INTRODUCTION

Hyperglycemia has been linked to worsened outcomes, including increased incidence of sepsis, increased ventilator dependence, hospital length of stay and mortality.

Tight glycemic control (TGC) has shown particular benefits in cardiac surgery ICU patients. STAR is a model-based TGC protocol accounting for inter- and intra-patient variability with a stochastically derived maximum 5% risk of blood glucose (BG) below 72mg/dL. This abstract describes the first clinical pilot trials of STAR.

CLINICAL TRIALS

Nine cardiac-surgery patients received model-based BG control for 24 hours with BG measured 1-2 hourly. Two-hourly measurements were used when BG was between 110-135mg/dL for 3 hours.

Carbohydrate intake (all sources) was monitored, but not changed from clinical settings except to prevent potential low BG. Insulin infusion rates were limited (6U/hour maximum), with limited increases based on current insulin rate (0.5-2.0U/hour). Approval was granted by the Ethics Committee of the Medical Faculty of the University of Liege (Liege, Belgium).

RESULTS

Overall trial results are presented in Table 1. There were 205 BG measurements taken during 215 hours of control. No hypoglycemia (BG < 40 mg/dL) occurred during these clinical pilot trials. The minimum BG was 63mg/dL. Average model prediction error was 13.9 mGd/L (10.5%), with larger errors due to small meals and other clinical events.

Carbohydrate intake varied widely between patients (4.2 [2.0 - 11.1] g/hour), and zero insulin rates were determined by the control system for 25% of interventions (Figure 2).

Insulin sensitivity in trial patients was significantly more variable than general medical ICU patients (Figure 3), but similar to recent post-surgery cardiac patients from other cohorts. The trial patients also exhibited relatively high sensitivity to insulin, contributing to the potential for increased variability in glycemic outcome.

MODELS AND METHODS

A metabolic computer system model, clinically validated in adult intensive care patients and virtual trials using neonatal data, is used in conjunction with a stochastic model of insulin sensitivity variability to provide tight control:

1. Previous and current blood glucose measurements are used to determine a patient-specific real-time insulin sensitivity estimate.
2. The stochastic model provides a distribution of possible insulin sensitivity parameter values for the next 1-2 hours.
3. Insulin rate required to achieve BG target of 125 mg/dL is computed with a misconic method.
4. BG outcome predictions are calculated for the 5th, 25th, 75th and 95th percentile SI values over the next 1-2 hours.
5. Predicted outcome BG range is checked to ensure the lowest possible BG is not < 72 mg/dL. If lowest BG is < 72 mg/dL, the insulin rate is reduced to ensure a guaranteed maximum risk of 5% of BG < 72 mg/dL for safety.

Conclusion: STAR effectively controlled all patients towards target. Observed patient variability in response to insulin and thus prediction errors were higher than expected, likely due to the recent insult of cardiac surgery and their immediate recovery. STAR effectively managed this enhanced variability with no hypoglycemia, and the high density BG data allows comparison of variability between surgical and medical ICU patients.