Non-Invasive Blood Glucose Monitoring in Ears

Seminar Paper

by

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Abstract

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1 Introduction (chapter)

1.1 Motivation

Diabetes is common. Approximately 37.3 million people in the United States have diabetes, which is about 11% of the population. Type 2 diabetes is the most common form, representing 90% to 95% of all diabetes cases. About 537 million adults across the world have diabetes. Experts predict this number will rise to 643 million by 2030 and 783 million by 2045.[1]

1.2 Goal and Scope of This Paper

2 Background: Diabetes and Blood Glucose Monitoring

2.1 Medical Context

Diabetes mellitus (I will be referring to it as diabetes but diebetes mellitus is the medical term) is a metabolic disease, involving inappropriately elevated blood glucose levels (hyperglycemia).[19] It can lead to severe complications, such as cardiovascular disease, kidney damage, nerve damage, eye and oral complications.[4] Diabetes can also develop when the body of a person isn't responding to the effects of insulin properly. Diabetes affects people of all ages and most forms of diabetes are chronic.

The most common types of diabetes are Type 2, Prediabetes, Type 1 and Gestational Diabetes. The most common of these is Type 2 Diabetes. This is the type where the body doesn't respond to insulin poperly or the body doesn't produce enough insulin. It is possible though that both is true for a person. Prediabetes is a condition where blood glucose levels are higher than usual, but not as high as to be diagnosed with Type 2 diabetes.[1] Type 1 diabetes on the other hand is an autoimmune disease, which is a malfunction of the body's immune system that causes the body to attack its own tissues.[1,9] In this case the immune system attacks insulin producing cells in the pancreas with up to 10% of people having diabetes, having Type 1 diabetes. Another form being Gestational diabetes that develops and usually goes away during pregnancy. But people that had Gestational diabetes are at a greater risk of developing Type 2 diabetes later in life.[1]

2.2 Traditional invasive measurement techniques

When left unmanaged and untreated, diabetes causes serious health problems, as discribed earlier. So it is crucial to manage diabetes where monitoring blood glucose levels is essential. Current/-traditional techniques to measure blood glucose levels are invasive. The most common method to measure the blood glucose level is with a glucose meter, or glucometer. This is a small and portable machine that can measure a person's blood glucose level, requiring only a small sample of blood. There are multiple ways to collect the blood sample but the most common one is to prick the finger with a small needle. Other test sites are the upper arm, forearm, base of the thumb or the thigh. But readings in the fingertip are much more accurate so preferred.[8]

Another method is continuous glucose monitoring where how the name already suggests the glucose levels are monitored constantly. The sensor for the monitoring is either inserted under the skin (a small needle) and held in place with a stick patch (disposable sensor) or it is placed fully under the skin (implantable sensor). These sensors then transmit the data to a reciever, which more often is a mobile phone. There a person can see its glucose levels, trends and get alarms, if the blood glucose level is too low or high.[21]

2.3 Need for non-invasive approaches

While continuous glucose monitoring (CGM) offers significant advantages over periodic finger-prick testing, such as enabling easier management of blood glucose levels and reducing the incidence of acute glycemic emergencies, the invasive nature of traditional methods remains a barrier to widespread and sustained use. Disposable CGM sensors must typically be replaced every 7 to 14 days, and implantable variants can last up to 180 days.[21]

However, these conventional and minimally invasive methods are often painful, can be costly, and may discourage consistent monitoring, leading to poor adherence to testing routines[14]. By contrast, non-invasive glucose monitoring approaches hold promise for daily and continuous use by being painless, more comfortable, and potentially less costly.

Such innovations could significantly improve patient compliance and quality of life, addressing the limitations of traditional monitoring modalities.[10,17] Ultimately, non-invasive technologies may deliver effective, user-friendly alternatives that facilitate better long-term management of diabetes.

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