

Complexity of Continuous Glucose Monitoring Data in Critically Ill Patients: Continuous Glucose Monitoring Devices, Sensor Locations, and Detrended Fluctuation Analysis Methods

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Abstract

Background:

Critically ill patients often experience high levels of insulin resistance and stress-induced hyperglycemia, which may negatively impact outcomes. However, evidence surrounding the causes of negative outcomes remains inconclusive. Continuous glucose monitoring (CGM) devices allow researchers to investigate glucose complexity, using detrended fluctuation analysis (DFA), to determine whether it is associated with negative outcomes. The aim of this study was to investigate the effects of CGM device type/calibration and CGM sensor location on results from DFA.

Methods:

This study uses CGM data from critically ill patients who were each monitored concurrently using Medtronic iPro2s on the thigh and abdomen and a Medtronic Guardian REAL-Time on the abdomen. This allowed interdevice/calibration type and intersensor site variation to be assessed. Detrended fluctuation analysis is a technique that has previously been used to determine the complexity of CGM data in critically ill patients. Two variants of DFA, monofractal and multifractal, were used to assess the complexity of sensor glucose data as well as the precalibration raw sensor current. Monofractal DFA produces a scaling exponent (H), where H is inversely related to complexity. The results of multifractal DFA are presented graphically by the multifractal spectrum.

Results:

From the 10 patients recruited, 26 CGM devices produced data suitable for analysis. The values of H from abdominal iPro2 data were 0.10 (0.03–0.20) higher than those from Guardian REAL-Time data, indicating consistently lower complexities in iPro2 data. However, repeating the analysis on the raw sensor current showed little or no difference in complexity. Sensor site had little effect on the scaling exponents in this data set. Finally, multifractal DFA revealed no significant associations between the multifractal spectrums and CGM device type/calibration or sensor location.

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Abbreviations: (BG) blood glucose, (BGA) blood gas analyzer, (CGM) continuous glucose monitoring, (DFA) detrended fluctuation analysis, (ICU) intensive care unit, (MARD) mean absolute relative difference, (SG) sensor glucose

Keywords: continuous glucose monitoring, detrended fluctuation, detrended fluctuation analysis, fractal, sensor

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Abstract cont.

Conclusions:

Monofractal DFA results are dependent on the device/calibration used to obtain CGM data, but sensor location has little impact. Future studies of glucose complexity should consider the findings presented here when designing their investigations.

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