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USE OF INTERNET OF THINGS TECHNOLOGY FOR DIABETES MANAGEMENT

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Abstract: The article studies the possibilities of using Internet of Things technology in medicine, in particular in the treatment of diabetes. The difficulties of IoT adoption, advantages and risks are analyzed.

Keywords: continuous glucose monitor, diabetes management, Internet of Things.

Nowadays the Internet of Things (IoT) technology has a broad use in many industries. Basically, the Internet of Things is a network of physical objects that contain embedded technology to communicate or interact with their internal states or the external environment. IoT is transforming the healthcare industry along with others. It has the application options that will benefit patients, their families and caregivers along with government and insurance companies [1].

IoT solutions may be interesting for the following medical organizations:

- Commercial clinics and medical centers that provide multidisciplinary medical services.
- State budgetary medical institutions with sufficient financial support for investment.
- Potentially - state polyclinics and diagnostic centers, especially in the rural areas to solve the problem of lack of healthcare personnel.

The market of IoT in healthcare has a trend of the use of devices by professional sportsmen or people interested in monitoring their health at home, without the health provider’s support[2].Fitness tracker, weight scales, blood pressure monitor, blood glucose monitor, pulse oximeter, thermometer and other may represent devices of Internet of Medical Things. However, even in a simple

scenario with only glucose meter and scales or fitness tracker, a vast number of specific interoperability issues arise.

Firstly, interoperability between device and data hub. For each of the measurement device types there are a number of manufacturers, but no one company manufactures all of these devices. Therefore, a telehealth system vendor will need to work with different suppliers to provide a complete set of measurement devices to its customers.

Secondly, interoperability between data hub and health service provider application. Often the supplier of a data hub is not the supplier of the EMR system that is used to store, integrate, analyze and display health data about the patient.

The solution to these challenges lies in the use of standards and adherence to use case guidelines. A key player in the domain of promoting the use of standards is the Continua Health Alliance, a non-profit, open industry coalition of healthcare and technology companies. Continua issues design guidelines and specifications for ensuring the interoperability of devices and information technology to allow health data to be safely shared [3].

The actors in this interoperability paradigm:

- the personal area network devices (PAN) for the measurement exchange;
- local area networking devices (LAN) for the measurement exchange at a location;
- application hosting devices (AHD) such as personal computer or smartphone;
- wide area networking device (WAN);
- health record application (HR).

The interfaces between these network devices are defined as the PAN, LAN, WAN, and health record network (HRN) interfaces.

The interface is further structured into three distinct layers. The three PAN layers are transport, optimized data exchange protocol and device specialization layer. Continua has constrained the lower level protocol standards for communication to USB and Bluetooth. For the optimized exchange of information in the PAN Interface Continua has selected the ISO/IEEE Standard 11073-20601 Personal Health Device Communication.Similarly, standards are identified on the

WAN interface (HL7 and IHE) and Health Record Network interfaces so that patient information can be sent safely from a WAN device (sender) to an electronic health record device (receiver)[4]. The WAN device could be the Telehealth Centre/Remote Patient Monitoring or the Application Server of a Social Care or Health & Fitness service provider.

The main purpose of the medical institutions is to meet the needs of the population of the area in medical care. At the same time ensuring optimization of budget expenditures and efficient use of resources: material, personnel, financial and other. The problem of most clinics is rational use of medical personnel's time. Often doctors have a lot of administrative work to do, fill in many papers, as well as patient reception. The problem can be solved by the decrease in paper work, decrease of no-show-ups of patients, optimization of reception times and procedures.

To determine the scope of the Internet of Things use in the clinic, diabetes was chosen as one of the most common chronic diseases. The number of people with diabetes in Russia today numbers in the millions and is progressing rapidly. Every 12-15 years the number of patients with diabetes doubles.

People with diabetes have to monitor their activity level, carbohydrates intake and blood glucose levels in order to control the development of the disease. Although long-term complications of diabetes develop gradually, they can eventually be disabling or even life threatening. However, diabetes can be managed or even prevented through real-time health monitoring, personalized treatments, and close collaboration between patient and providers.

If the patient is diagnosed with diabetes, he or she has to visit endocrinologist once a month or once every 3 months if the patient copes well with self-monitoring of his medical indicators. On the visits to his doctor, the patient has to provide detailed information about his diet, physical activity and blood glucose levels. That is where the challenge arises, as the patient often cannot provide sufficient information. What is more, even if the patient takes responsibility and measures glucose levels 4-5 times daily, at home tests do not show the full picture, as hidden peaks in glucose level immediately after a meal are missed, and it is problematic to monitor indicators at night. Due to the lack of information, it is difficult to prescribe an effective treatment.

The main problem in the usual procedure for treating patients with diabetes is the lack of communication between the doctor and the patient, the difficulty of providing up-to-date information about the patient's health. Lack of information

reduces the effectiveness of treatment and can even lead to a diabetic coma if the patient does not have the opportunity to contact a doctor.

The solution to this challenge lies in the use of Continuous Glucose Monitors or special Diabetes Management solutions. For example, if the patient wears a CGM device that measures blood glucose levels every 2-5 minutes and transmits it to the mobile application, which can later provide the access to the family member or doctor and generate alerts or reports on patient's health, he or she has the opportunity to better control personal well-being and save time[5].

However, for the success of the IoT implementation, the following risks should be considered and eliminated [6]:

- Unawareness of IoT among the patients.
- Non-acceptance of technology by medical practitioners or patients.
- Financial constraints and high implementation costs.
- Loss of data privacy.
- Lack of proper support of IT infrastructure, and slow sensor/middleware performance.

The benefits of IoT implementation for patients are linked with better data flow, continuous monitoring, extended analytics and detailed feedback from the doctor due to the up-to-date information. For doctors the benefits are mainly saving time due to decrease of paper work and eliminating the need to collect anamnesis. For hospitals the IoT implementation benefits in increased patient loyalty, effectiveness of care and improved personnel resource use.

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