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ISSN 2380-5544

Journal of Diabetes Research and Therapy

Case Report | Volume: 3.2 | Open Access

The Advancing Technologic Role in the Treatment of Diabetes

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Received date: 07 Sep 2017; **Accepted date:** 16 Oct 2017; **Published date:** 25 Oct 2017.

Citation: Roberts VL, List K (2017) The Advancing Technologic Role in the Treatment of Diabetes. J Dia Res Ther 3(2): doi http://dx.doi.org/10.16966/2380-5544.130

Abstract

Much has changed in the management of diabetes since the days of chemical reactions within urine samples and the use of extracted animal insulin. However, highly technologic and reliable tools such as continuous subcutaneous insulin infusion (CSII) and continuous glucose monitoring (CGM) devices especially utilized together are used in only a fraction of the diabetic population. The development, use, and positive effects of these two technologies are discussed below.

Case Presentation

The patient (LA) is a 31 year old female with a past medical history of type 1 diabetes × 11 years with no comorbidities. Medications include a basal/bolus insulin regimen by carbohydrate counting and self monitoring of blood glucose (SMBG) 4x daily. Family medical history is positive for diabetes; father is deceased due to complications from such. Pertinent social history is positive for former IV drug abuse and being a single parent to an intellectually disabled child. Physical exam is unremarkable and last reported HbA1c value was 11.1%.

Plan

LA came in as a new patient to discuss an alternative treatment regimen for her type 1 diabetes. She is seeking more autonomy in the management of her condition and is prepared to adapt to a new method. After discussing goals and limitations, LA was found fit to be a candidate for CGM and CSII and is returning in 4-6 to begin the process.

Discussion

CSII, i.e. the insulin pump, has been around for almost 40 years and is used in up to 30% of type 1 diabetics [1,2]. Throughout the decades, devices have improved in size, efficacy, and ease of use. One of the first commercial insulin pumps, Auto syringe, became available in 1978 and was referred to as the "Big Blue Brick," weighing up to almost half a kilogram [3].Primitive devices like the latter had problems such as tube blockages, needle dislodgments, and infection at injection sites [3].Pump therapy has greatly improved, with products weighing as little as ounces and containing touch screen options for ease of use. After years of development, CSII has not only liberated those with type 1 and 2 diabetes but also causes a significant reduction in HbA1c in adults and adolescents [4]. Pump usage can also help lower the amount of insulin dosage per day, 14% in one meta-analysis [5]. Manufactures like Medtronic and Animas generate products that are able to adjust insulin administration to increments as little as 0.025 units/hour [3]; precise dosing such as this helps to maintain a tight control of blood glucose levels to ultimately keep patients as close to normoglycemic levels as possible.

As there continues to be great strides in the treatment of diabetes, such as CGM, the concept of an artificial pancreas is no longer an imaginative one. With the use of another device weighing only ounces, CGM uses electrical currents generated by glucose within the bloodstream to provide an average glucose level every 5 minutes [6]. Thus, GCM can provide much more thorough data to patients and healthcare providers to assist in optimal management of blood glucose levels and HbA1c. In a 12 month follow up, the Juvenile Diabetes Research Foundation CGM trial concluded that the group using CGM greater than 6 days per week had a substantially greater improvement from baseline HbA1c than the group using CGM less than 6 days a week [7]. However, while CGM has been in use since the early 2000s, it is only used in as little as 15% of type 1 diabetics [8]. A major economic advantage of using CGM is reducing the cost of diabetic emergencies. In a retrospective cohort design, the average cost for an inpatient admission due to a hypoglycemic episode was $17,564 [9]. By providing values every 5 minutes, CGM has the potential to significantly reduce these costs by helping to prevent such events before they occur.

Although CGM devices require a minimum of two finger-stick samples per day for calibration, obtaining dozens of glucose readings prevents the patient from having to collect multiple samples throughout the day [10]. Our patient above shared the example of being out with friends and because of the setting, was less likely to sample blood from a finger-stick before eating lunch in order to dose her insulin. One qualitative study found that CGM was rated as significantly superior in multiple domains when compared to SMBG [11]. Diabetes management encompasses both bio and psychosocial elements, and tools such as CGM assist in providing a holistic approach to care.

There have been several studies to show how the two technologies in combination can result in positive treatment outcomes. For instance, the ASPIRE study looked at a CSII device from Medtronic which syncs with a CGM sensor. In the trial, the pump suspended insulin delivery for 2 hours if blood glucose levels fall below 70 mg/dL during sleeping hours; utilizing this threshold caused a significant decrease (32%) in the rate and severity of nocturnal hypoglycemia [12]. The STAR 3 study is one of the longest and largest trials comparing the use CSII and CGM against multiple daily injections (MDI) therapy and SMBG. After one year, those using CSII

with CGM were more likely to have HgA1c levels fall within age-specific targets and have lower mean levels of blood glucose with no increased risk of hypoglycemia [13]. The most recent study - the DIAMOND study - looked at two groups across 28 weeks using CGM: CGM plus CSII and CGM plus MDI. The use of CSII increased CGM-measured time in the glucose concentration range between 70-180 mg/dL by an average of 83 minutes, or a 6% proportion of the day [14]. While there was no glycemic control improvement reflected by HgA1c levels, there was a reduction in mean glucose concentration and hyperglycemia in the group using CGM plus CSII [14].

The American Association of Clinical Endocrinologists (AACE) along with the American College of Endocrinology (ACE) has gathered on two separate occasions to come to a consensus on the topics of CGM and CSII. Patient selection for CSII includes criteria such as the administration of 4 or more insulin injections and 4 or more self-monitored blood glucose measurements daily, a strong motivation to achieve tighter blood glucose control, and intellectually and physically willing to undergo pump therapy and maintenance [2]. Our patient meets nearly all of these criteria. Also, consensus conference participants unanimously agreed that real-time CGM should be an option to all who are insulin-dependent patients [15]. The next step is for these two technologies to combine into one; while this advancement may seem far from now, it is not out of sight. CGM with the use of CSII is the most current, efficient method for diabetes treatment and should be considered for responsible patients who would like a principal role in the management of their condition.

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