Reducing the Risks of Medical Diagnosis in an Epidemic or Pandemic

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***Abstract*— The authors set themselves the goal of exploring the possibility of reducing the risks of medical diagnosis in the face of epidemics and pandemics. In this case, an assessment was made of the most characteristic risks of medical diagnostics in these conditions, the identification of risk factors, as well as their dependence on the conditions of use. Some methods of laboratory and clinical diagnostics and the possibilities of increasing their efficiency through the use of modern achievements in the medical and technical fields of scientific and technological progress, which allow solving this problem, are considered.**

Keywords — medical diagnosis, reducing the risks, epidemic situation, telecommunication; information technologies.

I. INTRODUCTION

As the experience of recent years shows, mankind has entered a new phase of the confrontation between nature and man, when against the backdrop of ongoing changes in the Earth's noosphere, the dependence of the active influence of man on nature on the response manifestations of changes in the environment on human life conditions is increasingly affecting.

This process covers various spheres of humanity's activity and existence on our planet: climatic conditions, changes in natural resources and demographic situation, human interaction with nature, including at the microworld level.

From a biological point of view, the current processes of a sharp change in natural factors create favorable conditions for the emergence of new and mutations of the existing population of biological structures of various levels: including microorganisms, bacteria and viruses. The active spread of pathogenic bacteria and viruses, in turn, contributes to the emergence and spread of various infectious diseases, epidemics and pandemics [1, 2].

Over the past few centuries, humanity has experienced a fairly large number of such natural disasters, which claimed millions of lives. Such tragedies include diseases such as: smallpox, plague, cholera, typhoid, flu, tuberculosis, malaria, leprosy, HIV infection (AIDS), coronary virus infection COVID-19.

Natural (black) smallpox, a highly contagious viral infection that only people suffer from, was widespread throughout the globe, with a mortality rate of up to 40%. VIII-X centuries records about the mass epidemic in Blackpox in India and China have been preserved. In the 1870-1874s, a pandemic swept across the North American continent and Europe. To date, three pandemic plague are known, the last of which at the end of the eighteenth century claimed tens of millions of lives. Of the seven known cholera pandemics, the last in the 60s of the last century swept the Asian continent and claimed millions of lives. Millionth sacrifice at the beginning of the 19th century brought typhoid to Europe. Widespread in tropical and subtropical regions, including both America, Asia and Africa, malaria. Up to approximately 500 million cases of malaria are registered each year, of which up to 3 million end in death [1, 2]. Every year, around the world, 8 million people fall ill with tuberculosis and 2 million die. During the 20th century, about 100 million people died from tuberculosis [3, 4].

Influenza pandemics have definitely been known since the sixteenth century. Influenza epidemics and pandemics are caused by influenza serotype A viruses. Rarely (once every 4–6 years) the epidemic is also caused by influenza virus type "B", they develop slowly compared to those caused by the virus "A" and, as a rule, cover 8-10% of the population. In most cases, human flu is diagnosed clinically. However, during periods of low activity of influenza viruses and in the absence of epidemics in clinical diagnosis, it is difficult to differentiate influenza from infections caused by other respiratory viruses (rhinovirus, respiratory syncytial virus, parainfluenza virus and adenovirus).

The modern world is regularly shocked by epidemics of influenza, AIDS, as well as the current pandemic of the coronary virus infection COVID-19. According to the WHO, today 25 million people have died of AIDS, from 250 to 500

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thousand people die every year, in some years the number of deaths can reach one million [5, 6].

Coronary viral infection COVID - is a dangerous disease that can occur both in the form of an acute respiratory virus infection of mild course (more than 80% of all confirmed cases), and in severe form (no more than 5% of the total number of infected), specific complications of which may consist of viral pneumonia, which entails acute respiratory distress syndrome or respiratory failure with the risk of death. Since March 11, 2020, the spread of the virus has been recognized as a pandemic - the first pandemic in the history of mankind that can be taken under control.

In all cases, the human mind and common sense made it possible to find methods of counteracting and effectively treating these massive infectious diseases, using the achievements of modern science and technology in their various fields, microbiology, medicine, pharmacology, and a number of other natural sciences.

However, all these scientific achievements would not have been possible without the use of constantly improving methods and means of monitoring biological and technological processes. Such tools include modern means of studying and controlling natural processes, means of analytical research and active influence on these processes, tools and methods for processing research results, as well as the creation of technological processes that contribute to the achievement of positive results in countering the detection and counteraction of mass infectious diseases.

Thus, one of the ways to increase the effectiveness of counteraction to mass infectious diseases is to improve methods and means of medical diagnosis and control at all stages of the detection of the struggle for the patient's health.

II. Characteristic Features of Medical Diagnostics Under the Conditions of Epidemia and Pandemia

To analyze the main ways to increase the effectiveness of medical screening, diagnose and monitor the status of patients at all stages of detecting a struggle for patient health under conditions of mass pandemics, we consider the main characteristic features of the detection and clinical manifestations of an infectious disease of mass distribution using the example of coronavirus infection COVID-19 [7-9].

COVID-19 viral infection (SARS-CoV-2) is a positive-sense single-stranded RNA coronavirus that causes a disease called COVID-19.

This is a new strain of coronavirus that has triggered an outbreak of serious respiratory diseases for the first time in China, in the south of Wuhan province. According to the currently accepted version, this strain was first discovered in bats in a cave in Yunnan province. The virus is capable of spreading from person to person, spreading at an incredible speed. The World Health Organization (WHO) declared COVID-19 a pandemic in March 2020.

Unfortunately, a vaccine or recommended antiviral compounds specific for the treatment of COVID-19 has not yet been created and has not passed medical certification, which significantly reduces the effectiveness of countering its spread.

When analyzing the features of medical screening and diagnostics in the context of epidemics and pandemics, for example, we will use the features of this type of viral infection.

A. Analysis of the particular occurrence and spread of a particular type of pandemic and the possible contingent of patients.

First of all, it is necessary to take into account the peculiarities of the emergence and spread of a particular type of pandemic and the possible contingent of patients.

For the analysis, it is necessary to take into account the peculiarities of the occurrence and spread of a pandemic of this specific type and the possible contingent of patients.

In this sense, for the COVID-19 pandemic, as well as for other viral infections, the following risk factors can be noted, which led to the rapid spread and wide territorial coverage of the infected zone:

- Continuing active migration of the population from the affected area of the pandemic throughout the entire territory of the Earth's surface.
- Continuous communication and direct physiological contact with persons who are already infected.
- Continued spread of waste products from organisms of infected patients with their subsequent spread through sewage systems into the environment.
- Distribution of food products of a biological nature from infected regions throughout the entire Earth's surface.
- The spread of infection through inorganic household items and common use that have been in contact with infected patients, etc.

Comprehensive measures to reduce the influence of these risk factors can significantly reduce the rate of spread of the pandemic and the territory of its spread. This will allow to localize the affected area of the pandemic, providing an opportunity for effective screening and subsequent monitoring of the condition of infected patients.

Specifically for the COVID-19 viral infection, the following risk groups can be identified that are most susceptible to the likelihood of acquiring infection through the above risk factors:

- Groups of older people (over 60 years old), especially those in group social institutions (sanatoriums, boarding houses, social institutions of cohabitation, etc.).
- People who are overweight and obese.
- Patients with diagnoses of type 1 and type 2 diabetes, as well as in a state of pregnancy with these diseases.
- Patients with chronic diseases of the upper respiratory tract: bronchitis, pulmonary fibrosis, cystic fibrosis, pulmonary hypertension.
- Patients with chronic diseases of the kidneys and genitourinary system.
- Patients with chronic liver diseases: liver cirrhosis.
- Patients with cardiovascular diseases, congenital heart defects, acute heart failure, atherosclerosis, ischemic heart disease, cardiomyopathy, etc.

•.Patients with impaired immune system, especially against the background of severe diseases such as HIV, cancer, immunodeficiency and other factors that reduce the body's resistance to infections.

Concentration of the control zone on the indicated risk groups of the population will allow consolidating the efforts of specialists for their more effective screening and monitoring of the condition of already infected patients. This will significantly reduce the rate of spread of the pandemic, and provide more effective diagnosis and treatment of patients.

B. Signs and symptoms of this pandemic infection.

The next step in analyzing the characteristics of an infectious pandemic is to identify the signs and symptoms One of the important steps in ensuring effective diagnosis of viral infections and pandemics is the evidence-based identification of the main signs and symptoms characteristic of a given infection. Optimizing these signs and symptoms for specific manifestations of a given type of viral infection can significantly reduce the number of these signs, without reducing the likelihood of a correct result. In turn, this allows to reduce the number of errors of 1 and 2 childbirth when making a diagnosis, as well as to significantly simplify medical and technological operations in this case. In turn, this will significantly reduce the burden on medical personnel and the diagnostic equipment used, allowing them to be redistributed to solve more necessary tasks.

For example, the following symptoms of acquired infection are currently identified for viral COVID-19:

• The patient's body temperature is over 37.2 degrees.

• Dysfunction of the upper respiratory tract, accompanied by cough and inflammatory manifestations.

• Dysfunction of the respiratory system, accompanied by shortness of breath or shortness of breath

• Dysfunction of peripheral organs of the central nervous system, leading to a loss of perception of taste and smell.

• Muscle and headaches caused by dysfunction of the peripheral and central nervous system.

• Chills caused by vascular spasms with an increase in body temperature are also characteristic of a viral infection of the patient's body.

Viral infections can also be accompanied by feelings of fatigue, indigestion, abdominal pain, vomiting, diarrhea, and more.

In order to reduce risks when making decisions in the conditions of epidemics and pandemics in this way, it is recommended to conduct studies for any type of infectious disease. The results of the studies will help determine the right directions when choosing methods of screening, diagnosis and subsequent treatment of the disease., And also determine the necessary telemedicine and special material support and resources.

Thus, a comprehensive study of the characteristics of the occurrence and spread of epidemics and pandemics, as well as the study of the features of their clinical manifestations, allow the implementation of effective monitoring and diagnostic actions for their localization and subsequent therapy.

The world community, adequately responding to the peculiarities of the development and spread of pandemics in the world, based on the experience of previous tragedies, is developing joint regulatory and regulatory documents to reduce risks and increase the effectiveness of the fight against these diseases. An example of such documents would be: Guidance on the revision of a pandemic influenza preparedness plan. Lessons learned from the 2009 A (H1N1) influenza pandemic. (World Health Organization) [HH]. European Center for Disease Prevention and Control. Flu Pandemic Preparedness Plan Review Guidelines - Lessons Learned from the 2009 Influenza A (H1N1) Pandemic Stockholm: ECDC; 2017.

This paper examines 12 key areas of effort to actively counter the emergence and spread of pandemics.

One of these areas is the use of modern telemedicine diagnostic tools for timely monitoring and diagnosis of epidemics and pandemics [10].

III. PECULIARIES OF TELEMEDICAL DIAGNOSTICS IN THE CONDITIONS OF EPIDEMICS AND PANDEMIES.

Medical screening of the population in areas of active infection with viral infections is due to the need for timely identification of infected patients in order to provide them with timely and effective assistance, and to take measures to prevent the spread of infection.

Many infectious diseases at an early stage of their development have implicit, latent forms of manifestation, which complicates the timely detection of the disease.

This is fraught, first of all, with consequences for patients with such manifestations of the disease, since a viral infection, without giving pronounced symptoms, or veiled symptoms against the background of various other diseases, does not allow timely assessing the degree of damage to the patient and those negative changes in his body that occur with the development of a viral disease. Affecting various organs and tissues of the patient, a viral infection creates a complex of problems, the treatment of which is significantly complicated due to the severity of the damage to these organs at the later stages of the development of a viral infection.

Another, no less important aspect of this problem is the spread of viral infection by infected patients with mild manifestations among the healthy population, since there are no measures to localize this infection.

The need for medical screening, that is, the active detection of a disease or condition before a disease in persons who are considered or consider themselves healthy, is now widely accepted in the world community, since it can be an effective means in combating the spread of viral infections.

In this case, it is necessary to conduct scientific medical research on the characteristics of the occurrence, development and spread of this infection. To formulate and legally adopt the rules and norms of behavior for all categories of the population participating in solving this

problem. Subsequently, in the event of a situation defined as a pandemic, it is necessary to observe the established principles and criteria determined by the specifics of this infection [5].

In the medical aspect, at this stage, scientific research to determine the most effective methods of medical diagnosis and screening of a pandemic of this type, determined on the basis of previously obtained main signs and symptoms characteristic of this infection, is especially relevant.

At the same time, taking into account the property of viral pandemics for rapid and active spread among the population over large areas, the methods of geographically distributed, remote, mobile diagnostics, which are characteristic of telemedicine diagnostic complexes and telemedicine screening systems, are especially effective.

Currently, telemedicine diagnostics of viral infections allows all known methods of medical examinations and analytics: taking anamnesis, objective examination of the state of the body, analyzing the results of laboratory tests of blood and various secretions, X-ray studies, graphic methods, endoscopy, biopsy and others.

On the example of the pandemic of the coronavirus infection Sovit-19, it can be noted that the following diagnostic methods are the most appropriate for this infection[7].

First of all, these are clinical research methods, including laboratory studies, analysis of pathogens and the detection of antibodies against this virus in the patient's blood.

The following features of clinical laboratory research are characteristic of Sovit-19:

A blood test can show a decrease in the level of lymphocytes, an increase in lactate dehydrogenase and myohemoglobin, and in some severe patients, the level of troponin, etc.

Pathogen analysis for SARS-CoV-2: The virus can be detected in blood, feces, anal swabs and other samples.

Detection of antibodies against SARS-CoV-2 in the patient's blood.

X-ray and graphical chest examinations such as digital radiography and computed tomography can also be used.

For telemedicine complexes, this type of research can be acceptable in the form of mobile diagnostic complexes that screen directly in areas of active spread of infection, followed by teleconsultations in specialized medical centers.

Thus, to consider the possibility of reducing the risks of medical diagnostics in the conditions of epidemics and pandemics and effectively counteracting their development, it is necessary to use methods and tools that will most fully cover all the above-considered features of identifying, monitoring and diagnosing massive infectious diseases.

IV. Some Examples of Using Modern Telemedical Technologies of Pandemic Medical Diagnostics.

To comprehensively solve the problem of reducing risk and increasing the effectiveness of medical diagnostics in an epidemic and pandemic, modern telemedicine complexes are currently used.

These complexes are available for discount telemedicine screening and telediagnostics, with subsequent telemonitoring of the condition, risk and patients with already confirmed diagnoses [11, 12].

In this case, the following basic principles are used for the optimal acquisition of their medical, medical and professional resources, which allow them to be most fully and effectively used to solve the tasks:

- Clear specialization depending on the nature of the disease.
- Linking to a specific geographically distributed situation of the development of a pandemic.
- A centralized link to the basic inpatient medical facility and the consultative diagnostic medical center for this profile.
- Optimal deployment of medical devices, medical and professional resources.
- Creation of an effective medical telecommunication system.
- Creation of mobile specialized telemedicine teams "quick response".
- The creation of an effective social warning system and public information.
- Creation of a legal and regulatory framework.
- State control and support of ongoing actions.

In solving these problems, modern Internet technologies and modern telemedicine methods of screening and telediagnostics, telemonitoring, etc. can be actively used.

To solve the problems considered, modern telemedicine methods of screening and telediagnostics, telemonitoring, etc. are currently actively used. All these methods are based on the use of modern computers and technologies, actively using Internet communications and applied software and mathematical support.

Modern telemedicine complexes are built on the principle of a vertical hierarchy, with the organization of an extensive telecommunication network of clusters of various functional purposes.

The authors considered these issues in a number of their works [11, 12] from the point of view of optimal construction of mobile telemedicine complexes for various purposes, which can also include complexes for telemedicine diagnostics of epidemics and pandemics, meaning optimization taking into account the characteristic features of this direction of telemedicine, as described above.

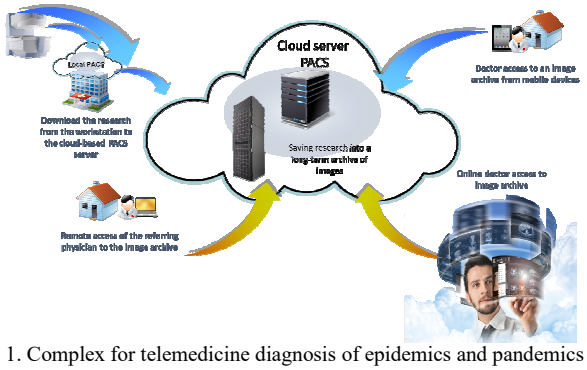

Fig. 1. Complex for telemedicine diagnosis of epidemics and pandemics

The complex of telemedicine diagnostics of epidemics and pandemics should provide fast and high-quality diagnostics of territorially disunited patients of various social groups who are in conditions of individual or group isolation. This is causes the dispersion of primary diagnostic telemedicine tools, together with centralized medical-analytical and diagnostic support for the process of disease detection and control his treatment.

At the same time, each level has a high level of responsibility, each link of this complex, which participates in the process of comprehensive diagnostics and treatment.

The complex for telemedicine diagnosis of epidemics and pandemics contains a telecommunication network for the collection, processing and transmission of biometric digital information and video images, which unites a number of mobile and remotely remote diagnostic tools with a central control point. As the central control point of the complex, a specialized medical institution is used, which includes the necessary medical specialists for analytical research and processing of the received biometric information, as well as a central server and relevant databases that allow accumulating and systematizing the information received. In addition, it has the necessary telecommunications facilities to ensure communication with regional and central level authorities, and geographically distributed medical institutions directly involved in the problems of this pandemic.

In order to successfully solve the task assigned to it, it must take into account the specifics of the research performed, as well as the peculiarities of the medical methods used.

For example, we can consider one of the aspects of complications in acute viral infection - the diagnosis of acute inflammatory diseases in otolaryngology: acute otitis media of the upper respiratory tract and middle ear [13, 14].

For this purpose, it is proposed to use devices for wireless digital otoscopy, which are connected to a smartphone via Bluetooth, or WIFI, allow you to record color features, identification contours and mobility of the eardrum, the presence of contents in the external auditory canal and the tympanic cavity.

Computer image analysis systems make it possible to abandon the rather subjective characteristics of the area being examined, which is associated with a qualitative assessment of the clinical picture.

The computer perceives the image captured by the digital camera, and with the help of specialized software provides the results of the study, which allows to achieve the objectivity of instrumental research. This direction in diagnosis, for the most part, is effective as predictor medicine, which allows the detection of diseases in the early stages.

At the same time, remote visual monitoring of the state of the patient's organs can significantly reduce the risks in diagnosing the patient's condition. Today, one of the main problems of medical imaging is the preservation of interactivity and the real time scale when displaying complex polygonal objects obtained as a result of processing of introscopic data.

The authors propose a new method for improving biomedical 3D-visualization of images, which allows implementing new visualization technologies using modern technical means and methods for processing biomedical information.

Fig. 2. An example of an otoscopic picture when visualizing the eardrum.

The results obtained significantly increase the effectiveness of telemedicine diagnostics of this disease, and reduce the risks both professional in the accuracy of the medical diagnostics and epidemic risks - from contact with the patient in conditions of increased infectious danger.

Another example of modern diagnostics can be a medical device for the early diagnosis of latent type 2 diabetes (DM2) with a long latent period, during which its late vascular and neurological complications are already developing [15, 16].

Patients with latent type 2 diabetes are at risk for many types of infectious diseases, and therefore it is especially important to monitor their condition to prevent possible complications.

The proposed operation technology uses a diagnostic biotechnological system to detect latent type 2 (DM2).

It based on a processing unit, where clinical, slightly invasive data allows you to obtain diagnostic information of the "gold standard" level of diabetic studies without a full-scale "hyperglycemic clamp", which is difficult to perform, burdensome and unsafe for the patient.

This device uses an original mathematical model of a carbohydrate metabolism regulation system to convert the clinical data of the simplest glucose tolerance test - the oral test (OGTT) - into the characteristics of a "hyperglycemic clamp" [17, 18].

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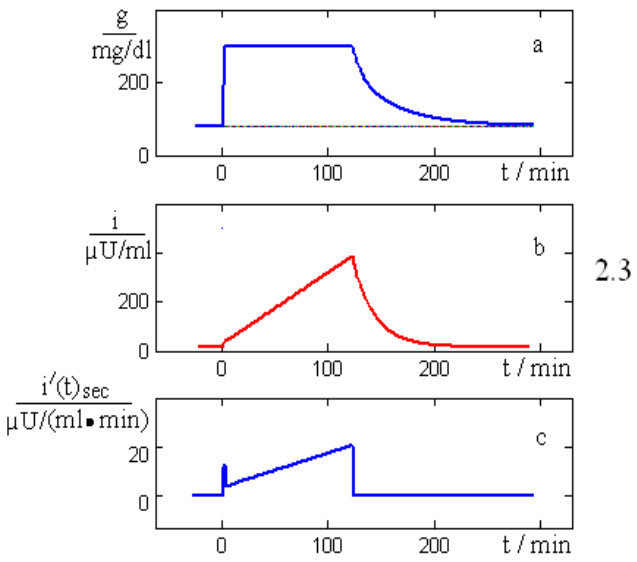

Fig. 1. Glycemic (a), insulinemic (b) and insulin secretion intensity (c) model curves: 2.1 - IVGTT; 2.2 - OGTT2; 2.3 - infusion test, constructed according to the values of the main parameters of the model (3), identified by the clinical data of OGTT of the healthy patient.

The considered examples show the wide possibilities of modern medical science in the implementation of effective methods of medical diagnostics, especially when solving such rather complex and urgent problems as protecting the world's population with mass infectious diseases.

V. CONCLUSION

Studies have shown that the practical use of modern laboratory and medical diagnostic methods that use new biomedical technologies, together with advanced telecommunication and computing technologies for processing biomedical information, can significantly reduce the risks of medical diagnostic measures in the face of epidemics and pandemics. In turn, they will increase the efficiency of these laboratory and medical diagnostic procedures, while reducing the likely risk of infection for both patients and medical personnel.

Using the capabilities of telemedicine in this application today is especially important not only for the healthcare system of Ukraine, but also for the entire human community as a whole.

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