Evaluation of Implementation of a Fully Automated Algorithm (Enhanced Model Predictive Control) in an Interacting Infusion Pump System for Establishment of Tight Glycemic Control in Medical Intensive Care Unit Patients

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Abstract

Background:

The objective of this study was to investigate the performance of a newly developed decision support system for the establishment of tight glycemic control in medical intensive care unit (ICU) patients for a period of 72 hours.

Methods:

This was a single-center, open, non-controlled feasibility trial including 10 mechanically ventilated ICU patients. The CS-1 decision support system (interacting infusion pumps with integrated enhanced model predictive control algorithm and user interface) was used to adjust the infusion rate of administered insulin to normalize blood glucose. Efficacy and safety were assessed by calculating the percentage of values within the target range (80–110 mg/dl), hyperglycemic index, mean glucose, and hypoglycemic episodes (<40 mg/dl).

Results:

The percentage of values in time in target was 47.0% (±13.0). The average blood glucose concentration and hyperglycemic index were 109 mg/dl (±13) and 10 mg/dl (±9), respectively. No hypoglycemic episode (<40 mg/dl) was detected. Eleven times (1.5% of all given advice) the nurses did not follow and, thus, overruled the advice of the CS-1 system. Several technical malfunctions of the device (repetitive error messages and missing data in the data log) due to communication problems between the new hardware components are shortcomings of the present version of the device. As a consequence of these technical failures of system integration, treatment had to be stopped ahead of schedule in three patients.

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Abbreviations: (BG) blood glucose, (CLINICIP) Closed Loop Insulin Infusion for Critically Ill Patients, (EC) European Commission, (eMPC) enhanced model predictive control, (ICU) intensive care unit, (SD) standard deviation

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Conclusions:

Despite technical malfunctions, the performance of this prototype CS-1 decision support system was, from a clinical point of view, already effective in maintaining tight glycemic control. Accordingly, and with technical improvement required, the CS-1 system has the capacity to serve as a reliable tool for routine establishment of glycemic control in ICU patients.

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