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ORIGINAL ARTICLES

Continuous Glucose Monitors and the Burden of Tight Glycemic Control in Critical Care: Can They Cure the Time Cost?

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Abstract

Background:
Tight glycemic control (TGC) in critical care has shown distinct benefits but has also proven to be difficult to obtain. The risk of severe hypoglycemia (<40 mg/dl) raises significant concerns for safety. Added clinical burden has also been an issue. Continuous glucose monitors (CGMs) offer frequent automated measurement and thus the possibility of using them for early detection and intervention of hypoglycemic events. Additionally, regular measurement by CGM may also be able to reduce clinical burden.

Aim:
An *in silico* study investigates the potential of CGM devices to reduce clinical effort in a published TGC protocol.

Methods:
This study uses retrospective clinical data from the Specialized Relative Insulin Nutrition Titration (SPRINT) TGC study covering 20 patients from a benchmark cohort. Clinically validated metabolic system models are used to generate a blood glucose (BG) profile for each patient, resulting in 33 continuous, separate BG episodes (6881 patient hours). The *in silico* analysis is performed with three different stochastic noise models: two Gaussian and one first-order autoregressive. The noisy, virtual CGM BG values are filtered and used to drive the SPRINT TGC protocol. A simple threshold alarm is used to trigger glucose interventions to avert potential hypoglycemia. The Monte Carlo method was used to get robust results from the stochastic noise models.

Results:
Using SPRINT with simulated CGM noise, the BG time in an 80–110 mg/dl band was reduced no more than 4.4% to 45.2% compared to glucometer sensors. Antihypoglycemic interventions had negligible effect on time in band but eliminated all recorded hypoglycemic episodes in these simulations. Assuming 4–6 calibration measurements per day, the nonautomated clinical measurements are reduced from an average of 16 per day to as low as 4. At 2.5 min per glucometer measurement, a daily saving of ~25–30 min per patient could potentially be achieved.

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Abbreviations: (BG) blood glucose, (CGM) continuous glucose monitor, (ICU) intensive care unit, (IQR) interquartile range, (MAPE) mean average percentage error, (SD) standard deviation, (SPRINT) Specialized Relative Insulin Nutrition Titration, (TGC) tight glycemic control

Keywords: alarm, blood glucose, continuous glucose monitor, glycemic control, hypoglycemia, sensor

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Abstract cont.

Conclusions:
This paper has analyzed *in silico* the use of CGM sensors to provide BG input data to the SPRINT TGC protocol. A very simple algorithm was used for early hypoglycemic detection and prevention and tested with four different-sized intravenous glucose boluses. Although a small decrease in time in band (still clinically acceptable) was experienced with the addition of CGM noise, the number of hypoglycemic events was reduced. The reduction to time in band depends on the specific CGM sensor error characteristics and is thus a trade-off for reduced nursing workload. These results justify a pilot clinical trial to verify this study.

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