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Architecture and organization of a Platform for diagnostics, therapy and post-covid complications using AI and mobile monitoring

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Abstract

Infectious diseases accompanied mankind throughout its existence. However, in the 20\textsuperscript{th} century, with the implementation of mass vaccination, this problem was partially forgotten. It reappeared at the end of the 2019 with the COVID-19 pandemic. The diseases are associated with high mortality, the main causes of which are: respiratory failure, acute respiratory distress syndrome, thrombotic complications, etc. As many centuries ago, the key to fighting a pandemic is to diagnose patients with infections as quickly as possible, isolate them, and implement treatment procedures. In this paper we propose a Platform supporting medics in the fight against epidemic. Unlike alternative systems, the proposed IT Platform will ultimately cover all areas of fighting against COVID-19, from the diagnosis of infection, through treatment, to rehabilitation of post-disease complications. Like most clinical information systems, the Platform is based on Artificial Intelligence, in particular Federated Learning. Also, unlike known solutions, it uses all available historical data of the patient’s health and information from real-time mobile diagnostics, using cellular communication and Internet of Things solutions. Such solutions could be helpful in fighting against any future mass infections.

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1. Introduction

Despite the noted successes in treatment and preventing infection diseases in 20th century, the danger of mass infections of mankind in third millennium remains valid. In the first step, contribute to this the increase number of people, climate changing and progressing environmental pollution which are the result among other with chemization of life. Taking advantage of the unprecedented migration activity of people, diseases spread almost without obstacles around the world, and dangerous viruses with their unlimited ability to mutate become a real threat. In December 2019, a series of previously unknown cases of pneumonia caused by a new strain of coronavirus, which the World Health Organization tentatively named COVID-19 in 2020, was registered in Wuhan, China. It caused a severe acute respiratory syndrome known as SARS-CoV-2, which was extremely often fatal. In the past 17 years, the coronavirus family has already caused a third pandemic. They are in line with the tendency of worsening human health that has been observed for two decades. Currently the bad health condition in the world keep in over 80% of population. The reasons for this are: unhealthy lifestyle (smoking, alcohol, drugs), unfavorable socio-economic, environmental and sanitary conditions, and high levels of mental stress. Coronavirus outbreaks are only confirmation of this phenomenon.

Although the epidemiological situation is slowly stabilizing thanks to mass vaccination, it is important to prepare for similar situations in the future. The global experience in fighting the COVID-19 pandemic has exposed the weaknesses of health care in virtually every country, and the search for methods to improve the effectiveness of health care has made it a priority task. Computerization of healthcare entities has been considered for several decades as one of the most effective ways to improve the efficiency of its functioning. Although the obligatory element of virtually every medical entity is the medical entity information system (MEIS), for many years its primary task of the MEIS was to collect and process information on the costs of its activities and ensure its continuity. Medical diagnostics and the therapeutic process appeared in the system only as a cost item. All such procedures were always carried out under the sole supervision of medical personnel. This state of affairs has lasted for decades, both due to the reluctance of the staff and the imperfections of the solutions offered.

A dramatic change occurred when artificial intelligence (AI) and the Internet of Things (IoT) methods were widely used in medical technology. The use of AI in medicine has a long tradition. In the first place, it is used to improve the quality of medical procedures. It is estimated that AI reduces the risk of diagnosis and therapy errors by approximately 70%. Thanks to its use, errors in the patient's prognosis are reduced, and it detects diseases that are often overlooked in the diagnosis, which are the cause of later death. At the current stage of medical IT development, no one questions the leading role of a doctor in medical procedures, methods based on AI allow only to improve the quality of medical services provided. It is widely believed that the use of AI significantly improves the precision of diagnostic and therapeutic procedures, simplifies the lives of patients, increases the speed of developing and making available new medicinal preparations, etc. The effectiveness of using AI to digitize and organize medical records and the implementation of its effective circulation is widely known and used. In 2020, the value of the machine learning-based applications market reached $ 40 billion. However, only 1% of available applications used AI, by 2028 their share will reach 80%. Publications in the area of machine learning, also in the field of combating COVID-19 infection, are widely available and confirm the thesis about the effectiveness of using this type of technology [1, 2].

Completely new functionalities of medical IT systems can also be implemented on the basis of the dynamically developing Internet of Things (IoT). In the simplest case, IoT is a system of devices connected by a network via the Internet that can not only collect and transmit data, but also interact with each other and with the surrounding environment. These devices, called sensors, can be worn by the patient as garments, placed on their body, or implanted in their body. Data obtained by sensors is collected in special databases and then processed using specialized analytical tools based on artificial intelligence. The entire process based on IoT: from measurement, through processing to changing the settings of the actuator, can be completely unattended, i.e. without human intervention. The Internet of Things has revolutionized the performance of many tasks in modern medicine, in particular related to medical diagnostics and patient care. However, IoT raises a number of concerns among potential users, in particular those related to broadly understood security. First, the Internet of Things relies on the widespread use of high-frequency wireless communication techniques. Despite nearly 40 years of mobile phone use by billions of people, there is still no clear evidence of the absence of harmful effects from electromagnetic radiation. Although communication with the outside world of sensors used in medicine is based on the considered safe bluetooth technology, many skeptics are convinced of the harmfulness of their radiation. While the use of IoT in the fight against the coronavirus epidemic is relatively new, the topic has already been reflected in the literature [3, 4, 5].
The unattended diagnostic and therapeutic processes appearing in the new systems pose other, much more serious threats. Data collected in traditional medical information systems, at best, supported decision-making processes in medical procedures. Everything was done under strict human supervision. The Internet of Things and intelligent data analysis offered an excellent process automation environment, closely tailored to the needs of a specific patient. Thanks to the real-time decision-making process, the efficiency of the procedures is significantly improved, thus reducing the costs and time of treatment. The wide application of the widely understood artificial intelligence methods allows to introduce two new terms: intelligent medical entity (IME) and intelligent medical procedure (IMP). While there are no unified terms to describe IME and IMP, you may be tempted to use your own terms. For example, the term IME can be defined as: a healthcare entity whose activity is based on optimized and automated processes built in the information and communication technologies (ICT) environment, in particular the Internet of Things. The primary goal of IPM is to improve the quality of medical care in qualitative and quantitative terms.

The decision-making process in which the role of the doctor has been minimized is not the only threat to the wide use of AI and IoT in medical systems. The necessity to integrate significant amounts of medical equipment in communication poses risks related to the possibility of taking over or, worse, modifying medical data, including data controlling the functioning of the apparatus. Accessibility attacks that make it possible to immobilize fragments or even the entire information system of a medical entity, including the therapeutic procedures carried out, are particularly dangerous in this area.

The work focuses on the description of the Platform for the diagnosis of viral infection, treatment and rehabilitation of postcovid complications with the use of artificial intelligence and mobile monitoring, constructed by the authors. We are currently working on the construction of neural network models and environment model for FL. We are also working on communication methods and the operation of this system as distributed. So far, a system for data collection at the level of medical facilities has been implemented. We collect data from X-ray, CT and basic parameters. We are now implementing first versions of networks using Tensorflow 2 and planning to use Nvidia Clara in the near future.

The work consists of 4 sections and a list of references. The topicality of the topic is justified in the introduction. The second chapter discusses the goals of the research and their medical conditions. assets and peculiarities of smart medical entities. The third chapter presents the Platform's IT architecture, and the fourth summarizes the results of the work so far.

2. Research objectives and their medical conditions

2.1. Purpose of research

The main goal of the research was to describe a comprehensive technical solution consisting of equipment, computer programs, communication tools and services that will provide support in the process of diagnosis, treatment and rehabilitation of COVID-19 infection and its complications. The described solution will be hereinafter referred to as the Platform. The most important scientific goal of the work was to create, based on artificial intelligence methods, a set of interoperable models, methods and algorithms for obtaining new knowledge on the level of health related to individual characteristics of the subjects from available real data, and to generate personalized recommendations for correcting health disorders in the area of COVID-19 related diseases.

2.2. Sources of medical information

Verification of COVID-19 disease syndrome caused by SARS-CoV2 virus in accordance with the current medical knowledge in the field of prevention, diagnosis and treatment of coronavirus infection is based on epidemiological, clinical, laboratory and instrumental research methods. These methods make it possible to obtain information about the patient's health and do not differ in any significant way from those used previously in the diagnosis of other diseases. The diagnosis of complications is based on methods and measures specific to a specific type of complication. Additionally, in this area, as well as in the rehabilitation of postviod complications, an additional source of information is a mobile remote patient monitoring system. It is designed to collect information about the basic vital functions of the patient in the course of everyday activities. This system is based on standard devices for tracking the user's physical activity integrated with the Internet or specialized measurement sensors placed on the patient's body, communicating with the components of the Platform via bluetooth channels and further mobile phones [4, 6]. Such solutions are used
when a more accurate or more time-consuming measurement is needed to make a diagnosis of complications, and in cases of supervising remote rehabilitation procedures. All of the above data relates to the health condition of a particular patient. In addition, after the anonymization procedure, they are made available in the Platform's medical database as input information for machine learning algorithms.

All activities related to the collection, processing and sharing of data carried out on the Platform are in accordance with the legal standards in force in the European Union, in particular with the general data protection regulation, in other words the regulation on the protection of personal data, GDPR and the Act on the provision of services by electronic means. The collection and processing of information about the user begins after the first use of the Platform, during which he grants all consents required by the GDPR. The basic sources of information used in the operation of the system are presented in fig. 1.

As current medical data describing the patient will be essential for diagnosis and therapy, they will constitute the starting point for the Platform's work.

### 2.3. Epidemiological interview

In traditional solutions, the epidemiological interview takes the form of a questionnaire and is conducted by an employee of Sanitary and Epidemiological Stations. In the Platform, it will be performed by an AI-powered Chatbot. During the epidemiological interview, first of all, it is necessary to clarify:

1) Has the patient been in COVID-19 infected areas for 14 days;
2) Has he / she been in close contact with people from virus-infected areas in the last 14 days;
3) Did he maintain contacts with people whose infection was confirmed by a laboratory.

If necessary, AI asks for additional explanations. The answers to the above questions should be binary (yes or no). A negative answer to all three of the above questions will not exclude the patient's infection and end the interview. Negative responses can be a deliberate or unconscious misrepresentation. Incorrect answers are most often a consequence of the reluctance of patients to undergo quarantine or treatment procedures and imperfections in human-machine communication. Therefore, the chatbot is equipped with a set of auxiliary questions, selected automatically as the needs arise. An interview conducted by a chatbot may be more detailed than a traditional one.

### 2.4. Clinical symptoms

The incubation period for the SARS-CoV-2 COVID-19 virus is 2 to 14 days, an average of 5-7 days. Virus isolation from the patient can begin 2 days before the onset of clinical symptoms and lasts up to 12 days for mild to moderate and 14 days for severe infection. The main clinical symptoms of COVID-19 infection are: an increase in body temperature (in more than 90% of cases); mostly dry or with a little sputum cough (80%); shortness of breath (55%), most pronounced up to 6-8 days after infection, muscle aches and fatigue (44%); feeling of pain in the chest...
(20%). In addition, there may be confusion (9% of cases), headache (8%), haemoptysis (5%), diarrhea (3%), nausea, vomiting and palpitations. The latter may also appear at normal body temperature. There may also be: sore throat, runny nose, disordered sense of smell and taste, symptoms of conjunctivitis. Gastrointestinal symptoms include anorexia (80%), diarrhea (28%), vomiting (0.8%), and abdominal pain (0.4%). These symptoms worsen as the infection intensity increases [7].

The clinical interview is initially conducted by a chatbot. If the level of obtained responses is unsatisfactory, it is continued by the doctor.

2.5. Laboratory diagnosis

To diagnose COVID-19 disease syndrome, the Polymerase Chain Reaction method is used, called RT-PCR (Real-Time PCR). The main method of laboratory verification of a new type of coronavirus infection is biological material from the nasopharynx or throat (swab). Additional material may be bronchoaspirate taken from the bronchial tree in bronchoscopy and aspirate after bronchoalveolar lavage, biopsy or autopsy of the lung parenchyma, blood or serum analysis, urine, feces.

Basic clinical laboratory diagnosis includes: general blood analysis, biochemical blood analysis, C-reactive protein determination, gasometry (blood gas determination), procalcitonin test (PCT test), blood culture, interleukin 6 level, ferritin test. In the case of COVID-19 infection, a general blood analysis may show leukopenia, lymphopenia, aneoinophilia, thrombocytosis or thrombocytopenia, anemia, leukocytosis. Changes in biochemical indicators are usually associated with the severe course of the infection and the appearance of complications. The level of C-reactive protein and procalcitonin is correlated with the intensity of the course of inflammatory processes. High levels of interleukin 6 and ferritin usually indicate an advanced form of the disease - acute respiratory distress syndrome.

Extended laboratory diagnostics is also used, consisting in the detection of SARS-CoV-2 RNA by RT-PCR or immunoabsorbt ELISA test. Experience has shown that IgM antibodies appear in the body on the fifth day of infection, IgG on the 14th day.

The Platform automatically classifies the results of laboratory diagnostics, supporting the physician in the decision-making process. The test results, along with clinical symptoms, are placed in the knowledge base, where, along with subsequent descriptions of the disease progression, are used in the machine learning procedure. Similar solutions were proposed in [8].

2.6. Instrumental diagnostics

Instrumental methods used in the diagnostic of COVID-19 disease syndrome include pulse oximetry, ECG, chest x-ray, ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI) of the head. The most common initial diagnostic symptom in CT scans is the so-called frosted glass symptom. Among the instrumental research methods, computed tomography of the lungs is preferred as the most sensitive method of diagnosing SARS-CoV-2 viral pneumonia and electrocardiography [9, 10]. If tomography cannot be performed, a control X-ray of the chest is required in the anterior-posterior and lateral projection. With an ambiguous location of the inflammatory process, radiography is indicated in the right lateral projection [11].

The Platform uses machine learning algorithms to analyze the obtained quantitative and qualitative data, in particular from imaging diagnostics, classifies the results and supports the doctor in the decision-making process.

2.7. Post-disease complications

Some convalescents after COVID-19 disease syndrome develop post-morbid complications. Most often, these are various diseases of the cardiovascular system, in particular: acute damage to the heart muscle, heart rhythm disturbances, inflammation of the heart muscle, new or worsening heart failure, pulmonary embolism. Among patients with COVID-19 and concomitant cardiovascular diseases, higher mortality was reported: on average 10.5% for patients with cardiovascular diseases, 6.0% for patients with arterial hypertension. At the same time, in patients without concomitant cardiovascular pathology, this indicator was 0.9%. The mechanisms leading to damage to the cardiovascular system, for the infection have not yet been fully understood. In addition to cardiovascular complications, there are also frequent pulmonary and cerebral complications, both caused by micro-clots. In adults, damage to the
nervous system and ENT disorders also appear. Neurological disorders are more often observed in elderly patients, the most common are symptoms of encephalopathy, few cases of encephalitis, strokes, delirium, and epileptic seizures, and memory impairments (often called post-covid brain fog) have been described. During the treatment of disease-related complications, the diagnostic and treating procedures typical for a specific complication should be used.

At present, the Platform is limited to collecting data on complications and diagnostic tests performed. This data will be used in the future to expand its functional capabilities to include treatment of complications.

### 3. Functional architecture of the Platform

#### 3.1. Functional components

The aim of the research is to prepare a software and hardware information system supporting the work of a specialist, in particular in the area of COVID-19 infection and related diseases. Although the Platform is addressed to medical specialist, it can also be used by internists. In general form, the Platform helps the doctor with the diagnosis and determining the most effective therapy. Platform, as an input, consumes current information about the patient’s health, obtained during various tests, and historical knowledge about particular and other (anonymous) patients, processed by the Platform using mainly machine learning methods. Currently, the operation of the Platform is focused on detecting and treating cases of COVID-19 infection and related complications. The Platform consists of the following basic systems:

1. Functional monitoring;
2. Obtaining historical data;
3. Medical interviews;
4. Local and mobile diagnostics;
5. Knowledge databases;
6. A specialist office.

These systems are interrelated software and hardware products whose task is to collect and process information in order to obtain results that support the work of a doctor.

#### 3.2. Functional monitoring

A functional monitoring component is a system that integrates all other components of the Platform into one common entity. In addition to intersystem communication, it supervises external communication procedures ensuring data exchange with medical data sources and the user himself, grants the security of collected and processed data, including authentication and authorization procedures. It operates on the basis of a rigid algorithm and uses artificial intelligence tools to a minimum extent. Correct operation of the monitor is fully automatic – no operator function is anticipated.

In the target, operational version of the Platform, it is not expected to create a user account authorizing the use of its resources. However, in the production version of the system, addressed to testers participating in the technological process, the use of the system is preceded by a registration procedure. It is limited to providing the original identified assigned to the user and confirming its identity with a business telephone number. All data necessary for user authentication and authorization are fetched directly from the Platform. In the operational variant, the user can use two modes: educational and diagnostic. The first, educational one, is used only to familiarize the user with the Platform. Authentication is then not required. In the diagnostic mode, authentication based on the ID number (PESEL in Poland).

#### 3.3. Historical medical data acquisition system

In Poland, data on the health condition of citizens is not collected centrally. There are many locations for their storage. The basic ones include: The National Health Fund, Voivodship Medical Information Systems, Electronic Patient Cards and others. They are collected in them, among others: information on past diseases, results of laboratory tests and functional diagnostics, medications and vaccinations take, results of periodic examinations, rehabilitation
procedures performed. Ultimately, the data will be obtained automatically, only for patients for whom diagnostic, therapeutic or rehabilitation procedures are performed. Legal regulations, which hinder the transfer of medical data between entities, prevent the immediate application of such a solution. In the test version of the Platform, the medical data of test users are collected in a semi-automatic mode.

3.4. Local interview system

As the public information systems (local or state government) do not collect data on treatment procedures paid for by the patient himself, the Platform has prepared a system of additional medical interviews based on an intelligent chatbot. It is used to automatically collect medical information about the patient. It has an open architecture that, based on artificial intelligence methods, extends the scope of the interview. The operation of the system focuses on medical procedures absent from the existing documentation, also due to the doctor’s unreliability.

3.5. Local and Mobile diagnostic system

When creating the local diagnostic system, a wide application of laboratory and instrumental diagnostics ordered directly by a specialist was assumed. Particular attention was paid to the use of the results of imaging diagnostics (X-ray, Computer Tomography, Magnetic resonance, Ultrasonographic Examinations). Contrary to the existing ones, the developed system is equipped with an analytical module – software that allows searching for images based on specific criteria, including similarity, as well as inference. Similar solutions have been described in the literature [12, 13, 14]. In our solution, in addition to traditional machine learning methods aimed at image processing (mainly Convolutional Neural Networks), the analytical system extensively uses biological methods, among others, genetic algorithms and particle swarm optimization, thanks to which its search accuracy will increase especially quickly with the number of search operations performed. Traditional diagnostic imaging (X-ray) methods can be placed in the database after they have been digitized, as well as pre-processed, which improves their readability on LCD monitors.

The mobile diagnostics system is designed to collect information about basic life functions during everyday activities. It is primarily intended to supervise rehabilitation procedures and can also be used to diagnose less studied postcovid complications. It is based on standard devices for monitoring the user’s activity or specialized measurement sensors mounted on the patient’s body, communication with the system via Bluetooth, ZigBee, and other low-energy sensor communication methods. Personalized solutions are used when more precise or highly specialized measurement is needed. Thanks to the use of the system, the scope of the Platform’s use is expanded, its medical recommendations become more precise – they are to a large extent addressed to a specific patient. Based on massively popular smartphones, smartwatches and activity monitors, the Platform has the knowledge necessary to estimate changes in vital parameters during physical activity or performing typical everyday tasks, e.g. in the period of preparation for a medical procedure or rehabilitation. The data obtained in this way make it possible to determine the actual physical and mental health of the monitored people, patient care is personalized, and the therapeutic activities performed are optimal for his health. The use of permanent monitoring enriches the individual documentation of the treated patient with data on lifestyle and environmental factors. Individualization of diagnostic and therapeutic measures can be performed with unprecedented time and measurement resolution. It is worth noting that its implementation is almost cost-free, any possible outlays appear only when an attempt is made to interpret the data obtained through it in detail. The functional scope of the system can be extended through the use of specialized sensors, addressed to the diagnosis of specific diseases. Sensors should be mounted directly on the patient’s body or be a part of his wardrobe, manufactured with the use of intelligent fabrics. For the needs of the Platform, a method of joint use of strain gauges and accelerometers to determine chest movements was developed. Both the frequency of breathing and its depth can be measured. The applied solution is equally effective, but much cheaper than the one described in [6], based on the simultaneous use of continuous Doppler radar and ultra-wideband pulsed radar. The use of other sensors is currently at the stage of laboratory research.

3.6. Knowledge database

The knowledge base is a key element of the entire system. It is a place of collecting and intelligent processing of information about patient and his health. Built on the basis of a virtual cluster performing computing and storage
functions, it widely uses various machine learning techniques. The use of machine learning in the diagnosis of COVID-19 is widely described in the literature [1, 2, 12].

The use of a cloud-based organization simplifies the implementation of communication between system components. A solution based on the use of physical servers is also possible. In specific cases, the size of the system (i.e. the number of active users) will determine the choice of solution. Of course, one could imagine a system where the virtual cluster and the physician’s computer would be connected. In practice, however, the effectiveness of the Platform depends on the amount of data processed – the more there are, the more accurate output. Massive use of the Platform, especially in the area of data acquisition, should be considered the key to its success.

3.7. A specialist office

The second basic element of the Platform is the specialist doctor’s office. It is equipped with a computer and local diagnostic equipment. After the patient’s diagnostic tests (imaging, auscultation, morphology, palpation, etc.) are performed, their results are added to the database and are visible for specialist on his computer. Then, they are automatically compared with the knowledge contained in the medical database. On its basis, the expert system decides on further recommendations for the doctor.

Admittedly, the concept of the offered solution is universal, and the type of diseases whose diagnosis and therapy are supported is a secondary issue. The possibility of adapting the solution to a specific group of diseases is mainly determined by access to the collected medical data describing the course of the disease in previous patients and a set of diagnostic equipment, which the office is equipped with. At present, all the authors’ work is focused on diseases related to COVID-19 infection.

4. Architecture of the Intelligent Platform – AI to the rescue

Due to the large dispersion of the health services, it is necessary to properly design the Platform. The architecture of a distributed system will bring the greatest benefits. To speed up the process of detecting changes in the human body after infection (and possible reinfection) with COVID-19, we can prepare a pipeline for segmentation of medical images. The main goal will be to divide the object of interest on a medical image from MRI, CT or X-ray during the disease and after the external symptoms of COVID-19 have subsided. Since it is not possible to predict how the COVID-19 epidemic will affect the development of other comorbidities, the Platform must be adapted to cooperate with other medical institutions. Preparing training of the COVID-19 diagnostic system often requires a large database in order to capture the full spectrum of possible anatomies and pathological patterns. Thus, we propose adoption of Federated Learning (FL, or Collaborative Learning) in the Platform. It can be implemented in different distributed architectures, including peer-to-peer, cyclic and server-client. There are already few approaches of utilizing FL in the healthcare described in the literature [15], including detection of COVID-19 using X-ray images processing [16]. The Platform will include features of FL and can be connected with any specialist office. Moreover, the collaborative learning enables different special offices to safe collaboration. Training process and contributing to the global model on the Platform can be maintained and data is less likely to flip the model. The structure of the Platform with FL as a backend ML technology is shown in Fig. 2. Particular hospitals and offices can gather different data, depending on the equipment.

At the bottom is the Medical Office. In most cases, the facility belongs to a larger system, either physically (part of a hospital or clinic) or logically (network of hospitals or clinics. In the case of public health services, at the top is a central organization that manages entire networks. So, the structure of the system is hierarchical with three levels. With this system architecture the best solution, from the efficiency point of view, is to use Federated Learning.
5. Current progress of the work

Scientific research and implementation work on the Platform are planned for a period of 3 years. According to the developed schedule, its first functionalities appeared in 2020. They will be targeted at machine-based infection detection. It is assumed that after the completion of the work on the Platform, its primary purpose will be to support the diagnostic and therapeutic process of postcovid complications. As the length of the entire cycle is significant, the created algorithmic and software components are highly versatile. Thanks to this, the Platform will be able to be used in the event of another pandemic, as well as in the diagnosis and treatment of civilization diseases.

At present, scenarios for the Platform’s operation are still being considered in order to ensure its long life cycle. Several attractive alternative scenarios are considered. Scenarios can be classified according to several different criteria. The first is the extent to which a specialist doctor is involved in the Platform’s operating procedures. In extreme cases, it can be eliminated from the diagnosis and therapy procedure. Such a solution dominates in modern intelligent medicine systems, but due to the type of diseases (relatively poorly diagnosed COVID-19 infections), it is not recommended in this case. Of course, as the knowledge acquired through machine learning increases, the role of a medical specialist may decrease. The intermediate solution assumes that the decision-making process will still be performed by a doctor and only supported by artificial intelligence. The role of AI will be focused on suggesting a diagnosis and treatment that will be compulsorily accepted with or without modification. The above scenario is the preferred one. The second extreme scenario is the limitation of the Platform to the role of an information system providing the doctor with knowledge, supporting the decision on diagnosis and therapy. All of the above scenarios are linked by the wide use of chatbots for machinery obtaining medical data from patient. In the second and third scenarios, an additional interview may be conducted by a specialist.

The functioning of the Platform can also be modified from the point of view of the sources of information used about the patient’s health. In the richest variant, the specialist, when making a diagnosis and determining the therapy, will be based on the knowledge base, data from mobile and local diagnostics and own experience. In the second extreme case, diagnosis and therapy will be determined only on the basis of the doctor’s knowledge.
Generally speaking, the currently tested Platform operation scenario can be described as follows: Chatbot, on the basis of the interview conducted, introduces personalized information about the patient, his complaints and reported symptoms into the system. AI, if necessary, asks for additional explanations. The detailed and supplementary interview made earlier is performed by the doctor himself. Based on the obtained data, AI initially determines the diagnosis, which is verified by a specialist doctor. After the diagnosis, the Platform supports the doctor in preparing recommendations for the treatment of a specific patient, taking into account their sex, age, health condition, and stage of the disease.

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Generally speaking, the currently tested Platform operation scenario can be described as follows: Chatbot, on the basis of the interview conducted, introduces personalized information about the patient, his complaints and reported symptoms into the system. AI, if necessary, asks for additional explanations. The detailed and supplementary interview made earlier is performed by the doctor himself. Based on the obtained data, AI initially determines the diagnosis, which is verified by a specialist doctor. After the diagnosis, the Platform supports the doctor in preparing recommendations for the treatment of a specific patient, taking into account their sex, age, health condition, and stage of the disease.

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