ABSTRACT

for the dissertation work of Kulbayeva Shynar Kambarovna on the topic: "Scientific substantiation of the conceptual approaches of remote communication of medical personnel and patients with chronic cardiovascular diseases at the level of PHC" for the degree of Doctor of Philosophy PhD in the specialty 8D10103 – "Public Health"

Relevance of the research topic. The digital and information revolution has served as a motivation for the further development of the healthcare sector around the world. The need to implement an individual patient-associated approach to human health is beyond doubt. A large number of information systems that make it possible to implement technologies for taking into account individual health characteristics can become a "platform" for developing appropriate information and telecommunication technologies (Baklaushev V.P., Archakov A.I., Moshkovsky S.A., 2014).

According to WHO (2009), one of the methods for improving the level of medical services is a measure of self-management of the patient's health. These achievements of modern technologies, which are actively used by patients and their relatives to address issues of prevention and rehabilitation, are not under the control of a medical worker.

Taking into account the active spread of various mobile technologies, measures of health self-control using mHealth technologies are presented from the economic side. The universal implementation of self-help activities is a necessity for both geographical and financial accessibility of self-help programs, an outflow of qualified personnel at the central and peripheral levels, as well as training costs (Lloyd-Jones, D.M.; Leip, E.P., et al., 2006).

An important point in the process of prevention and support of the patient is his motivated participation, where information technologies should play a significant role (Hood L., Balling R., Auffray C., et al., 2015).

As indicated in the Strategic Plan of the Ministry of Health of the Republic of Kazakhstan, in order to improve the quality of service, reduce the queue and overload of personnel, the management of primary health care organizations (PHC) will be upgraded based on improved operational management, modern queue management technologies. Taking into account the current state of public health and the predicted increase in the number of non-communicable diseases, it is important to introduce an integrated model for organizing medical care.

The development and implementation of modern remote technologies in healthcare provide an opportunity to use non-pharmacological prevention and management strategies to combat this growing burden of chronic diseases (Widmer R.J., Allison T.G., et al., 2017).

Rural health care in Kazakhstan is not left without attention, which faces serious difficulties associated with isolation (remoteness), underdeveloped infrastructure, weak material base, difficult climatic conditions, lack of medical workers and staff turnover.

In general, all of the above determines the relevance of the digitalization process for the healthcare system of the Republic of Kazakhstan, the development of mobile healthcare, which will improve the quality and efficiency of preventive programs for patients with chronic non-communicable diseases.

The purpose of the study is to evaluate and develop technologies for remote communication of medical personnel and patients with chronic cardiovascular diseases to improve the provision of medical care at the PHC level.

Objectives of the study

1. To study the bases of modern information technologies used in the management of the health status of patients with chronic non-communicable diseases at the international level.
2. To determine the level of organization of medical care for monitoring the health status of patients with chronic cardiovascular diseases in dynamics, highlighting the main areas of remote communication and the quality of medical care provided.
3. To develop the design and functionality of a mobile application, optimizing the mechanisms for routing the movement of patients with chronic cardiovascular diseases.
4. To evaluate the effectiveness of a pilot model of remote communication between medical personnel and patients with chronic cardiovascular diseases.
5. Develop a concept for remote communication and monitoring the health status of patients with chronic cardiovascular diseases and develop guidelines.

Research and materials methods

As part of the *first task* of the dissertation work, the available mobile applications, used in the primary cardiological care service, were investigated. In addition, we explored the drivers and barriers to widespread adoption of mHealth services. The study was conducted in accordance with the guidelines of the Cochrane Handbook of Systematic Reviews of Interventions, version 5.1.0. The work was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. It has been shown that mobile medical applications can help improve cardiac rehabilitation, improve adherence to treatment, exercise tolerance and endurance, reduce major cardiovascular symptoms, improve psychosocial status, and thereby reduce overall morbidity and mortality. The present review aims to analyze a range of mHealth solutions used to improve primary cardiac care. There are also factors that encourage and hinder the widespread adoption of mHealth services in clinics. The search for publications was carried out using the databases of PubMed, Web of Science, Cochrane Library, Scopus and Google Scholar, regulatory documents in the field of medical examination, medical care in PHC organizations, digitalization were studied in detail. Various remote and information technologies in the field of health care of foreign countries and their application experience were studied, as well as the stages and prospects for the use of remote technologies in the field of health care of the Republic of Kazakhstan, as part of a literature review, an in-depth analysis of 111 sources was carried out.

To accomplish the *second task*, the readiness of patients with chronic non-communicable diseases and medical specialists to use a mobile application was analyzed, and the design and functionality of a mobile application for monitoring health indicators were also studied.

This study was carried out in medical institutions in Astana, Turkestan region, North Kazakhstan region, as well as by distribution through Google platforms (online) from February 1, 2020 to May 25, 2020. According to the survey, original questionnaire questions were developed separately for medical specialists and patients, which were heard at a meeting of the department of NJSC "MUA". The questions indicated in the questionnaires received a positive conclusion from the LEC (Minutes No. 4 of 02.20.2020, No. 3 of 03.30.2022). Participation in the study was voluntary and anonymous.

At this stage, the analysis of the "Electronic Register of Dispensary Patients" portal of city and district clinics in two regions of the Republic of Kazakhstan (Turkestan and North Kazakhstan regions) was also carried out. The retrospective study was conducted for 2015-2020. The material was the data of state medical institutions (5 city and 4 region). And forecast calculations were made until 2025 for this category of morbidity. In the electronic database, they were selected according to the International Qualification of Diseases (ICD-10), the following nosologies were selected: I25 - Chronic ischemic heart disease and its nosological forms (I25.0-I25.9).

In the Turkestan region, it was chosen – UE based on the REM "Turkestan City Polyclinic" in the city of Turkestan and its branch "Birlik" in rural areas. Also the city polyclinic No. 1 in Petropavlovsk and the Taiynshinsky region polyclinic.

For *the third task*, the mobile application "My Heart" was developed, it was developed on the basis of a study of international experience, based on the results of a survey of patients and medical workers to study the wishes and suggestions and indicators of patients on dispensary records. It is available to download for Android phones. Handouts were prepared for polyclinic doctors in the form of instructions for a mobile application, where they, in their turn, explained to patients at the reception how to download and use the "My Heart" mobile application. This was at the period from December 2021 to April 2022.

To complete the *fourth task*, the patient satisfaction criteria were used to provide feedback on the effectiveness of this mobile application. 128 (North Kazakhstan region (city) – 32, village – 30; Turkestan region (city) – 35, village - 31) patients with chronic cardiovascular diseases, which are on dispensary records in polyclinics, were interviewed. Subsequently, their feedback was obtained through responses to satisfaction questionnaires. The Student Satisfaction Questionnaire was used after modifying and supplementing the items used in Kim and Hwang's study to take into account the behavioral patterns of our population. For evaluation, 17 items are included, evaluated on a five-point Likert scale for application composition, design and layout. For the usefulness of application for Cronbach's α scale reliability in this study was 0.95. The main questions included such sections as general question to the content (quality and structure of the content), usefulness of the application (usefulness of health monitoring, managing

one's own health, medication reminders, etc.), design and functionality of the application (general content and sections, accessibility, ease of download and use, content logic, registration, profile, health indicators, calendar for recording, survey results, training content, analyses).

In order to fulfill the *fifth task*, the main directions of the Concept of remote monitoring of the health status of patients with CVD were defined, where, based on the collected materials and the results of the analysis, such documents as the Concept of remote communication and monitoring of the health status of patients with chronic cardiovascular diseases and methodological recommendations were developed on remote communication and monitoring of the health status of patients with chronic cardiovascular diseases "Algorithm for managing a patient registered with a dispensary for chronic cardiovascular diseases based on the "My Heart" mobile application in Russian and Kazakh (Minutes of the Meeting of the Expert Group of the UE based on the REM "Salidat Kairbekova NRC" No. 328, No. 329 dated 22.08.2022).

The scientific novelty of the study lies in the fact that:

1. For the first time, the effectiveness of remote technologies for accompanying patients with chronic diseases was determined, including such functions as daily monitoring of health indicators, medication intake, training materials on prevention at the international level.

2. The indicators of dispensary observation according to CVD (according to ICD-10 (I25.0-I25.9)) by age and sex for the last 6 years in the context of urban and rural polyclinics of the Northern and Southern regions of Kazakhstan (Turkestan and North Kazakhstan regions) were studied. Data on the forecast of morbidity until 2025 in these regions have been obtained.

3. The assessment by respondents (health workers and patients) on the readiness to use modern remote technologies in the provision of medical care, as a dispensary observation at the PHC level in polyclinics of Kazakhstan, was studied.

4. The concept of remote communication and monitoring of the health status of patients with chronic cardiovascular diseases based on the studied materials and methodological recommendations have been developed.

Practical significance:

1. The main elements of operational management are identified, which are most effective for remote communication between medical personnel and patients.

2. The approaches and principles of remote communication between medical personnel and a patient diagnosed with chronic cardiovascular diseases are substantiated, which will optimize and improve the quality of medical care in terms of timeliness, mobility, motivated participation of the patient in the process of treatment and prevention of their health, taking into account the introduction of modern technologies.

3. Taking into account the standard of organization of medical care for patients with chronic non-communicable diseases, the mobile application "My Heart" was developed. And as a result, work has been optimized in the direction of remote prevention, monitoring the condition and treatment of the patient,

improving communication between medical personnel and the patient in the mechanisms for routing patients with CVD at the PHC level.

Theoretical significance of the study

The theoretical significance of the scientific work lies in the fact that the results of the research part of the work can be used in the further study of the development of mobile applications for other nosologies.

The analysis and results of the study are set out in the guidelines "Algorithm for managing a patient registered with a dispensary for chronic cardiovascular diseases based on the "My Heart" mobile application in Russian and Kazakh languages".

The key elements for defense:

1. According to the results of foreign scientific research, mobile medical applications can speed up and optimize the care of patients with cardiac arrest at the prehospital stage. The main purpose of mobile applications is to remotely monitor the patient's condition, increase adherence to treatment and, as a result, reduce the development of cardiovascular risk.
2. Analysis of the ERDP information system showed a low level of care and monitoring of patients with CVD, since the dynamics of the incidence of CVD over the past six years has tended to increase.
3. A survey among patients and medical workers showed their readiness to move to a new level of medical care using modern mobile devices, due to the upward trend in the number of dispensary patients with a forecast up to 2025, both in the city and in rural areas.
4. The necessity of developing the Concept of remote communication of medical personnel and patients with CVD of dispensary observation is substantiated, taking into account the measures under the current orders and recommendations for improving the quality of medical services for patients at the outpatient level.

Approbation of the dissertation:

The main results of the dissertation research were presented at the following conferences:

- The IX Annual International Scientific-practical Conference "Medicine Pressing Questions" (Baku, May 6-8, 2020);
- Materials of the XXIV International Scientific Conference "Oncology – XXI Century", X Italian-Russian Scientific Conference on Oncology and Endocrine Surgery, XXIV International Scientific Conference "Health of the Nation – XXI Century" (Istanbul, May, 2020);
- Materials of the International Online Conference "Modern Science. Management and Research Standards II" (Prague, November 17-18, 2020);
- International Scientific-practical Conference of students and young scientists "Insurance medicine. The science. Education" (Nur-Sultan, December 21-22, 2020);
- 8th International Public Health Conference 2022. The 8th International Conference on Public Health 2022 (ICOPH 2022), July 28-29, 2022 (online).

Personal contribution of the dissertation author

The collection of material was carried out independently, the author developed questionnaires, traveled to the regions and conducted the survey. The defender of this thesis organized work on the development of the mobile application platform and its testing in the regions and participated in its effectiveness evaluation at the outpatient level. At the same time, she participated in the development of the Concept and methodological recommendations.

Independently the author carried out the analysis and generalization of the obtained data, their statistical processing, respectively, writing a dissertation and scientific articles.

Implementation into practice

The platform of the "My Heart" mobile application can be used by patients registered with dispensaries in polyclinics, both in the city and in the countryside.

The developed methodological recommendation will allow specialists to get acquainted with international experience in the development of mobile applications, along with this, it will be possible to develop similar mobile applications for other nosologies.

Methodological recommendations are intended for heads of scientific departments of healthcare institutions, researchers, teachers, specialists of educational organizations, as well as doctors, residents and interns.

Publications on the topic of the dissertation

On the topic of the dissertation work, 22 publications were published, including: 3 articles in journals recommended by the Committee for Control in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 7 publications in the collections of the international conference and 3 publications in the collection of the domestic conference, 1 article was published in the journal included in international database Scopus, 4 certificates of state registration of ownership of the object of copyright No. 6975 dated 11.12.2019, No. 9345 dated 20.04.2020, No. 17428 dated 12.05.2021, No. 23535 dated 11.02.2022 and 5 Acts of implementation of the results of research work in medical organizations of the regions of the Republic of Kazakhstan. Methodological recommendations "Algorithm for managing a patient registered with a dispensary for chronic cardiovascular diseases based on the "My Heart" mobile application in Russian and Kazakh languages" were issued (Minutes of the Meeting of the Expert Group of the UE based on the REM "Salidat Kairbekova NRC" No. 328, No. 329 dated 22.08.2022).

Conclusions

1. The base of modern information technologies used in the management of the health status of patients with chronic NCDs at the international level has been studied. Mobile medical applications will improve cardiac rehabilitation, increase treatment adherence, exercise tolerance and endurance, reduce major cardiovascular symptoms, improve psychosocial status and thereby reduce overall morbidity and mortality.
2. The level of organization of the provision of medical care for monitoring the health status of patients with CVD was determined based on the analysis of the

work of the ERDP at the outpatient level in the Republic of Kazakhstan (North Kazakhstan and Turkestan regions). Consequently, where those registered in the dispensary in rural areas for 6 years (2015-2020) tended to increase (growth dynamics by 2 times), the number of patients consisted of 8117, including adults - 8009 (98.4%) and children under 17 years old - 108 (1.6%). In urban areas, the situation is similar (3 times) - 13417, including adults - 13216 (94.1%) and children under 17 years old - 201 (5.9%). In terms of social status, pensioners accounted for the largest share of 50.0%, both in urban areas and in rural areas.

3. According to the results of a questionnaire survey, patients showed their readiness to move to a new level of medical care using modern mobile devices. The analysis showed that 90.0% of respondents have a good level of mobile phone proficiency, of which more than 47.6% are registered in social networks and regularly visit such resources. 84.0% of respondents indicated that they need online consultation on taking medications, especially with side effects, as well as to assess the dynamics of their condition, recommendations.

4. According to the survey, medical workers indicated how much the treatment and diagnostic process improved using medical information systems: slightly improved – 38.0%, significantly improved – 38.0%, significantly worsened – 14.0%, did not change – 10.0%. It is better to give a patient with chronic diseases an online consultation than to take him in a polyclinic: yes, online consultation – 54.0%, no, call to a polyclinic – 46.0% of respondents.

5. The design and functionality of the mobile application covered the main points of patient registration, monitoring of health indicators, a reminder of taking medications, and, if necessary, an emergency button for an alarm call. Also, daily self-assessment of your health by zones and further recommendations based on the results. Materials are included on the training menu, on measures to prevent cardiovascular diseases. According to the results of evaluating the effectiveness of the mobile application, about 85.0% of respondents answered that they are satisfied with the composition, design, layout and usefulness of the application. They showed high satisfaction with the content, design and usability of the program.

6. The concept of remote communication and monitoring of the health status of patients with CVD and methodological recommendations “Algorithm for managing a patient registered with a dispensary for chronic cardiovascular diseases based on the mobile application “My Heart” was developed to improve the quality of medical services to patients.

Practical recommendations

1 Developers of mobile applications in the field of healthcare

1.1 To study the regulatory legal acts in the area under development on nosologies.

1.2 Analyze the protocol of patient management for a specific nosology.

1.3 When developing mobile applications in the field of healthcare, study the issue and consult with narrow specialists.

1.4 In a mandatory manner, highlight the features of managing patients of the selected nosology for subsequent high-quality remote communication.

1.5 Develop terms of reference with step-by-step explanations for monitoring participants.

1.6 Constantly keep in touch with the developer and IT specialists to clarify every detail of the Application.

1.7 Use the proposed methodological recommendation in the work, which will allow healthcare professionals to get acquainted with international experience in developing mobile applications, along with this, it will be possible to develop similar mobile applications for other nosologies.

2 District doctors (GPs) at the outpatient level

2.1 Maintain strict control over patients who have cardiac pathology, with timely taking them to the dispensary; provide the necessary laboratory and instrumental studies.

2.2 On an ongoing basis, carry out explanatory work to a patient with a high risk of developing complications or a life-threatening condition, namely, the rules of action for their development and the need to call an ambulance in a timely manner using a mobile application.

2.3 Consideration of culture change: from "guide" over the patient to the doctor's role as a mentor (assistant) who supports his patients in the process of self-management.

2.4 Participate in increasing the informed responsibility of the population for their health based on the rationalization of nutrition and the promotion of a healthy lifestyle, the development of sanitary and physical culture using modern technologies.

2.5 Use innovative technologies to inform and educate citizens, expand their opportunities to improve personal health, promote proper nutrition in chronic diseases.

3 Heads of PHC

3.1 Wider use of the best evidence for the effective use and implementation of digital technologies for the management of dispensary patients.

3.2 Consideration of culture change: from providing information solely through patient education to providing information, in accordance with the wishes of the patient for the purpose of self-management, which are determined by the patient himself, depending on the nosology.

3.3 Raising awareness of the population and its involvement in measures to prevent and reduce morbidity, unhealthy diet and behavioral risks using modern technologies.

3.4 If necessary, use the My Heart mobile application for patient self-management and reduce the burden on district doctors. With the introduction of the My Heart mobile application, the patient can monitor his health around the clock, manage health indicators and have information on the timely prevention of cardiovascular diseases.

3.5 Strengthening disease prevention and effective management of chronic noncommunicable diseases. The incentive component of process and outcome indicators at the PHC level should be expanded.

4 Public health departments at the oblast level

4.1 Health authorities, when developing action plans and when taking a set of appropriate measures to improve the activities of the cardiological service, should take into account the number of patients who are registered with dispensaries, both in urban and rural areas in the Northern and Southern regions of the Republic of Kazakhstan.

4.2 The design of the organized system and chronic disease support is designed in a way that meets the needs of the target populations and is integrated into the system so that patients can navigate the use of modern technology.

4.3 Development of indicators to stimulate early detection of diseases and maintain the quality of life of people throughout life with the help of modern technologies.

4.4 Provide preventive services to key populations at the outpatient level through the introduction of various innovative technologies.

4.5 It is necessary to form joint responsibility of people for their health and manage the disease in order to prevent complications and unreasonable hospitalizations.

5 Ministry of Health of the Republic of Kazakhstan at the republican level

5.1 Remote medical services, like mobile healthcare, should be integrated into the routine processes of providing medical care, ensuring an increase in the availability and efficiency of the healthcare system.

5.2 It is necessary to develop incentive indicators for new proposals for the development and implementation of telehealth technologies for managing the health of patients with chronic diseases.

5.3 Develop a regulatory document for remote monitoring of the health status of patients with chronic cardiovascular diseases using mobile applications at the outpatient level.

The length and structure of the dissertation:

The dissertation is presented on 93 pages of typewritten text. The structure is represented by the introduction, literature review, chapters: research materials and methods, research results, discussion, conclusion. Practical recommendations and applications are also given. The manuscript is accompanied by 25 figures, 10 tables, 11 appendices. The bibliographic list contains 111 literary sources, including historical references to original research, generally in Russian (41%) and foreign languages (59%).