Summary

The performance of six interstitial fluid glucose sensors simultaneously inserted in the subcutaneous tissue of a diabetic patient undergoing major surgery was studied. On average, the interstitial fluid sensor measurements lagged the arterial plasma glucose measurements by 15 minutes.

Background

Continuous glucose monitoring has the potential to improve glycemic control in the hospital. Device characterization is important to understand the limitations of sensor technology.

Materials and Methods

Six investigational interstitial fluid (ISF) glucose sensors were simultaneously inserted in a patient with type 2 diabetes prior to surgery. The sensing portion of the ISF sensor was identical to the Guardian® RT Continuous Glucose Monitoring System commercialized by Medtronic Diabetes (Northridge, CA). Sensors were grouped in two arrays, one in the lateral right chest (sensors 1-3) and the other in the upper right arm (sensors 4-6). Sensor measurements were wirelessly transmitted to a laptop computer every minute for 60 hours. Reference glucose measurements were taken in duplicate every 20 minutes using arterial blood. Only duplicate reference measurements that differed by less than 10% were used in the subsequent analysis.

Analysis was performed on a continuous 40-hour block of data that began 7 hours and 43 minutes after the sensors were inserted and 4 hours and 4 minutes after the surgery was completed. The Pearson correlation coefficient (R) between the reference and sensor measurements was calculated. Since the frequency of measurement differed, paired values were obtained by matching the closest sensor measurement in time with its corresponding reference measurement. To determine the time lag between the reference and sensor measurements, the sensor measurements were shifted in time and R was calculated for each shift. The shift that produced the largest value for R was determined to be the time lag between the reference and sensor measurements.

Results

On average, the sensor measurements lagged the reference measurements by 15±6.5 minutes (mean± SD). Using an unpaired Student's t-test to compare the lags from the two sensor arrays, it is improbable that the lags from the arm array came from the same sample population as those from the chest array (p<0.05).

Conclusions

The time lag between ISF glucose sensor measurements and reference blood glucose measurements is the sum of the physiological and instrumental lags. Previous studies in healthy outpatient diabetic subjects observed lags between 0-10 minutes\(^1\)-\(^3\). The 1-minute sensor measurement used in the current analysis provided far greater time resolution. Although current analysis did not use any filtering of the sensor measurements, a commercial ISF sensor would most likely use a filter to suppress noise. Real-time filtering, however, can add further delays.

References


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