

Time Spirals: a new approach to visualize large datasets obtained from CGM measurements of patients with diabetes

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Introduction

Continuous glucose monitoring (CGM) systems can generate datasets consisting of thousands of data points. Traditionally, these time series are visualized as lines or dots in two dimensional Cartesian coordinates. When comparing daily measurements of glycaemia, multiple 24-hours of measurements are usually visualized in a single graph superposing each other or as a set of separate pictures placed next to each other.

However, to plot large datasets, to reduce space needed for its effective representation and to still clearly see (ir)regularities in data, time spirals may be utilized. In time spiral plots, events are marked on a one-dimensional line. The color of each point on that line varies according to the value of the variable. The line has the shape of a spiral with a constant cycle. The relationship in time between the data points can be visually estimated.

Methods

CGM data was collected for approximately one week from 86 patients with Type 1 diabetes. Time spirals were generated from the data for graphic visualization and interpretation of the CGM measurements. The glucose measurements were classified into three different ranges to distinguish in-range values, hypoglycemia and hyperglycemia. The three ranges were labeled with different colors. The R software and its ggplot2 package were used to generate the graphs.

Results

The time spiral plots have been generated from the data of each patient. Differences among patients are clearly visible. One example of a patient with high glucose values (HbA1c = 92 mmol/mol, average blood glucose = 13.4 mmol/L, case 50) and another one with lower values (HbA1c = 51 mmol/mol, average blood glucose = 6.9 mmol/L, case 58) have been selected to demonstrate the differences in visibility of glucose measurements (Figure 1).

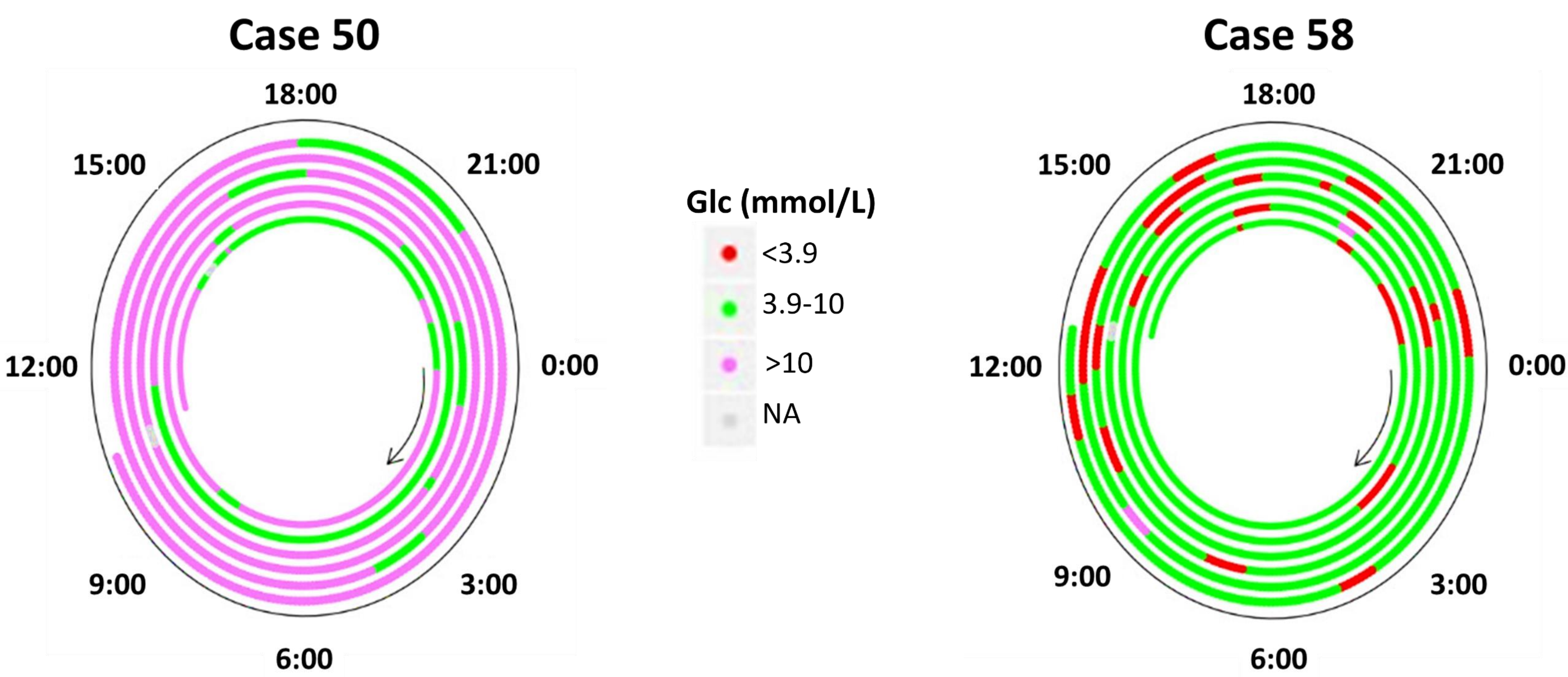


Figure 1: Graphical representation of spiral graphs used to display approx. one week of CGM data sets of 2 different patients. Case 50 shows glycaemia out of normal range most of time, whereas case 58 explains data of a patient with in-range glycaemia and some hypoglycaemia measurements. Glc = glucose. NA = missing values.

Conclusion

Visualizing time-series data of diabetic patients in time spirals is an effective way to visualize large datasets while reducing space on the screen and time spent on the data analysis. This method also allows comparison between datasets and, theoretically, quick identification of periodic behavior.