Monitoring of the Treatment Process of Tuberculosis Patients via Mobile Applications

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Abstract Development of information and communication technologies, mobile technologies, the creation of laptops, netbooks and pocket personal computers, as well as smartphones, new horizons opened up in improving virtual contact between highly qualified doctors of the central hospitals and medical staff of primary health facilities in the outskirts, and remote settlements. Analyzing the problems and barriers in improving tuberculosis (TB) detection indicators, and the further deterioration of the situation with multi-drug resistant tuberculosis (MDR) worldwide, TB scientists concluded that the cornerstone is the belated identification of the focus of the infection and the impossibility of monitoring the performance of the outpatient treatment regimen. Insufficient financing and staffing, especially in rural areas, exacerbates the situation. In this review article we tried to analyze the effectiveness of using various mobile applications in monitoring tuberculosis therapy conducted in rural areas. To do this, you can use applications such as WhatsApp, SMS. While the patient is taking tuberculosis medications, a medical officer removes the video on the smartphone and sends it to the central hospital. These video materials are archived. Also an employee can send SMS to the central hospital. The use of this technique allows us to monitor the medical process, actually being at great distances. This method is also effective for patient adherence to treatment.

Keywords Mobile applications, Monitoring, Tuberculosis therapy

1. Introduction

Development of information and communication technologies, mobile technologies, the creation of laptops, netbooks and pocket personal computers, as well as smartphones, new horizons opened up in improving virtual contact between highly qualified doctors of the central hospitals and medical staff of primary health facilities in the outskirts, and remote settlements.

The article presents the concept of e-health with usage some mobile technology in applications' examples. The classification of mobile application for healthcare knowledge management was based on some past reviews, actually in tuberculosis healthcare system. According to the Moscow Declaration on the Elimination of Tuberculosis adopted at the First Global Ministerial Conference of WHO (17-17.11.2017), despite concerted efforts by the world community, tuberculosis, including MDR forms, takes more lives than any other infectious disease worldwide [1]. Analyzing the problems and barriers in improving TB detection indicators, and the further deterioration of the situation with MDR worldwide, TB scientists concluded that the cornerstone is the belated identification of the focus of the infection and the impossibility of monitoring the performance of the outpatient treatment regimen. Insufficient financing and staffing, especially in rural areas, exacerbates the situation [1, 2]. This problem is especially acute in sparsely populated, remote villages, in hard-to-reach highlands, hot savannahs (for example, in Kenya, Africa), tropical forests (eg, India, Thailand, Argentina, etc.) or severe, cold climatic zones for example, Russia, the USA and Canada). Since, in such settlements, as a rule, the standard of living and social conditions are extremely difficult, the establishment of treatment and prophylactic institutions is not cost-effective, and the difficulties of communication of the patient with central health facilities are extremely difficult.

A number of authors have established over many years that age, gender, ethnicity, socioeconomic status, educational level, marital status, culture and religious beliefs-all these factors do not help identify those who will or have become a non-executive patient. Unexpected visits at home and counting tablets have established that regular visits

to health facilities on the ground do not serve as proof of the patient's careful intake of tablets. The only reliable fact of the patient's careful performance of prescribing and doctor's recommendations is the direct taking of tablets in front of the camera. In our opinion, creating conditions for direct observation of a highly qualified TB professionals in the process of taking medications by a patient in remote settlements can be a very effective health tool [3-5].

2. Methods

Creation of mobile technologies for voice communications (cellular phones), text messages (SMS), video communication (videophones, Skype) and finally, complex communication of voice, text and video information (WhatsApp) greatly facilitated the contact of the doctor in the center with patients in remote settlements. This trend has laid the foundation for the creation of a new, so-called "mobile health" (mHealth) in developed countries [3-6, 8-10]. Along with other directions of the organization of healthcare, the TB service has also received a great impetus for development, which is closely connected with the creation and development of mobile technologies Skype, SMS and WhatsApp [3-5, 7, 11-13]. Analysis of existing scientific works on the use of mobile technology in anti-tuberculosis measures shows that the main area is patients in sparsely populated villages remote from cities, remote, mountainous or tropical areas, which is also remote, sparsely populated mountain villages in northern regions of Azerbaijan [3].

Globally, mobile phones have reached wide availability and mobile phone applications have become more and more common among users. The number of healthcare-related applications that were based on the two leading platforms (iOS and Android) in 2014 has reached more than 100,000. However, it is of great interest to establish scientifically based evidence on the effectiveness of mobile phone applications in changing people's behavior regarding their health [3-5, 14-16].

3. Results

Our results of the analysis of existing scientific and medical information on the application of mobile technology in health care proves their effectiveness in health-related applications. A large sample of high-quality scientific research statistics improve the quality of individual health care directions are of a sporadic nature, the results highlight a significant opportunity to influence the patient's behavior, his propensity to perform a treatment regimen. In view of the high cost of mobile technology, only developed countries have financial opportunities for widespread implementation, while countries with low national incomes have so far only used pilot projects of leading scientific foundations to apply these innovations very rarely [17-20].

Significant achievements are in improving the quality of

TB services in the developed countries of the EU, USA, Canada, Australia, etc. [7, 9, 15, 18, 22].

SMS Messaging Technology. The first work on the use of mobile technologies in improving the quality of TB work concerns the use of short text messages (SMS) in cell phones. However, publications on the use of short text messages in the treatment of TB patients are extremely scarce [3, 11, 18, 23, 25, 26].

The use of text messaging or so-called "short messages" (SMS) has been applied in various areas of the health organization [4, 5, 9]. However, few researchers reported on a scientifically sound explanation of the SMS application process. In addition, although SMS was a promising tool for improving the TB service, there were several studies that applied this to the management of anti-tuberculosis activities [4, 5, 9, 17, 18].

First, the SMS function of a mobile phone is more economical than a phone call. Secondly, an SMS message can be sent, saved, restored, and available to all mobile phone users. Thirdly, the provision of information via SMS is significantly more efficient than paper exchange. Fourth, you can choose the style, language, and length of the text. However, many researchers, phthisiatricians used SMS to send reminders to the patient for a medication regimen, but less described in their scientific works the use of its interactive function, the description of the stage of the joint process [4, 5, 17].

Based on our medical practice, the great advantage of using SMS messages between a TB doctor and outpatient patients in remote villages makes it possible to send hundreds of identical text messages in a short time interval [15, 20].

Thus, it is clear from the review of SMS usage that this technology should be standardized specifically for anti-tuberculosis activities, taking into account the needs of the local community. The process of using SMS messages should be flexible, acceptable for the treatment schedule of a large number of patients. In addition, SMS messages should be adapted for training of medical personnel of primary health facilities, in remote, mountainous villages during the autumn-winter period. The TB professionals prepares a template of SMS-messages with answers to frequently asked questions of patients and medical staff [4, 5, 19].

Video-DOT technologies: Skype and WhatsApp [3, 11, 21, 23-26]. Tuberculosis can be effectively treated with antibiotics, treatment usually takes 6 months, and can last up to 24 months for patients with MDR. In addition, it is extremely important to adhere to the treatment regimen to avoid re-infection, and the emergence of drug resistance. The World Health Organization recommends direct (directly) observed therapy (DOT) as an important component of patient care in order to guarantee treatment and to stop the spread of infection to others and drug resistance. DOT is a patient-centered approach to treatment in which patients are observed swallowing each dose of anti-TB treatment, and is designed to maximize the likelihood of completion of therapy. This can be provided in the patient's home, primary

health facility, or other mutually agreed place, for example in a DOT cabinet [1, 10, 21].

As a rule, medical legislation provides for the allocation of resources for DOT. However, in countries with low national income, resources for services are very limited, and DOT can not be organized for all patients. Although, studies have shown that DOT is very effective at achieving a high adherence to treatment, especially when care is individualized. DOT is especially limited for patients living in remote, sparsely populated, high-altitude villages. In such cases, the necessary drugs are delivered in advance to the places of residence of patients with MDR [3, 4, 19, 21, 23].

In such cases, TB professionals and clinicians decided to use the mobile technology Skype and WhatsApp (mHealth), to visually monitor compliance with treatment regimen and timely and accurate drug taking [9, 10, 12, 20, 22]. To do this, either a PC, Notebook or Netbook from Skype or a smartphone with the Android system is used. This allows the doctor on the video monitor to remotely observe patients taking medication. Today there are few scientific articles dedicated to video-DOT. Existing works include a feasibility study for the implementation of video DOT, for example, in Kenya [21] and the United States [20, 22].

Summarizing the above video-DOT materials, we can conclude that using the capabilities of mobile technologies Skype and WhatsApp, you can visually observe the process of treatment of a remote patient. Directly observed therapy and strict adherence to medicines can significantly improve the effectiveness of antituberculous activities in sparsely populated, mountainous rural areas [3, 9, 10, 23].

From the analysis of available scientific and medical literature data it follows that currently there are not enough research papers devoted to the scientific justification for the organization of specialized TB care to improve the effectiveness of anti-tuberculosis activities in rural areas. There are only a few studies on improving tuberculosis work in sparsely populated rural areas. In addition, these works do not suggest ways to modernize the TB service [1-4, 7].

Insufficiently studied risk factors that affect the epidemic situation of tuberculosis in rural areas. In general, demographic, medical and seasonal factors affecting morbidity and mortality of patients in rural areas of many countries, as well as Azerbaijan with mountainous terrain and low population density, have not been studied at all [3].

At the same time, new means of antibacterial and pathogenetic therapy, modern methods of examination and diagnosis of the disease (for example, flexible and rigid bronchoscopy, etc.) have appeared, the system of monitoring tuberculosis patients has changed [3, 7, 16].

The conclusion. In the context of the reorganization of the TB services, the analysis of the scientific and medical literature on the organization of anti-tuberculosis activities is relevant. Strategies to combat tuberculosis have not yet reached the planned indicators for the identification and treatment of patients. As follows from the review of the literature, in modern approaches to the treatment of the disease there are several trends due to modern features of the

course of this disease (including the growth of immunodeficient conditions, HIV infection and other concomitant diseases), the introduction of chemotherapy regimens in accordance with the categories of patients, significant specific gravity of primary resistance to anti-tuberculosis drugs. When analyzing approaches to disease prevention, it is shown that different approaches are applied in different countries. Chemotherapy is recognized as an effective and effective method, if it is controlled and without admission passes. Within the DOTS + strategy and Stop-TB strategy for TB diagnostics, such studies as seeding, cultivation of mycobacteria and determining their sensitivity to chemotherapy are mandatory. Today, there are significant achievements in the world in the molecular-genetic and microbiological diagnosis of tuberculosis [1, 14, 19].

Figure 1. *An example of using the WhatsApp mobile technology capabilities in a medical facility*

4. Conclusions

Thus, summarizing the state of the study of the problem (a review of the literature), it can be unequivocally stated that the epidemic of tuberculosis in most countries, as in Azerbaijan, enters the stage of stabilization [1, 2, 3]. Almost the same approaches are used in all countries around the world to identify patients, diagnose, treat and prevent tuberculosis, which motivates the intensification of scientific research on the development of new vaccines, new anti-tuberculosis drugs, and new standard treatment regimens. It is pleasant to note that our country has also

begun work on the introduction of such new innovative technologies as GENE XPERT, mobile technologies, etc., aimed at early detection of the disease and patient monitoring under the video-DOT program [1, 3, 17, 24].

However, the adaptation of new innovative anti-tuberculosis technologies in sparsely populated, mountainous, inaccessible settlements in rural areas is still an urgent problem. This situation once again proves the urgency of the problem of the scientific justification for the organization of specialized TB care to improve the effectiveness of anti-tuberculosis activities in rural areas.

We would like to note separately the results of the implementation of this method in the mountainous settlements of the Guba region of Azerbaijan, which are far from the center. This area is difficult to access, especially in winter. Under such conditions, it is especially difficult to control the treatment of patients. This method allowed us to monitor both the patient's treatment process, thereby guaranteeing the patient's adherence to treatment, as well as the work of the local employee of the medical institution.

This technique was also introduced in the Akmola region of Kazakhstan. In this regard, we want to thank the leadership of the anti-tuberculosis network of the Guba region of Azerbaijan and Akmola region of Kazakhstan.

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