators of the fraction of the left ventricle, left ventral systolic volume and left ventral diastole. The virtual baths were carried out for the benefit of patients for 4 days using uncontrolled cardio-magnetic resonance. All patients previously underwent coronary angioplasty.⁽²⁴⁾

The data were evaluated using the IBM SPSS statistics (Statistical Package for Social Sciences) method. Based on the results of the follow-up, it was established that a complex of regular training combined with therapeutic treatments had a positive impact on the indicators of the left ventricle fraction, an index of impaired local myocardial velocity. As for left ventricular end-diastolic and systolic volumes, no significant changes in these parameters were recorded, which may be evidence of the impaired ability of cardiomyocytes to stretch, as well as the phenomenon of post-hypoxic rigidity of the heart muscle.

No daily changes were recorded in the most predictable indicators among the participants in the control group, which is conclusive evidence of the need for a complex of regular gentle physical training for more effective rehabilitation. and post-factual patients.

A large percentage of patients with a history of myocardial infarction sometimes deliberately refuse to participate in rehabilitation programs, motivating their choice by physical and moral exhaustion in the early

post-infarction period, the ease of taking cardiac drugs, and a low level of trust in hospital staff.⁽²⁵⁾

Over the past 10 years, the method of telecardiorehabilitation has become increasingly popular. Of particular importance is this method of recovery from the fate of the COVID-19 pandemic.⁽²⁶⁾ This method significantly expands patients' access to rehabilitation in their own environment without the additional stress that can come from being in a hospital.⁽²⁷⁾ And in people's minds, the development of current technologies can be helped by their availability in a more compliant patient. Similar cardiac rehabilitation tests were carried out by Ukrainian researchers on the basis of one of the Kiev clinics. The rehabilitation program included patients up to 70 years old with ischemic heart disease, who were included in the group of low and moderate risk.

Patients with complex cardiovascular pathologies could not participate in the program. Rehabilitation included 24 classes and was carried out partly on the basis of a leisure center at the place of residence of the patients, and then by the patients themselves using digital technologies of the smartphone application (Leap Fitness Group) with weekly consultation by a physical therapist. Analysis of the results revealed that patients who did not undergo rehabilitation had no small changes in the quality of life, and indicators of the quality of life after undergoing cardiac rehabilitation significantly improved, especially with little impact on the physical component of health by 13 % and by 4 % the mental component of health improved.

The results of cardiac rehabilitation are optimistic, but the selection of participants and the inclusion of patients with moderate and low risk group were small, and the trial value of the experiment was also low.⁽²⁸⁾

The Americans are now planning to conduct more representative studies of an increased number of patients who are ready to take part in the investigation.⁽²⁹⁾ One of the tools for successful rehabilitation is the smartphone as the most accessible high-tech device for everyday people.⁽³⁰⁾ This research encouraged a group of researchers from Johns Hopkins University and Apple to conduct a randomized controlled trial.

A characteristic feature of this research is the desire of post-infarction patients for self-service applications on a smartphone, as well as Bluetooth-connected devices. Corrie's study followed the fate of 1,064 patients with a history of heart attack. Corrie HCR aims to test the effectiveness of new technologies in patients who have experienced different types of cardiac events, including: myocardial infarction, coronary angioplasty, aorto-coronary bypass. The purpose of this study is to evaluate the results of patients using additional technological methods to improve the performance of the cardiac function and the overall improvement of the vitality of life. The effectiveness can be verified using an additional 6-step walking test (after 12 long-term rehabilitation programs).

It is also possible to evaluate the risk of development of cardiac functions in the future.⁽³¹⁾ The randomized study includes 200 patients undergoing rehabilitation at Johns Hopkins Health System (Johns Hopkins Hospital, Johns Hopkins Bayview Medical Center, Howard County General Hospital, and Suburban Hospital). The final group included patients from different races, similar to their 100-acre warehouse in the structure population in the United States.^(32,33) Participants in the physical rehabilitation program for goiters are required to take special rights 2-3 times per day. The total number of training sessions is 36 sessions. Corrie is accompanying the patient during the ongoing experiment. The addition looks for the following aspects: life displays, faces, mood displays, encouragement of healthy progress, etc. Other technical equipment was available: Omron BP monitor, Apple Watch, and Fitbit Versa collecting BP, heart rate, and step count.⁽³⁴⁾

In order to continue the cardiorehabilitation program, participants are taught self-control and training at home, obligatory and on the basis of medical centers for 2 sessions to provide basic consultations. progress assessments. Participation in the experiment is encouraged if risks for the development of cardiac functions are revealed.⁽³⁵⁾ A detailed analysis of the participant's vital signs and assessment of his progress allows the clinician to give the participant specific recommendations to improve results.⁽³⁶⁾

It is important to avoid feeding the participants at home, so that additional risks of cardiac conditions can be identified.⁽³⁷⁾ Participants are encouraged to telephone their supervisors in order to convey the necessary instructions and direct interaction with the patient, as well as reinforce the importance of prompt response to alarming symptoms, such as: sudden chest pain and shortness of breath.⁽³⁸⁾

In conclusion, it can be said that Corrie HCR follow-up can become an alternative rehabilitation program. One of the key features of this cardiac rehabilitation program is the presence of participants at home, which is the main reason for participation in the program for rich patients. Another characteristic of the innovativeness of Corrie HCR is the ease of recording data, fragments of vital signs, necessary insertions before receiving drugs, monitoring the patient's progress is recorded on the basis of software smartphone security.

Patients may encounter a number of difficulties, among which the participants lack the right to make an unsatisfactory recommendation through the lack of visibility from the side to the medical staff.⁽³⁹⁾ The social factor can also play a big role, such as the presence of other participants in the seminar. Undergoing cardiac rehabilitation with other participants may become more effective through "fighting for the right to sleep", as well as the mutual exchange of information between participants.⁽⁴⁰⁾

The key to successful cardiac rehabilitation is the treatment of the patient himself before he can be seen. Based on statistics, the incidence of myocardial infarction is directly proportional to increasing age.⁽⁴¹⁾

The difference in the established flight limit between the countries of Europe and Central Asia is colossal. So in Europe, the figures reach 75 years, while in Iran, people who have reached 60 years of age already enter the summer age. It also means that approximately 80 % of patients who meet the criteria for participation in the cardiac rehabilitation program are not eligible to participate in the program. Some investigators speak of the formulated indicators of “inner strength” and “strength to renew strength” as evidence for cardiorehabilitation. According to Gholami, the relationship between the study participants in cardiac rehabilitation intervention programs and increased internal strength is insignificant, or burned out on a daily basis.⁽⁴²⁾

In parallel with the randomized follow-up of the intervention program, 56 people participated in the demonstration of internal strength and until the renewal of strength. All participants met the following criteria: aged 60 years or more, discharged after acute myocardial infarction, presence of caretaker in the homeland, with the necessary minimum knowledge of using a smartphone, in absence of severe concomitant pathology

The level of inner strength was also assessed using a questionnaire presented to the participants. The questionnaire consists of 27 questions. Participants need to score a minimum of 27 points. This indicator corresponds to a low level of internal strength. 135 points correspond to the maximum number of points (high level of internal strength). As for the indicator of recovery ability, it was also determined using the survey method. Accordingly, participants could earn 0-100 points for all 25 questions.

The results of this investigation may provide additional evidence that medical personnel are actively involved in successful cardiac rehabilitation. The absence of a statistical difference in the control group before and after the experiment probably indicates that the correlation between the implementation of the physical training program and the indicators of internal strength and the ability to recover is statistically insignificant or absent.⁽⁴³⁾

Post-infarction rehabilitation is a complex and step-by-step process that requires the participation of specialists in a variety of fields: cardiologists, rehabilitation therapists, physiotherapists, psychotherapists, etc. Post-infarction patients, especially elderly patients, face a high number of calls when they become participants in cardiac rehabilitation programs.⁽⁴⁴⁾ Some start the course without any particular responsibility and do not place any special hopes on the result, while others are faced with the problem of too many tasks, as a result of which they take part in the program.

The presence of a curator or mentor stimulates the participant to the highest level of compliance, and the digital warehouse of the program greatly facilitates the interaction between the participant and the mentor.⁽⁴⁵⁾

Regardless of the recent development of digital technologies and improved cardiac rehabilitation programs, the number of episodes of repeated myocardial infarction is increasing. This is partly due to insufficient modification of the way of life and turning to the extreme.

This problem is encountered in modern Korea, which prompted researchers to evaluate the capacity of cardiac rehabilitation services based on cardiac rehabilitation centers. For the analysis, the following indicators were selected: those that were followed in the procedures (types, strength, coarseness of the program). The assistance of a specially designed hospital included: warehouse programs, cardiorehabilitation, care, depth of burial, etc.

The study was carried out at 12 cardiac rehabilitation centers and was aimed at the personnel of cardiological, cardiac surgery and rehabilitation departments.⁽⁴⁶⁾

Based on the results of the investigation, it was established that such indicators as: assessment of risk factors, recognition of cardiorehabilitation rights, monitoring of the risk of health problems were also in the high level.⁽⁴⁷⁾ On the other hand, it was found that the psychological component of cardiorehabilitation was developed much worse. Indicators of assessment of professional counseling, as well as the level of stress management and general psychological assessment were qualified as low (42 %, 50 % and 33 %, respectively).

The analysis of literary sources showed that in the vast majority of studies, the early start of rehabilitation, which includes a complex of physical exercises, significantly improves and stabilizes the state of the cardiovascular system: it improves the cardiac output fraction of the left ventricle, normalizes central venous pressure, which stabilizes the performance of the cardiovascular system: blood pressure, heart rate, ECG indicators. Physical rehabilitation covers the inpatient and outpatient period. It is important to start cardio rehabilitation after the patient is discharged from the hospital.⁽⁴⁸⁾

Thus, patients with heart failure and with a preserved ejection fraction have features of adaptation to physical exertion: the increased elasticity of the left ventricular chamber disrupts relaxation, which increases the pressure in the pulmonary capillaries and causes significant shortness of breath at light exertion. Changes in blood vessels in such patients reduce tolerance to physical exertion, and changes in the composition and functioning of skeletal muscles sometimes add to the negative effects of physical exertion.⁽⁴⁹⁾ This indicates the need to develop other effective methods, so one of such approaches was the introduction of interval training, which improved tolerance to physical exertion. Specialists are unanimous in their opinion that cardiorehabilitation is the method that will develop and improve in today's aging population.

In the clinical aspect, it means faster recovery, improvement of the general condition of the patient. The

organization of cardiorehabilitation methods at the current stage is in the stage of formation. There are no approved rehabilitation protocols for all components of this process. Medical rehabilitation remains the most understandable for patients after surgical interventions or ischemic attacks, but in the last 10 years, physical rehabilitation has demonstrated significant success.

Such methods of rehabilitation usually increase the access of a larger number of patients to recovery, since this method does not have such a financial burden on patients. But in the analyzed sources of literature, there was practically no emphasis on research into the psycho-emotional sphere of patients with CVD, although one of the reviews indicated that up to 70 % of patients have disorders in the form of anxiety and depression, which worsens the prognosis for recovery.^(50,51)

CONCLUSIONS

According to the literature, the use of innovative technologies in cardiorehabilitation had a significant impact on the recovery process of patients after heart attacks and ischemic attacks and contributed to prolonging life expectancy, restoring physical activity and generally improving the quality of life. The use of telemedicine for the purpose of constant monitoring of the patient's condition, as well as the connection of software on a smartphone, creates opportunities for patients to monitor their condition themselves and notify specialists in a timely manner in case of deterioration.

The development of complex physical activity and the addition of telecardiorehabilitation, which can be carried out remotely using online technology, increased the share of patients who joined such programs. Such innovations in cardiorehabilitation reduce the possibility of repeated ischemic attacks and return patients to a full life. Despite the numerical advantages, questions remain unanswered: creation of simplified programs for use by patients, individual approach in physical cardiorehabilitation, security of personal data

REFERENCES

1. Qin S, Tian Z, Boidin M, Buckley BJR, Thijssen DHJ, Lip GYH. Irisin is an effector molecule in exercise rehabilitation following myocardial infarction (review). *Front Physiol.* 2022; 13:935772. doi: 0.3389/fphys.2022.935772
2. Xu M, Jiang H, Xiao J. Exercise protects sympathetic stress-induced myocardial fibrosis by regulating cytokines. *J Cardiovasc Transl Res.* 2020; 13:570-1. doi: 10.1007/s12265-019-09933-x
3. Chovhaniuk O, Bashkirova L, Meleha K, Yakymenko V. Study of the state of health in the conditions of constant numerous transitional and intermediate stages. *Futurity Med.* 2023; 2(2), 26-33. doi: 10.57125/FEM.2023.06.30.03
4. Tršan J, Košuta D, Rajkovič U, Fras Z, Jug B and Novaković M. Vascular function in patients after myocardial infarction: the importance of physical activity. *Front Physiol.* 2021; 12:763043. doi: 10.3389/fphys.2021.763043
5. Ambrosetti, M., Abreu, A., Corrà, U., Davos, C. H., Hansen, D., Frederix, I., et al. Secondary prevention through comprehensive cardiovascular rehabilitation: from knowledge to implementation update. A position paper from the secondary prevention and rehabilitation section of the European association of preventive cardiology. *Eur J Prev Cardiol.* 2020: 2047487320913379.
6. Vovchenko O, Leonova I, Soroka I, Klymenko I, Tsekhmister Y. The impact of emotional intelligence on the academic performance of students with intellectual disabilities in inclusive education. *J Intellect Disab - Diagn & Treat.* 2022; 10(4):187-196. doi:10.6000/2292-2598.2022.10.04.4
7. Alemasi A, Cao N, An X, Wu J, Gu H, Yu H, et al. Exercise attenuates acute beta-adrenergic overactivation-induced cardiac fibrosis by modulating cytokines. *J Cardiovasc Transl Res.* 2019; 12:528-38. doi: 10.1007/s12265-019-09894-1
8. Dibben GO, Faulkner J, Oldridge N, Rees K, Thompson DR, Zwisler AD, Taylor RS. Exercise-based cardiac rehabilitation for coronary heart disease: a meta-analysis. *Eur Heart J.* 2023; 7;44(6):452-469. doi: 10.1093/eurheartj/ehac747.
9. Miloradova, N. Current assessment methods of investigator's psychological readiness for professional activities: improvement perspectives. *Futur Soc Sci.* 2023; 1(2), 45-58. doi: 10.57125/FS.2023.06.20.04
10. Wu M, Wang W, Zhang X, Li J. The prevalence of acute stress disorder after acute myocardial infarction

and its psychosocial risk factors among young and middle-aged patients. *Scientif Rep.* 2022; 12:7675

11. Lazorko O, Overchuk V, Zhylin M, Bereziak K, Savelchuk I. Modern types of psychological correction and their practical application. *System Rev Pharm.* 2020; 11(11):1316-1322 doi: 10.31838/srp.2020.11.186

12. Kostenko VP, Balazh MS. The use of modern information technology in cardiac rehabilitation: a review of foreign experience. *Sports Medic & Physical Rehab.* 2020; 1:111-1114. doi: 10.32652/spmed.2020.1.111-114

13. Pelliccia A, Sharma S, Gati S, Bäck M, Börjesson M, Caselli S. *et al.* 2020 ESC guidelines on sports cardiology and exercise in patients with cardiovascular disease. *Eur Heart J.* 2020; 42:17-96. doi: 10.1093/eurheartj/ehaa605

14. Suiuebekov B, Yeshmanova A. New research and changing paradigms of coagulopathy in children after cardiac surgery: A narrative review. *Futur Medic.* 2022; 1(1):29-36. doi: 10.57125/FEM.2022.03.25.03

15. Kostenko VP, Balazh MS. Effects of cardiac rehabilitation with the use of telemedicine technologies on the quality of life of people with coronary heart disease. *Sports Med & Phys Rehab.* 2021; 2:78-83; doi: 10.32652/spmed.2021.2.78-83

16. Prabhakaran D, Chandrasekaran AM, Singh K, Mohan B, Chattopadhyay K, Chadha DS, *et al.* Yoga-based cardiac rehabilitation after acute myocardial infarction: a randomized trial. *J Am Coll Cardiol.* 2020; 75:1551-61. doi: 10.1016/j.jacc.2020.01.050

17. Elshazly A, Hasan R.L., Saleh MA, Ibrahim AS, Khorshid H. Impact of exercise training on myocardial contractile functions assessed by cardiac magnetic resonance in post-myocardial infarction patients. *The Egypt Heart J.* 2022; 74:51. doi: 10.1186/s43044-022-00288-4

18. Lim EJ, Kang EB, Jang ES, Son CG. The prospects of the two-day cardiopulmonary exercise test (CPET) in ME/CFS patients: a meta-analysis. *J Clin Med.* 2020; 9:4040. doi: 10.3390/jcm9124040

19. Tsekhmister Y, Stepanenko V, Konovalova T, Tsekhmister B. Analysis of physicochemical natures of modern artifacts in MRI. *Intern J Online & Biomed Engin (iJOE).* 2022; 18(03):89-100. doi: 10.3991/ijoe.v18i03.25859

20. Nykyruy Yu, Mudry S, Shtablavyi I, Borisyuk A, Tsekhmister Ya, Gnilitzkyi I. Formation of laser-induced periodic surface structures on amorphous Fe- and Co-based alloys and its impact on magnetic properties. *Materials Chem & Phys.* 2022; 287:126317. doi: 10.1016/j.matchemphys.

21. Znamenshchikov Y, Volobuev V, Kurbatov D, Kolesnyk M, Nekrasov S, Opanasyuk A. Photoresponse and X-ray response of Cd_{1-x}Zn_xTe thick polycrystalline films. 2020 IEEE KhPI Week on Advanced Technology (KhPIWeek); 2020; 253-256, doi: 10.1109/KhPIWeek51551.2020.9250105.

22. Turk-Adawi K, Supervia M, Lopez-Jimenez F, Pesah E, Ding R, Britto RR, Bjarnason-Wehrens B, Derman W, Abreu A, Babu AS, *et al.* Cardiac rehabilitation availability and density around the globe. *E Clin Medic.* 2019; 13: 31-45.

23. Maddison R, Rawstorn JC, Stewart RAH, Benatar J, Whittaker R, Rolleston A, Jiang Y, Gao L, Moodie M, Warren I, Meads A, Gant N. Effects and costs of real-time cardiac telerehabilitation: randomised controlled noninferiority trial. *Heart.* 2019, Jan;105(2):122-29. doi: 10.1136/heartjnl-2018-313189.

24. Alkhalil M, Borlotti A, De Maria GL, Wolfrum M, Dawkins S, Fahrni G, *et al.* Hyper-acute cardiovascular magnetic resonance T1 mapping predicts infarct characteristics in patients with ST elevation myocardial infarction. *J Cardiovasc Magn Reson.* 2020; 22:3. doi: 10.1186/s12968-019-0593-9

25. Shi X, Chen X, Qiu X, Luo W, Luo X, Liu H, Geng Q, Ma H, Xue L, Guo L. Effect of high-intensity interval training, moderate continuous training, or guideline-based physical activity on peak oxygen uptake and myocardial fibrosis in patients with myocardial infarction: protocol for a randomized controlled trial. *Front Cardiovasc Med.* 2022; 9:860071. doi: 10.3389/fcvm.2022.860071

26. Zhylin M, Makarenko S, Kolohryvova N, Bursa AI, Tsekhmister Y. Risk factors for depressive disorders

after coming through COVID-19 and emotional intelligence of the individual. *J Intellect Disab - Diagn & Treatm.* 2022; 10(5). <https://doi.org/10.6000/2292-2598.2022.10.05.6>

27. Shahrour G, Dardas LA. Acute stress disorder, coping self-efficacy and subsequent psychological distress among nurses amid COVID-19. *J Nurs Manag.* 2020; 28(7): 1686-1695; DOI: 10.1111/jonm.13124

28. Shvets AV, Kikh AYU, Volyansky OM, Saliev AYU, Horishna OV. Rehabilitation of cardiological and cardiosurgical patients in modern conditions: possibilities and military health care problems. *Physic Rehab, Phys Therapy, Occupat Therapy.* 2022; 1(63):100-108; doi: 10.24144/2077-6594.1.1.2021.227163

29. Virani SS, Alonso A, Benjamin EJ, Bittencourt MS, Callaway CW, Carson AP, et al. Heart disease and stroke statistics-2020 update: a report from the American Heart Association. *Circulation* 2020; 141:e139-596.

30. Yudi MB, Clark DJ, Tsang D, Jelinek M, Kalten K, Joshi SB, Phan K, Ramchand J, Nasis A, Amerena J, et al. SMARTphone-based, early cardiac REHABilitation in patients with acute coronary syndromes: a randomized controlled trial. *Coron Artery Dis.* 2021;32:432-440. doi: 10.1097/MCA.0000000000000938

31. Patti A, Merlo L, Ambrosetti M, Sarto P. Exercise-based cardiac rehabilitation programs in heart failure patients. *Heart Fail Clin.* 2021 Apr;17(2): 263-271. doi: 10.1016/j.hfc.2021.01.007

32. Yatsenko N. The philosophical content of the definition of the national mentality. *Futurity Philosophy* 2022; 1(1): 41-56. doi: 10.57125/FP.2022.03.30.04

33. Yang WE, Spaulding EM, Lumelsky D, Hung G, Huynh PP, Knowles K, Marvel FA, Vilarino V, Wang J, Shah LM, et al. Strategies for the successful implementation of a novel iPhone loaner system (iShare) in mHealth interventions: prospective study. *JMIR Mhealth Uhealth.* 2019;7:e16391. doi: 10.2196/16391

34. Mathews L, Brewer LC. A review of disparities in cardiac rehabilitation: evidence, drivers, and solutions. *J Cardiopulm Rehabil Prev.* 2021; 41:375-382. doi: 10.1097/HCR.0000000000000659

35. Isakadze N, Kim ChH, Marvel FA, Jie J, MacFarlane Z, Gao Yu, Erin M, Stewart KJ. Rationale and design of the mTECH-rehab randomized controlled trial: impact of a mobile technology enabled corrie cardiac rehabilitation program on functional status and cardiovascular health. *J Am Heart Assoc.* 2024; 13:e030654. doi: 10.1161/JAHA.123.030654

36. Mahanova TV, Tkachenko NA, Popovych VP. A study to evaluate willingness to pay using Van Westendorp's method on the example of contraceptives. *J Appl Pharmac Sci.* 2022; 12(5): 178-186. doi: 10.7324/JAPS.2022.120516

37. McMahon SR, Ades PA, Thompson PD. The role of cardiac rehabilitation in patients with heart disease. *Trends Cardiovasc Med.* 2017 Aug; 27(6):420-425. doi: 10.1016/j.tcm.2017.02.005

38. Bozkurt B, Fonarow GC, Goldberg LR, Guglin M, Josephson RA, Forman DE, Lin G, Lindenfeld J, O'Connor C, Panjrath G, Piña IL, Shah T, Sinha SS, Wolfel E. Cardiac rehabilitation for patients with heart failure: JACC expert panel. ACC's heart failure and transplant section and leadership council. *J Am Coll Cardiol.* 2021 Mar 23; 77(11):1454-1469. doi: 10.1016/j.jacc.2021.01.030.

39. Iastremska O, Tryfonova O, Mantaliuk O, Baranets H. The impact of strategic decisions on the future development of organisations and economic dynamics. *Futur Econom & Law.* 2023; 3(4): 117-134. <https://doi.org/10.57125/FEL.2023.12.25.08>

40. Beatty AL, Brown TM, Corbett M, Diersing D, Keteyian SJ, Mola A, Stolp H, Wall HK, Sperling LS. Million hearts cardiac rehabilitation think tank: accelerating new care models. *Circ Cardiovasc Qual Outcomes.* 2021; 14:e008215. doi: 10.1161/CIRCOUTCOMES.121.008215

41. Heine M, Turk-Adawi K, Supervia M, Derman W, Lopez-Jimenez F, Naidoo P, Grace SL. Cardiac rehabilitation delivery in Africa. *Cardiovasc J Afr.* 2019 May/ Jun 23; 30(3):133-137. doi: 10.5830/CVJA-2019-011

42. Alhumaid W, Small SD, Kirkham AA et al. A contemporary review of the effects of exercise training on

cardiac structure and function and cardiovascular risk profile: insights from imaging. *Front Cardiovasc Med.* 2022; 9:753652

43. Smith JR, Thomas RJ, Bonikowske AR, Hammer SM, Olson TP. Sex differences in cardiac rehabilitation outcomes. *Circ Res.* 2022 Feb 18; 130(4):552-565. doi: 10.1161/CIRCRESAHA.121.319894.

44. Baman JR, Sekhon S, Maganti K. Cardiac rehabilitation. *JAMA.* 2021 Jul 27; 326(4):366. doi: 10.1001/jama.2021.5952.

45. Josephson RA. Cardiac rehabilitation. *Prog Cardiovasc Dis.* 2022 Jan-Feb;70:1. doi: 10.1016/j.pcad.2022.01.010.

46. Kim C, Sung J, Han J-Y, Jee S, Lee JW, Lee JH, Kim W-S, Bang HJ, Baek S, Joa K-L, et al. Current status of cardiac rehabilitation in the regional cardiocerebrovascular centers in Korea. *J Clin Med.* 2021; 10:5079. doi: 10.3390/jcm10215079

47. Squires RW, Bonikowske AR. Cardiac rehabilitation for heart transplant patients: Considerations for exercise training. *Prog Cardiovasc Dis.* 2022 Jan-Feb; 70:40-48. doi: 10.1016/j.pcad.2021.12.003.

48. Yang Z, Zheng X, Hu N, Zhang F, Wang A. "Challenges to Normalcy"- perceived barriers to adherence to home-based cardiac rehabilitation exercise in patients with chronic heart failure. *Patient Prefer Adherence.* 2023; Dec 21;17:3515-3524. doi: 10.2147/PPA.S440984. PMID: 38146500; PMCID: PMC10749573.

49. Tucker WJ, Angadi SS, Haykowsky MJ, Nelson MD, Sarma S, Tomczak CR. Pathophysiology of exercise intolerance and its treatment with exercise-based cardiac rehabilitation in heart failure with preserved ejection fraction. *J Cardiopulm Rehabil Prev.* 2020; Jan;40(1):9-16. doi: 10.1097/HCR.0000000000000481. PMID: 31764536; PMCID: PMC6928441.

50. Zhang W, Zhu G, Li B, Chen C, Zhu Y. Effect of cardiac rehabilitation therapy on depressed patients with cardiac insufficiency after cardiac surgery. *Open Med (Wars).* 2023; Nov 14;18(1):20230821. doi: 10.1515/med-2023-0821. PMID: 38025544; PMCID: PMC10656761.

51. Tatarina O. Innovations in Ukrainian medicine: priorities, directions, and forecasts. *Futur. Medic.* 2022;1(3):50-59. doi: 10.57125/FEM.2022.09.30.05

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