

Preventive Systems for the Late Complications of Diabetes

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Aim of this work is to review and characterize methods and systems that are used to prevent onset and to slow down the progression of the late complications of diabetes. Two groups of methods and systems that might be used to prevent or to slow down the progression of the late complications of diabetes are characterized in this paper. Each of these two groups serves a different purpose. The first group is composed of the systems that facilitate a maintenance of strict metabolic control in diabetic patients, i.e. the systems which are used for monitoring and treatment of diabetes. The second group contains systems that are aimed at screening/monitoring or treatment of the risk factors or the early signs of the late complications. Obesity increases risk of diabetes and its complications. Thus, body mass monitoring and control systems are examples of the tools that belong to this group. Other examples include the diabetic retinopathy telescreening systems and the systems for monitoring of the diabetic foot syndrome.

K e y w o r d s: diabetes mellitus, diabetes late complications, telemedicine, glucose monitoring, diabetic retinopathy, diabetic foot syndrome, telecare, telemonitoring

1. Introduction

According to the WHO the main chronic diseases including diabetes are related to some non-modifiable risk factors such as age and heredity but also to some common modifiable risk factors such as unhealthy diet or physical inactivity. Common interaction of these factors together with some underlying socioeconomic, cultural, political and environmental determinants, e.g. population aging leads to intermediate risk factors such as overweight/obesity, glucose intolerance, insulin resistance, which in turn leads to diabetes [1].

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Diabetes mellitus is listed among the most serious and dangerous chronic diseases. The International Diabetes Federation and the WHO describe the dramatic increase of the number of cases of diabetes that is occurring throughout the world today as “the most challenging health problem of the 21st century” [2]. Diabetes is characterized by high blood glucose level (hyperglycemia) leading to a number of late complications related to the microangiopathy, the macroangiopathy and the neuropathy that impair vital functions of the body. The most serious complications include: the diabetic retinopathy (DR), the diabetic foot syndrome (DFS), the diabetic nephropathy as well as cerebrovascular, cardiovascular and peripheral vascular diseases, which means that diabetes is not only one of the main chronic diseases but it is also a risk factor for some other chronic diseases. Because of this in the course of diabetes the risk of kidney failure, heart attack or stroke is 2–4 times higher than in the healthy population. Moreover, the prevalence of blindness is 10 times higher and the lower limb amputations have to be conducted 20 times more often among diabetic patients. In fact, DR is the primary cause of blindness in the developed countries and the diabetic foot syndrome is the primary cause of no traumatic lower limb amputations [2].

The most obvious way for preventing the late complication of diabetes is to prevent diabetes itself. This has not been possible for type 1 diabetes yet. However, in case of type 2 diabetes all the life-style related factors, such as diet, physical activity, alcohol consumption, etc. might be controlled and modified in a way lowering the risk of onset of the disease. An appropriate control of the life-style related factors, especially diet and physical activity, is also necessary during treatment of diabetes. In this respect, similar or virtually the same methods and systems can be used to facilitate such a control preventing from both diabetes in case of a healthy person and the late complications of diabetes in case of a diabetic patient.

There can be distinguished two groups of methods and systems that might be used to prevent or at least to slow-down the progression of the late complications of diabetes when diabetes has been already diagnosed. Each of these two groups serves a different purpose.

The first group is composed of the systems that facilitate a maintenance of strict metabolic control, i.e. long-term stabilization of the glycemia course in the normal range in diabetic patients, that is the systems which are used for monitoring and treatment of diabetes. The glucose concentration meters (for sparse or continuous; invasive or non-invasive measurements), the electronic logbooks, the home and mobile telecare systems, the data analysis and decision support systems and the insulin dosage devices such as injectors and pumps are the major components of such a system. Currently, these elements are usually interconnected in the open-loop systems but close-loop systems have been under development for the last 30 years, too.

The second group contains systems that are aimed at screening/monitoring or treatment of the risk factors or the early signs of the late complications development. Obesity increases the risk of the micro- and macroangiopathy or the foot ulceration

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