AI based systems for diabetes treatment: a brief overview of the past and plans for the future

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Abstract. Humanity continues to suffer from deadly diseases. Successes of science are great, but diseases that cannot be treated still exist. The only solution is to continue research in the search for drugs, as well as in methods of treating and preventing the onset of these diseases. This article is an overview of the development of AI on the issue of diabetes in a larger population of the planet over the past couple of years. The article contains information about the latest existing innovations of medical AI that helps in the fight against type 1 and type 2 of diabetes in 2019. A general assessment of existing AI systems and research has been conducted, as well as statistics on the distribution and usage of these technologies in the world today. The main problems that have not yet found a solution in the field of diagnosing and treating diabetes of both types are presented in conclusion.

1. Introduction

How did AI come to medicine? The use of artificial intelligence in medicine today can significantly improve the accuracy of diagnosis, make life easier for patients with various diseases, and with the development of technology it will make the emergence of highly effective personal medicines real, as well as a personal medical assistant in every smartphone. According to Global Market Insights, an explosive annual growth of 40% is expected from 2017 to 2024 in the use of artificial intelligence in the health care market. The large companies, in particular Microsoft, Apple, Google and IBM, is working on creating products using artificial intelligence for the healthcare field. According to analysts, there are already 800 such firms in the world. At the beginning of the 21st century, one of the most striking developments was a joint project of Washington University, Intel and Elite Care to design an artificial intelligence system that could take care of Alzheimer’s patients and improve their quality of life. This system will help patients recover the necessary skills to solve everyday tasks. Thus, the Activity Compass will help you navigate in space and find your way to your destination, even if the patient has forgotten where to go. Several UK hospitals are already using a similar development from Google-DeepMind Health. It is also helps to process all the information about human health, it shares some findings with a doctor, who as a result makes the final diagnosis. Technological giants like Google, Amazon, Microsoft and Apple invest huge sums in the development of artificial intelligence to create personalized search engines or a virtual personal assistant. But, if we talk about medicine, the most important player and supplier of news in this market is IBM and its famous supercomputer Dr. Watson. The American Heart Association has already announced a project with the participation of IBM Watson, whose goal
will be to modernize the treatment of cardiovascular diseases. The supercomputer will analyze the best treatment options using Workplace Health. The program based on AI, Sense.ly monitors the condition of people who have recently undergone long-term treatment or are suffering from chronic diseases. It was developed by a San Francisco startup and raised 8 million venture capital investments initially. The application was created in order to structure data about the state of a person, it sends them to a specialist and gives recommendations. The system is also able to remind you about the time of taking the medicine, the need to visit a doctor. However, it is not yet known when artificial intelligence will be good enough to give 100% accurate advice to doctors about the best method of treatment.

2. Diabetes Mellitus

Before giving an explanation of what diabetes is, it would be convenient to give a few facts to date. The number of people with diabetes increased from 108 million in 1980 to 425 million in 2018. Diabetes is one of the main causes of blindness, kidney failure, heart attacks, strokes and lower limb amputations. In 2018, an estimated 1.6 million deaths were directly caused by diabetes, and another 2.2 million deaths in 2018 were due to high blood glucose.\(^1\) It is clear that diabetes needs the same efforts in research area of developing AI in finding solutions how to treat this disease. Diabetes mellitus is a chronic disease, the main symptom of which is an increase in the level of glucose(sugar) in the blood (or scientifically hyperglycemia). There is glucose in the blood of every person, because it is the main source of energy. The mechanisms of diabetes are plenty and they are quite complicated. But two variants of diabetes mellitus are most common: type 1 and type 2 diabetes. Despite almost the same name, these are completely different diseases. There are a lot of complications that can occur with diabetes, such as an increase level of glucose in blood. The glucose, which does not enter muscle cells, liver and adipose tissue, enters other organs and tissues for which insulin is not needed: vessels of the eyes and kidneys, nervous tissue, walls of large vessels, contributing to the development of diabetes mellitus-retinopathy, neuropathy, atherosclerosis.\(^2\) It is complications that make patients with diabetes disabled and shorten their lives. Thus, maintaining a normal blood glucose level, i.e. the kind with which people live without diabetes is a guarantee of reducing the risk of the development and progression of complications, in other words a guarantee of a long and fulfilling life. Now that we have understood the concept of diabetes, we can go further and analyze, how the development and research in the field of AI will help us in finding solutions to these problems.

3. AI for diabetes diagnosis and treatment

Nowadays there is no perfect AI system that can face and solve the existing problem of diabetes. However, for the treatment and control of this disease, scientists have already offered some special automated insulin delivery systems and “smart” stickers measuring blood sugar.\(^3\) The company Diabnext presented management tools based on artificial intelligence algorithms that will help in diabetes treatment at the international exhibition CES in 2017. The Diabnext AI platform, which integrates several interactive software packages and specialized devices, uses the JARVIS interface to communicate patients with doctors. The «Clipsulin» is intelligent insulin dose registration system, which is compatible with a variety of insulin pens and can capture injection data such as dosage, number of injections, time and date, and then store them in a system running on a smartphone or computer. Doctors and patients can connect to the Diabnext system using a voice-activated interface that allows them to use any device connected to the Internet to monitor patients. Particularly, physicians can visualize insulin injection metrics, medication data, blood sugar levels, patient food and calculated carbohydrate counts, standard test results, trends in glycated hemoglobin, diabetes genome sequencing profiles, and also graphs of changes in exercise and weight data. All this allows to better control the treatment of patients. According to the developers, the Diabnext AI platform allows to unite doctors, nutritionists and nursing specialists, researchers and patients into one big team to create new therapies that will prevent and treat diabetes in future generations. The «Clipsulin», which is part of Diabnext AI, won the 2017 CES Innovation Award in the biotechnology category. The company Diabeter is the leading company which provides methods
for diabetes treatment in clinics of Netherlands, tested a new AI-based system that improved the treatment of the disease. The system «Rhythm» is able to predict and control the blood glucose level of people with diabetes based on data from non-invasive biometric sensors. In this case, for each patient, you can personalize the approach and offer individual treatment, based on its needs. «The introduction of an artificial intellect to the bedside has the potential to markedly change the traditional role of the physician and nurse. In the future, clinicians will oversee the time pattern based analysis and decisions made by the AI to assure that the patients under their care are safe from the nascent, twenty-first century dangers of statistical insignificance and heterogeneous treatment effects».

There is AI revolution nowadays, in particular in medical causality, where deep learning neural networks screen through big data bases, extracting associations between a patient’s condition and possible causes. Performance overview and analysis of an Artificial Intelligence based systems in medicine was discussed in Ref.7, 8, 9.

Figure 1. The number of published articles in Google Scholar which includes the terms «diabetes» and «artificial intelligence» in the past 5 years.

3.1. The problem of multitasking

The problem of multitasking of AI is that it is not deployed in sufficient volume yet. Most of systems which are in use today can: diagnose the patient with diabetes, or select the right treatment for the patient, or monitor the patient's condition. In general there are just a few well qualified systems that can do not do all this operations together, but at least can deal with two tasks. But in most cases, we can observe the following picture today. There are AI diagnosticians who collect data on the level of sugar in the patient's blood. There are also systems that can assist a doctor for a particular patient in the selection of personal treatment for this patient. There are also AI pharmacists, which are even not presented as a finished product today. AI pharmacists will be directly involved in the development and search for new drugs that are more effective in diabetes treatment and its complications. Over the past 5 years, more than 35 thousand articles on the problem of diabetes and the search for solutions in the field of computer technology have been published. The main problem that needs to be emphasized is that 90% of these articles considered diabetes type 1 and 2 solutions separately, that many solutions were proposed in the use and development of technologies for diagnosing patients with already identified diabet- es. A new machine learning framework for diagnosing the type 2 diabetics using temporal fuzzy ant miner decision was described in Ref.10. Another novel model which will use hybrid machine learning for diagnosis of diabetes type 2 is offered in Ref.11. Article describes another solution that can be used in the diagnosis of diabetes type 2. An expert system called «Diabetes Diagnoser» which is powered by four Artificial Intelligence based algorithms was developed. 12 All of algorithms have been trained,
tested and validated using a primary database of 400 people from different sections of the society.

3.2. Prediction and probability

The basis of the answer to the question to which scientists from all over the world are looking for is not in the treatment of diabetes that has already been identified in extend patient, here it is necessary to drip deeper. It would be much more effective to prevent the problem than to fight against an existing one. The field of machine learning is quite well developed today. So using machine learning and the theory of probability in predicting which child is prone to diabetes disorder and which one is not. According to research scientists already made it clear that almost 65% of patients with diabetes, especially with type 2 diabetes, inherited this disorder genetically.13,14

![Figure 2. The percentage of published work on certain topics.](image.png)

Today, the algorithm can predict human qualities such as growth, bone density, and even the level of education that a person can achieve based on his genome. For example, Stephen Wan, an epidemiologist at the University of Nottingham in the UK, in his study compared the ACC/AHA guidelines with four machine learning algorithms: random forest, logistic regression, gradient enhancement and neural network. All four algorithms were aimed at analyzing the multitude of data that, in theory, would allow AI to make medical predictions better than humans. In this case, data were obtained from electronic medical records of 378,256 patients in the UK. The goal was to find patterns of records that were associated with cardiovascular events. Using this direction, making medical predictions, for the future research will help outline the genetic architecture as well as the future risk of diabetes development. Group of scientists made their research on creating algorithm to predict the future risk of diabetes development: «We decided to develop a multi-step clinical decision tree that uses various clinical characteristics and biomarkers to identify patients with MODY» .15 Furthermore, using artificial intelligence in creating and developing new drugs for the treatment of both types of diabetes is in dire need of deep and extensive research. According to Judy Stewards, Pfizer’s top manager, it takes more than 12 years to develop and launch a new drug. Preparations are complex organic compounds whose structure is searched almost blindly. The scientist changes the molecules in the original compound and checks the reaction of the experimental animal to the drug. And so on until the optimum result is achieved. After that, they can begin clinical human trials. Before entering the market, the drug passes a lot of inspections and checks. But even the most rigorous tests do not guarantee that it will be effective. Using Artificial intelligence in this direction will give opportunity to find and develop more accurately form the necessary molecular structure for drugs. Today there are already a few companies offering that kind of solutions. One of them, Atomwise, uses supercomputers to find the optimal formula for a drug. Another example of a similar project is Berg Health. But both companies oriented more in finding drugs for cancer treatment and heart diseases. Blood glucose level prediction based on support vector regression using mobile platforms and Data based prediction of blood glucose concentrations using evolutionary methods was discussed in Ref. 16,17. Because of a lot of complications, from 2 main types of diabetes, type 1 diabetes is more dangerous and less common. There are many research works on diagnosing and finding a right
treatment for type 1 diabetes, such as automated blood glucose control.\textsuperscript{18,19,20}

4. Conclusion and future work
This article reviewed the published articles on the use and development of the field of artificial intelligence to solve the problem of diabetes today. The latest innovations in the field of diagnosis, selection of diabetes treatment, the statistics of published articles and research over the past five years were introduced in this paper. It is concluded that the scope of the development and use of artificial intelligence to fight against diabetes is in dire need of deep analysis and development. Further work will be to study diabetes and its genetic inheritance, and the possibility of developing systems using machine learning and deep learning techniques and probability theory to predict the likelihood of diabetes in young generation. There will also be an analysis of the problem of multitasking of today's systems, as taking both types of diabetes and going through of all stages from diagnosis to drug development for diabetes treatment.

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