Limiting the Functionality of IT Systems Monitoring Patients with Diagnosed Metabolic Disorders

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Introduction. Telemedicine is a term coined in the 1970s, which literally means, "healing at a distance" [1]. It involves the use of ICT to improve patient outcomes by increasing access to care and medical information. Recognizing that there is no one definitive definition of telemedicine, the World Health Organization adopted the following broad description: "*The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities*" [2].

Growing data exchange has occurred thanks to advances in transmission technology over the Internet, smart phone apps, as well as other specific closed networks.

Certain elements constitute a telemedicine service:

- A separation or distance between the parties
- Application of telecommunication technology
- Interaction between the units and/or resources
- Medicine or healthcare

Another aspect of telemedicine that has to be considered is the mode of data transmission: synchronous or asynchronous. Synchronous refers to bilateral exchange, with simultaneous communication between the doctor and a patient. Asynchronous telemedicine refers to store-and-forward systems. Both forms of telemedicine are very different from each other but play important roles in providing telemedicine services [3].

Development of telecom networks in Poland. In 1990, the Polish telecom market was formally separated from the state-run "Polska Poczta, Telegraf I Telefon" (Polish post, telegraph and telephone). The Polish state released the first frequencies for mobile networks in 1991 and today the majority of Polish people possess a mobile phone. The growth in the use of mobile phones in Poland has benefitted patients diagnosed with diabetes (and other diseases). Type 2 diabetes is recognized as one of the world's most common chronic medical conditions and represents a major threat to world health. In 2007, the number of people in the world with type 2 diabetes was estimated as some 220 million [4], but by 2011, the International Diabetes Federation estimated that 336 million people worldwide would have type 2

diabetes. This disease kills approximately 4.6 million people every year, which incredibly equates to 1 death every 7 seconds; therefore, close monitoring of patients is crucial. Based on previous long-term data, a doctor can remotely assess the development of the illness and optimize the patient's treatment.

One example is the project launched in 34 European facilities and 15 regions around the world, the purpose of which is lifetime diabetes monitoring, with an initial trial involving approximately 13,000 patients. The national beneficiary of program universal solutions in telemedicine deployment for European health care – United4Health – is the John Paul II Cracow Specialist Hospital, with the total cost of the project being approximately 10 billion Euro. Pilot programs will be conducted for two years and focus particularly, among other factors, on lifetime diabetes monitoring.

This research program is large-scale and is sponsored by many institutions and is not necessarily directed at the average individual patient, and definitely not at a potential undiagnosed patient. Good Polish web applications are available free of charge that are directed at many medical conditions, not just diabetics, and also at healthy people. The solution that can be used by anyone, whether ill or healthy, is DiabLab, an independent scientific research initiative.

Detailed requirements. DiabLab is a system that allows the recording and monitoring of basic parameters, including glucose levels as well as blood pressure and body weight/body mass index. The main focus is to provide patients with 24/7 access to an online service from anywhere in the world. A very important aspect in determining making an accurate diagnosis is constant monitoring, according to the assumption that the more data collected the more accuracy will be the prediction about the illness. Personal data management is a field which has developed, while medical data management has contributed significantly to collecting knowledge about progress in treating various diseases. Conducting individual records in a hand-written log or in a computer does not provide for results repetitiveness, because even the most accurately conducted tests do not guarantee repetitive blood glucose level results. However, the computer version provides additional functions besides data archiving, such as graphical depiction of results, conclusions, predictions or reminders when tests are due. An important feature of electronic systems is the simplicity and user-friendliness of application websites. Therefore, the majority of monitoring apps now use graphic versions, which have replaced more primitive text-only designs. Moreover, present web browsers offer tools that have improved their ease of use and legibility of the visited websites. Examples include the option to enlarge the font on the website or display the website on a mobile device such as a tablet smart or phone.

Thanks to the DiabLab website, a person who is interested in monitoring their health receives access to their own previously recorded medical data or can record the daily results of their blood glucose levels, blood pressure, weight, etc. The website has been designed in such a way that the potential average user will not incur any costs. The app requires access to an internet

connection on devices compatible with standard web browsers, glucometers, scales or blood pressure monitors. Thanks to these devices, a person can monitor and continuously collect their own medical history at home if need be and present the data to a doctor for diagnosis. Another commercial website offers a paid monthly plan, which provides additional analysis of results, a calculator and excellent dietary advice for a patient with diabetes (Type 1 or Type 2).

Online log of daily changes in a diabetic's blood glucose levels – DiabLab. Using Diablab medical databases of patients begins when a person registers with the site and creates an individual account within the system. The patient enters their glucose levels in mg/dL at www.virtualnet.com.pl measured with any available appropriate device. In order to verify the user, before he or she can begin entering data in the online log, they are requested to enter their email address and create a unique password. Such a process identifies a unique patient in the database in a simple and straightforward easily verifiable manner. The most basic medical parameters that require supplementary information in order to monitor correctly the patient's health are: body weight, age and sex. The system requires the user to enter this information, after which it directs the user to a webpage with their measurement's history. There, the patient fills out and updates their blood glucose measurements. The patient is able to use them further on by entering more measurements, as well as other blood parameters [4 –6].

Behavioral causes of limiting the functionality of online medical parameters log DiabLab. From a technical standpoint, the construction of IT systems was enforced by the construction and requirements of IT tools. From a functional standpoint, the main focus was put on ensuring 24/7 access to the online log with the proviso that an internet connection is available [7]. A very important aspect of the system is continuous health monitoring, in accordance with the assumption that the more data collected will mean a more robust, less faulty system. Unfortunately, we cannot influence the repetitiveness of blood glucose level results. An important feature of the system is also the user-friendliness of the website http://virtualnet.com.pl/diab.html, which is why its graphical side was largely scrapped. Moreover, current web browsers offer tools which improve the comfort and legibility of visited website, e.g. font enlargement. Though simple, the solution requires the patient to leave their daily duties for a moment and spend time measuring health parameters and entering the values into the system. Such discomfort is an important one and unfortunately it substantially contributes to patchy data entry, which in turn affects the accuracy of the system.

Legal causes of limiting the functionality of online medical parameters log DiabLab. Polish law falls behind the current state of technology and social mood changes. This results in outmoded regulations on IVF procedures, euthanasia or abortion, with conflicting scientific and ethical models of the application of law. Telemedicine can be divided into the

categories of telediagnostics, medical knowledge, medical information and administrative information. The legal regulation of medical information exchange is the most detailed; however other categories require further regulations [8]. According to the regulations in force, there are several limitations to the delivery of telemedicine services. Such limitations are set out in article 42 of the Doctor and Dentist Profession Act, which requires doctors to share health information only with the patient's consent, except for certain situations described in other legal acts, as well as article 9 of the Doctor Ethical Code. Different regulations more in touch with today's realities are the laws on providing first aid. In accordance with article 14, paragraph 3 of the National Medical Rescue Act, a person performing a rescue operation can use remote assistance from a doctor indicated by the dispatcher. ECG signals, as well as RTG and CT scans have been used in diagnostics for a long time. The perfect solution would be to allow such off-site diagnosis without the need to dispatch a medical team to the site of an accident.

Scalability of telemedical systems. Another fundamental issue of telemedicine is its scalability, which usually is not taken into account in telemedical systems. However, this problem can be solved with the help of appropriate algorithms or a general network structure. At present, we are not yet able to customize telemedical systems. Customizing the algorithms and network structures according to an individual patient's features requires immense computing power. At the moment, we cannot solve such basic system settings as individual blood glucose levels, which includes their daily activity and personal features of the patient

Other causes of limiting the functionality of online medical parameters log DiabLab. The environment that probably, unconsciously, contributes the most to limit functionality is the doctors themselves, who display arrogance and scepticism towards diagnoses suggested by electronic systems. The debate about the possibility of supplementing conventional diagnosing with modern telediagnostic systems bears a resemblance to similar debates at the turn of the 20th century regarding the usefulness of X-rays in medical diagnostics.

A worse situation is found in such areas as telepathology, teleradiology and teleendoscopy, which have always suffered from a deficit of specialists who could perform not only surgery but also off-site diagnosis. Teleconsulting is a tool, which also does not find many 'enthusiastic' supporters. The need for an in-person encounter between a patient and a doctor is today an undisputed element of diagnosis and treatment, even in cases of highly contagious diseases, where doctors put their own health or even their lives at risk. This raises a question that many supporters of telediagnostics have been trying to answer: does each consultation require a direct contact with a doctor?

The most technologically advanced area related to the storage and forwarding of data is the information exchanged by medical administrations. A traditional, hardcopy patient card has been replaced by an electronic version. In

Poland, the public administration systems [9] operating in a data cloud are also implemented in healthcare, i.e. Integrated Patient Information (ZIP) or Electronic Verification of Beneficiary Rights [10, 11] – eWUŚ, storing information on all procedures performed on a patient and the cost. There is also an experimental electronic card introduced by the Silesian Healthcare, entitled Silesian Patient Card, which permanently stores a patient's National Healthcare Fund number and basic personal information. This experiment, provided that the healthcare institution possesses the necessary infrastructure and software, has significantly shortened a patient's registration time. Another experiment funded by the Silesian Marshall Office is the mobile list of subsidized medicine, which allows the patient to learn about the prices of this medicine.

Surveys conducted among DiabLab users. Through the delivery of an accessible, cost-effective and quality healthcare service, information and communication technologies (ICT) carry great potential for solving some of the challenges faced by developed and developing countries alike. Telemedicine takes advantage of the ICT, with the aim of erasing geographical barriers and improving access to healthcare. This is especially favourable for rural populations and in developing countries – the two groups that have traditionally suffered from the lack of access to appropriate healthcare. The survey conducted among many patients and users of DiabLab has confirmed the proposition that one of the biggest and most important obstacles hindering the usage of e-health systems is the lack of basic knowledge and education on these systems.

The main goal of the survey was to check what is a patient's level of knowledge about their own health conditions. Do they deepen their knowledge upon learning their illness diagnosis? Do they take advantage of modern diagnostics and information exchange systems? What role do IT systems play in their treatment? Do the IT systems facilitate or hinder the treatment process?
In conclusion, on the basis of surveys, it can be stated unequivocally that infrastructural access to DiabLab has improved, as it can now be used with a smart phone, computer and other devices which can access the Internet.

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This article is focused, how an important barrier is the legislation concerning for medical support decision systems, for example - DiabLab functionality or rather the lack thereof. To date, there are no legal interpretations on how such a system should operate. In its current form, the system performs the function of supporting specialist decisions. The system is scaled to handle and accept data from a defined and previously entered number of patients. Exceeding this number would affect the cost of maintenance and the system availability, which is currently available free of charge.