**Analyzing the Effect of a Structured Daily Schedule on Blood Sugar Control for a Type 1 Diabetic**

**Abstract**

Managing Type 1 Diabetes requires consistent monitoring and many adjustments to insulin, diet, and lifestyle. The timing of insulin doses, meals, physical activity, and other daily routines plays a very critical role in staying within a healthy blood glucose target range. A structured daily schedule - whether at home, at school or at work - helps diabetics maintain that control by ensuring consistency and oversight in accurate insulin delivery, carbohydrate intake, and exercise, which minimizes fluctuations in blood glucose levels. This paper explores how adherence to a well-planned daily routine and qualified adult supervision can lead to improved glycemic control, fewer complications, and better overall health outcomes for individuals with Type 1 Diabetes.

**Introduction and Background**

Some of the better resources available, providing guidance to patients and parents of diabetics include an article about diabetes management from the Mayo Clinic. [**https://www.mayoclinic.org/diseases-conditions/diabetes/in-depth/diabetes-management/art-20047963**](https://www.mayoclinic.org/diseases-conditions/diabetes/in-depth/diabetes-management/art-20047963)

This article addresses how lifestyle and routine affect blood sugar levels. The importance of planning balanced meals and carbohydrate counting is instrumental. It also recommends regular exercise and understanding ones blood sugar levels prior to exercise. Managing medications appropriately and being prepared for times of illness are also important.

Another great resource recommending daily routines is from PEAQ Medical. [**https://peaqmedical.com/daily-routines-for-managing-diabetes-a-step-by-step-guide/**](https://peaqmedical.com/daily-routines-for-managing-diabetes-a-step-by-step-guide/)

It provides a step-by-step guide for living daily with diabetes. It mentions having a good routine for the day helps to provide better control. Meal planning, proper exercise and monitoring are all important in establishing a routine that should be followed for healthy blood glucose control.

Finally, adolescent patients with diabetes and their parents or caregivers should refer to sites explaining the medical devices they use to control their blood glucose levels. A good example of this is The Tandem Diabetes site for their products. **https://www.tandemdiabetes.com/products/software-apps/mobile-apps**

It provides details about how to use their products effectively and how to get any needed support for managing the disease with their products.

As a parent of multiple diabetics, I greatly value these sources of information and products that companies like Tandem Diabetes make to help us to manage the disease. I have also received great advice from endocrinologists and have also read many great articles from reliable sources about strategies for better blood glucose control.

There is a great deal of learning and daily struggle for a person dealing with Type 1 Diabetes. It can be particularly more challenging when going through body changes and the desire to fit in and be ‘normal’. Patients with diabetes are encouraged to meet with their endocrinologist on a quarterly basis to review their health and make needed corrections as they grow and as the disease progresses. Common adjustments needed include the insulin basal rate (the amount the body needs, even without food), the bolus amount (insulin to carbohydrate ratio), and the correction bolus rate (amount of insulin needed to lower a high blood sugar level). These adjustments also need to account for the time of day, as insulin needs vary based on time of day or night. In addition to all of this, a diabetic needs to be aware of the effects of exercise (or lack thereof), stress, hormonal changes, and sickness on their blood sugar levels.

I have also observed that when lacking a structured daily schedule, healthy blood sugar control can be compromised. Having access to food at all times of the day (and night), varying times for meals and inconsistent serving size and composition of nutritional makeup of a meal can all affect blood sugar levels. Additionally, the lack of qualified adult supervision in the disease while away from home can negatively affect healthy blood glucose levels.

Therefore, I question whether blood sugar control is better when diabetics are in a school or work environment without experienced adults to oversee diabetic needs versus when they are at home with that type of supervision.

**Why it is important**

Having a good understanding of the effects of a structured schedule on blood sugar control will help my sons and our family to better plan and prepare our home environment as well as giving them tools to implement them away from home to achieve that important control. This can also be used as a starting point for discussions with their endocrinologist for good strategies to improve their daily health habits. It may also help in clinical practice settings for other patients as they visit with their practitioners and jointly discuss ways to achieve better outcomes.

**What is already being done**

Most continuous blood sugar monitors do a good job with alerting high and low blood sugar levels. They also can use the information from the monitor to create graphical time series graphs and detect patterns based on time of day. These are very useful to help in the understanding and correction of trends for those times of day experiencing high or low levels of blood glucose.

There are also great applications and ways to help diabetics understand the nutritional information in food products, especially in the grams of carbohydrate which is critical to the calculation of insulin needed. Individual serving sizes of common snacks is also helpful to maintain consistent portion sizes, which is important for understanding insulin needs.

**Objective and Hypothesis**

The objective of this project will be to determine whether being at home (with qualified adult supervision) or at school or work (with a more structured schedule) makes a positive impact on maintaining blood glucose levels. The hypothesis is percent of the time in the target blood glucose range is different during the times of the day and days of the week when the diabetic is in school or at work versus the times at home.

**Data Description**

The data for this analysis will come from the information uploaded from my son’s T-Slim insulin pumps over the period of the last 2-3 months.

The data contains the measurement of blood glucose levels every 5 minutes -- assuming the pump is operating as it should. The data also contains events associated with the delivery of insulin amounts at meal and bolus correction times.

**Methodology**

The data will need to have some categories built to create groupings used for the analysis. Identifying which days were school days and times of day in school (or work) is being held will be derived. It will also be important to perform exploratory statistics on the key variables to understand distributions and potential outliers and any missing data.

**Statistical tests and outcomes**

As the hypothesis can be expressed as either a continuous variable (percent of time in target range), or as a binary variable (in target range or not), there are at least a couple of different statistical tests I could perform on the data. I could try a paired t-test or z-test and could also do a Chi-squared test. It will be interesting to see the differences from those, or possibly other methods to test the hypothesis. I could also do some predictive models using the data captured on the pump to determine blood glucose level outcomes.

With these statistical tests and predictive models created from the data, I plan to use these to compare to an independent sample of data from my older son’s insulin pump and CGM data. I would like to see how well the model predicts the blood glucose levels on my other son.

**Expected Outcomes**

I would like to see if there is a significant difference in blood glucose control on weekends versus weekdays and school hours versus evening hours. I expect there to be some degree of association as there are fewer opportunities for parents to be aware of and correct blood sugar or insulin pump issues than when they are at home. Conversely, at home there are more opportunities for snacking and less of a structured schedule. So, it will be interesting to see how it plays out.

Similarly, I want to see if and how closely the data and models created from my younger sons data can apply to my older sons data.

**Descriptive Statistics on Blood Glucose**

Table 1 identifies the descriptive statistics for Blood Glucose levels from measurements taken every 5 minutes on child 1’s insulin pump. The MinTarget and MaxTarget contain the range of healthy blood glucose levels we are trying to achieve.

|  |  |  |  |
| --- | --- | --- | --- |
| **Stats** | **BG** | **MinTarget** | **MaxTarget** |
| **count** | 16778 | 16778 | 16778 |
| **mean** | 199.9 | 70 | 150 |
| **min** | 39.0 | 70 | 150 |
| **25%** | 149.0 | 70 | 150 |
| **50%** | 191.0 | 70 | 150 |
| **75%** | 240.0 | 70 | 150 |
| **max** | 401.0 | 70 | 150 |
| **std** | 63.4 | 0 | 0 |

**Table 1**

Table 2 contains descriptive statistics on key numeric variables for the pump events that child 1 entered for grams of carbohydrate that are being eaten. The total units of Insulin Delivered at that time, broken out by amount of insulin needed for Food and amount needed for Correction of an already high blood glucose level.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stats** | **BG** | **InsulinDelivered** | **FoodDelivered** | **CorrectionDelivered** | **CarbSize** |
| count | 124 | 124 | 124 | 124 | 124 |
| mean | 237.75 | 12.79 | 12.01 | 0.78 | 50.01 |
| std | 72.98 | 4.78 | 4.57 | 1.55 | 20.02 |
| min | 107.00 | 0.25 | 0.25 | 0.00 | 1.00 |
| 25% | 178.75 | 10.00 | 9.99 | 0.00 | 40.00 |
| 50% | 245.50 | 12.55 | 12.40 | 0.00 | 50.00 |
| 75% | 278.00 | 16.50 | 15.00 | 0.96 | 60.00 |
| max | 401.00 | 20.00 | 20.00 | 9.45 | 100.00 |

**Table 2**

Table 3 contains the percentage of days in the sample period that he has input the number of grams of carbohydrate that are being consumed, broken out by the time of day that the information was entered. Typically, we would like to see carbohydrates entered for each time food is being consumed. The Other category corresponds to overnight hours when too often a high blood glucose needs to be corrected by giving more insulin.

|  |  |
| --- | --- |
| **Time Range** | **% Day Carbs Entered** |
| Morning (5-10 AM) | 32.65 |
| Midday (10 AM - 2 PM) | 38.78 |
| Afternoon (2-5 PM) | 36.73 |
| Evening (5-10 PM) | 63.27 |
| Other | 34.69 |

**Table 3**

Graph 1 contains boxplots showing the distribution of of carbohydrate grams by time of day

A chart with blue squares

AI-generated content may be incorrect.Graph 1

Graph 2 contains histograms of bolus types (insulin delivery) when he needs some insulin for reasons other than basal rates. The categories we would like to see being used the most is for Food. The Auto type is a feature to automatically bolus when blood glucose levels start to go high.

A graph with blue squares

AI-generated content may be incorrect.

Graph2

Graphs 3, 4 and 5 contain the number of blood glucose measurement readings from the continous glucose monitor (CGM) during various time intervals. Measurements taken include those during weekend versus weekdays, Holidays (from school) versus non holidays, and School Hours versus non school hours.

A graph with a number of blue squares

AI-generated content may be incorrect.

Graph 3

A graph of a number of holidays

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Graph 4

A graph of a bar chart

AI-generated content may be incorrect.

Graph 5

Graph 6 shows a distribution of all blood glucose levels taken over the 2 month sample time period.

A graph of blood glucose reading

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Graph 6

Graphs 7, 8 and 9 are histograms showing the percentage of blood glucose measurements comparing different time periods.

A graph of a normal distribution

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Graph 7

A graph of a graph of a graph

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Graph 8

A graph of a normal distribution

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Graph 9

Graph 10 contains the number of measurements across the full 2-month sample that were in the target range versus those that are not in range.

A graph with blue squares

AI-generated content may be incorrect.

Graph 10

**References**

**https://www.mayoclinic.org/diseases-conditions/diabetes/in-depth/diabetes-management/art-20047963**

[**https://peaqmedical.com/daily-routines-for-managing-diabetes-a-step-by-step-guide/**](https://peaqmedical.com/daily-routines-for-managing-diabetes-a-step-by-step-guide/)

**https://www.tandemdiabetes.com/products/software-apps/mobile-apps**