Modern Technologies in Diabetes Treatment

Lucie Cerna and Petra Maresova
Department of Economics, Faculty of Informatics and Management,
University of Hradec Kralove, Hradec Kralove, Czech Republic

Abstract: The incidence of diabetes is rising across the world. This global problem significantly affects the economic and social development of the 21st century. Modern technologies penetrate into all spheres of medicine and the treatment of diabetes is no exception. These devices help patients to better control this disease. The aim of this study is to specify the advanced technologies used in medical devices for diabetes and verify patients' attitude to these technologies. On the basis of this knowledge an approach for more effective use of these technologies for patients is proposed. To achieve the stated objective, a method of literature review and quantitative research were used. To verify the attitude to modern technologies the research question was formulated as follows: "do patients know the modern technical tools which can to control diabetes". The research question was verified on the basis of responses from a questionnaire survey among 313 diabetic patients in the Czech Republic. The results of this research confirmed that the offer of diabetes applications was wide but the awareness of technology possibilities for diabetes patients in the Czech Republic is low.

Key words: Technology, diabetes mellitus, mobile application, attitude of patients, knowledge

INTRODUCTION

The incidence of diabetes is rising across the world. This global problem significantly affects the economic and social development of the 21st century. According to the International Diabetes Federation (IDF), 8.3% of adults suffer from this disease. The total number of adults is approximately at 382 million. That number will continue to increase and therefore many states are starting to deal with the issue of diabetes (WHO, 2011). Diabetes is not just a health or social issue but also it is an economic threat of the 21st century. It is estimated that in Europe in 2014, average costs were 2,760 USD per one diabetic and 10,800 USD in the US. Diabetes relates not only to the direct costs of medical care but its indirect costs must be also to taken considered. The cause of indirect cost consist in reduced productivity due to morbidity and mortality. Already in the 80s of the 20th century the first studies in the US were initiated as a response to the growing threat. These studies dealt with the costs associated with diabetes. The survey of the American Diabetic Association (ADA) of 1992 was one of them. In those years, the US recorded approximately 7.7 million people suffering from diabetes and the total costs were a calculated at 91.85 billion USD (Javitt and Chiang, 1995). Modern technologies penetrate into all spheres of medicine and the treatment of diabetes is no exception. These devices help patients to better control this disease. The Interconnections between individual devices and data sharing are becoming a new trend. The main objective is to create a fully automated closed loop where each device will assess and execute necessary measures to achieve and optimal health state without the patient load. This research is in progress. Therefore diabetics have to learn to evaluate outputs and interact with these individual devices.

MATERIALS AND METHODS

To achieve the stated objective, a method of literature review and quantitative research were used. To verify the attitude to modern technologies the research question was formulated as follows: "do patients know the modern technical tools which can to control diabetes". The research question was verified on the basis of responses from a questionnaire survey among 313 diabetic patients in the Czech Republic.

Modern technologies as support of basic medical devices for diabetes: The basic devices for the diabetes control are a glucometer. The glucometers can be divided according to the used technology as follows:

Corresponding Author: Lucie Cerna, Department of Economics, Faculty of Informatics and Management, University of Hradec Kralove, Hradec Kralove, Czech Republic

Table 1: Technologies for glucometers

Type of technology	Specifications	Type of the glucometer	Source
Bluetooth technology	Data can be sent wirelessly to other devices	Diamond Mini, iHealth BG5, OneTouch Verio Sync, MyGlucoHealth Wireless, Genesis Meter	Tsai (2015) and Walsh *et al.* (2015)
Cellular technology	The devices have a cellular connection and data are automatically stored in the could system without synchronization via another device	In Touch, Solus Mobile, Telcare BGM	Walsh *et al.* (2015)
USB port	Data can be downloaded to a computer by using a USB cable or directly via the USB port.	Contour Next USB, Contour Next Link	Tsai (2015), Walsh *et al.* (2015), and Why (2007)
Data cable	Standard technologies connections via cables	FreeStyle Freedom Lite, Contour, Diamond Prima, OneTouch VerioIQ, OneTouch Vita, OneTouch UltraEasy	Why (2007)
IR sensor	For the data transfer into the computer, another device (reader) is required	Accu-Chek Performa Nano, Accu-Chek Performa, Accu-Check Combo	

- Bluetooth technology
- Cellular technology
- USB port
- Data cable
- IR sensor

Table 1 describes type of glucometers with connection to the type of the used technology. Thanks to the development of mobile technologies, a new opportunity of self-control for patients is formed. It is estimated that currently, more than one billion telephones and 100 million tablets worldwide are used. This fact is an ideal opportunity for their use in health care (Tsui *et al.*, 2014). Diabetes patients have to check some indicators as: blood sugar levels, body weight and carbohydrate intake and insulin doses. Recording of all the results is essential. The collected data offer a complete history of patient's health. The data recording can be done in several ways such as paper documentation or data downloads to a computer. Mobile applications represent an alternative solution. They provide another very useful tool in the treatment of diabetes with interesting functions (Ristau *et al.*, 2013; Lee, 2014).

Functions of diabetes applications:
- Documentationdata input of blood glucose values, the number of hyperglycaemia or hypoglycaemia, about eating habits, physical activity records and drug use
- Data analysis and their interpretationdata collection, glycaemia trend graphs based on the previous data
- Informative (educational)information of diagnosis, disease, treatment options and associated diseases, saccharide units database
- Communicationdata sharing among physicians, social networking or blogs, health state reports, sending SMS messages and e-mail to doctors and family members
- Drugs reminders, insulin and measurement
- Recommendations and advice on treatment

The applications also motivate. Patient thinks about his/her illness, he immediately can see a response to the resulting value and thus he can adjust his own future goals. Some studies have shown a reduction in glycated haemoglobin in connection with the use of mobile applications and the overall improvement of adherence (Free *et al.*, 2013). This fact has to motivate diabetes industry to invest in this area. In 2014, the market appeared >650 applications designed for diabetics working on the iOS system or Android. Due to the high prevalence of diabetes, the number is growing. Most applications are available free of charge (over 60%). There in user ratings are not lower in comparison to paid versions (Arnhold *et al.*, 2014). Developers are small companies or individuals. That fact carries many advantages but also disadvantages. Only 1.2% of diabetic patients use an application to encourage self-monitoring. The low use is connected with low sophistication compared to other mobile applications. Only a few diabetes applications combine more than one function.

Table 2: The absolute and relative frequency of smartphone owners according to the type of diabetes

Do you own the smartphone?	DM1	DM1 (%)	DM2	DM2 (%)	Different type	Different type (%)	Total	Total (%)
Yes	106	74.6	83	49.4	2	66.7	191	61
No	36	25.4	85	50.6	1	33.3	122	39
Total	142	100.0	168	100.0	3	100.0	313	100

Patients are forced to use several applications simultaneously. The data become less transparent and the connection between them is lost. The key functions are missing such control of associated symptoms (Arnhold *et al.*, 2014).

An example of a mobile application which allows to download the data from the glucometer or other medical device is SiDiary. This application is free of charge. It supports many languages data can be recorded via Bluetooth or manually. The recorded data are weight, physical activity or dose of insulin. These data are then shown in graph. It is a comprehensive tool for self monitoring and it is one of the best diabetes applications. The applications are a comprehensive tool for self monitoring, making it one of the best evaluation of applications. Disadvantages include a user interface that is not very well developed compared another applications as: OnTrack Diabetes, MySugr, Diabetes:M. OnTrack application does not allow wireless downloads. OnTrack do not differ from SiDiary significantly. MySugr is one of the most graphically sophisticated application but neither

This application is able to download data wirelessly. The solution is to make a photo of the results from the glucometer and the application processes these data. Photos complete the information about glycaemia which make this even more attractive. The last-mentioned application is Diabetes: M. This applications is free of charge. Its graphical refinement is one of to the most comprehensive applications although the data can be not recorded wirelessly. Diabetes: M. supports an import of the data from diabetic equipment (Carelink, Glucofacts and OneTouch) and is able to export reports and subsequently stored them into the server storage such as DropBox or Google Drive.

Simplicity is among the most important parameters. Applications must be intuitive, not to burden, do many operations automatically so that also the older population should not have any problems with their service. In doing so, patients must be asked about their needs and difficulties during the treatment of diabetes.

Patients' attitudes toward the use of technology for diabetes case study in the czech republic: To verify the attitude to modern technologies tin diabetes treatment in the Czech Republic the research question was formulated: "do patients know the modern technical tools which can to control diabetes". The research question
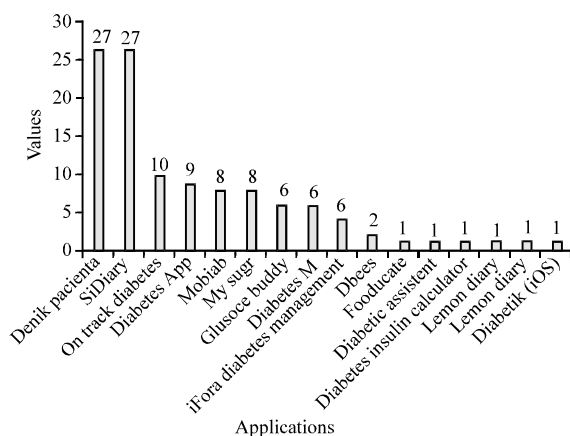

Fig. 1: The absolute frequencies of awareness about specific mobile applications for diabetes treatment

was verified in 2015 on the basis of responses from a questionnaire survey among 313 diabetic patients in the Czech Republic.

Results of the questionnaire survey: Only 4% of the diabetics use a mobile application for self-monitoring of the treatment, an additional 8% of the diabetics use the application but they are not satisfied with it and 88% of the diabetics do not use any application.

Expansion of smartphones among the diabetics: Mobile applications in the treatment of diabetes are meaningful for people who own a smart phone. About 61% of respondents own a smart mobile phone. It can be assumed that the aging population and the development of technology will change and the number of owners of smart phones will increase (Table 2).

Awareness of diabetes applications: The awareness plays a major role. Only 25% of respondents know some kind of application designed for diabetics. The remaining part of respondents have never heard of any application. Even a small number (few) diabetologs (9%) know about these technological possibilities. Within the research 11 applications were evaluated by the respondents. The Applications SiDiary and diary patient were chosen 27 times. The diary of a patient is not primarily intended for diabetics (Fig. 1). This application is used more as a notebook for medications, allergies, vaccinations and blood glucose values without the possibility of further

processing and analysis. These results indicate that the respondent have low knowledge about the diabetes applications.

The use of applications for health control: Surprisingly, in comparison with diabetes, in other fields of healthcare mobile applications are widely used (as pedometers, menus and sleep control). These other applications are already used by >30% of respondents. It has been shown that patients have basic information about the treatment but their focus on modern methods of treatment (mobile applications or CGM devices) is low.

RESULTS AND DISCUSSION

The aim of this study was to specify the advanced technologies used in medical devices for diabetes and verify patients' attitude to these technologies in the Czech Republic. To verify the attitude to modern technologies the research question was formulated as follows: "do patients know the modern technical tools which can to control diabetes". The presumption of low knowledge and frequency of the use of mobile applications in diabetes has been confirmed. Only 4% of the diabetics use a mobile application, an additional 8% of the diabetics use the application but they are not satisfied.

The low frequency of the use of modern technologies in diabetes is confirmed by other studies (Free *et al.*, 2013), too. The findings of the University of California at San Francisco of online survey examining the data downloads on the diabetes device were published in 2014. 155 diabetic patients (77 males and 78 females) were included in this research. The results showed that approximately 70% of patients have never downloaded data from their monitoring devices. This research monitored the low level of knowledge in this area. As the respondents, for example, stated: "I did not know that I can do that", "I did not care about the possibility to use an application." The causes are attributed to their knowledge of diabetes devices and difficulties with data downloading and reporting (Free *et al.*, 2013). In the context of the current research in the Czech Republic it was found that only 6% of 1 type diabetes patients were downloading the data from the glucometer to a computer or mobile phone although 95% of patients own these devices.

Another study was published and carried out, by a team of blog diabetes mine which currently ranks among the top rated blogs in the field of diabetes. The aim of this study was to discover patient's opinions and needs in the treatment of diabetes. In addition, researches wanted to influence diabetic industry to change current
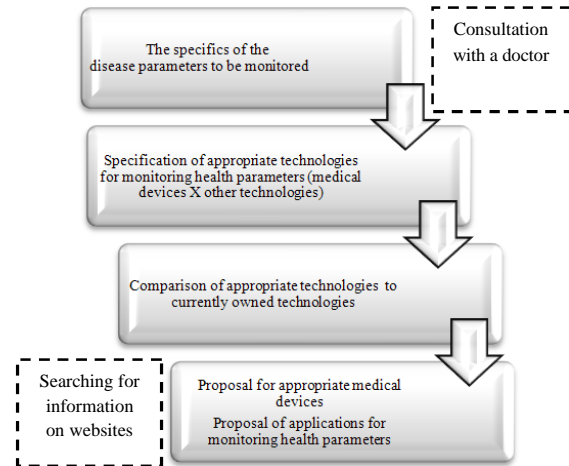

Fig. 2: An approach for deployment of healthcare technologies among diabetes patients

technologies. Participants of the research were diabetic patients and caregivers, totally 796 respondents. Similarly to the conducted research in the Czech Republic, the results showed that doctors were identified as the most frequent sources of information. A better situation than in the Czech Republic is in the data downloading from monitoring devices (approximately 40% of respondents). 60% of the respondents use mobile applications and software tools for diabetes monitoring (in the Czech Republic only 30%). Participants also evaluated the quality of applications as a user interface or software compatibility.

The solution for more frequent use of modern technologies is in cooperation with doctors. They are the most common information source for patients. Figure 2 represents an approach for deployment above mentioned technologies among patients. Given that patients have a positive attitude towards the use of medical devices and applications (as confirmed by surveys) it, is possible to increase their use within specific types of disease. Not only within a general health parameters such as pulse frequency or pressure. The main source of information for patients should be doctors or websites associating patients of diabetes whichsss according to the survey results are used frequently.

CONCLUSION

The aim of this study is to specify the advanced technologies used in medical devices for diabetes and verify patients' attitude to these technologies. On the basis of this knowledge an approach for more effective use of these technologies for patients is proposed.

ACKNOWLEDGEMENT

REFERENCES

Arnhold, M., M. Quade and W. Kirch, 2014. Mobile applications for diabetics: A systematic review and expert-based usability evaluation considering the special requirements of diabetes patients age 50 years or older. J. Med. Internet Res., 16: 104-104.

Free, C., G. Phillips, L. Galli, L. Watson and L. Felix *et al.*, 2013. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: A systematic review. PLoS Med., Vol. 10.

Javitt, J.C. and Y. Chiang, 1995. Economic impact of diabetes: Diabetes in America. National Inst. Diabetes Digestive Kidney Dis., 1995: 601-611.

Lee, J., 2014. Hype or hope for diabetes mobile health applications?. Diabetes Res. Clin. Pract., 106: 390-392.

Ristau, R.A., J. Yang and J.R. White, 2013. Evaluation and evolution of diabetes mobile applications: Key factors for health care professionals seeking to guide patients. Diabetes Spectr., 26: 211-216.

Tsai, A., 2015. Meters: Does your device measure up?. Diabetes Forecast., 68: 42-51.

Tsui, I., A. Drexler, A.L. Stanton, J. Kageyama and E. Ngo *et al.*, 2014. Pilot study using mobile health to coordinate the diabetic patient, diabetologist and ophthalmologist. J. Diabetes Sci. Technol., 8: 845-849.

Walsh, J., R. Roberts, R. Morris and L. Heinemann, 2015. Device connectivit: The next big wave in diabetes. J. Diabetes Sci. Technol., 9: 701-705.

Why, S.M.B.G., 2007. Benefits and limitations of self-monitoring of blood glucose. J. Diabetes Sci. Technol., 1: 130-132.