

Tight glyceimic control models for critically ill patients in intensive care units

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Introduction

Critically ill patients often present stress-induced hyperglycemia and low insulin sensitivity [1]. Recent studies have shown that high blood glucose (BG) levels are linked to worsened patient outcomes and increased mortality [2, 3]. Tight glyceimic control (TGC) aims at reducing BG levels taking into account inter-patient variability, evolving physiological patient conditions and minimizing hypoglycemic risks. Clinical protocols are used to specify insulin and nutrition rates and BG measurement frequency during control. This research compares different protocols to determine the best one to use at the CHU of Liege.

Methods

We compare three protocols described in Table 1. Glucontrol B is a experimental protocol while Targeted and STAR controllers are model-based. Moreover, STAR controller uses a stochastic model accounting for hour-to-hour patient variability.

% BG	Glucontrol B	Targeted/STAR controllers
Origin	Belgian protocol	Designed for Christchurch, NZ
Features	Experimental sliding scale	Adaptive, model-based predictive controller
BG target	140 – 180 mg/dL	90 mg/dL
BG measurement frequency	1 – 4 hours	1 hour

Table 1 – TGC protocols description

Controller performance was tested in virtual trials using Glucontrol retrospective clinical data and the glucose-insulin model. STAR was adapted to Belgian ICU requirements to create STAR-Belgium.

Results

Initial results : better performance for the Targeted and STAR controllers.

Two main problems with the STAR controller :

1. Aggressiveness, increasing the risk of hypoglycemia (BG < 40 mg/dL) → nutrition rates can be increased & limit the insulin rate changes;
2. Controller differences, harmful to comparison quality → define new BG target of 144 mg/dL and allow 2-hourly measurement

The resulting controller, STAR-Belgium, has the **lowest** percent of hypoglycemic events and provides the **tightest** control around its BG target illustrated by the **steeper** BG cumulative density function (CDF) in Figure 1 and in Table 2.

% BG	Glucontrol B	STAR	STAR-Belgium
< 40 mg/dL	0.054	0.062	0.020
> 180 mg/dL	24.1	6.8	12.9
in 140-180 mg/dL	42.4	8.5	50.1
in 120-160 mg/dL	39.33	67.96	58.43

Table 2 – Virtual trial results: whole cohort statistics

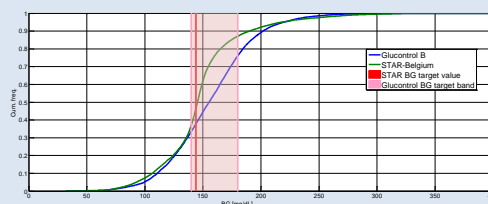


Figure 1 – Comparison of BG CDF for Glucontrol B (blue line) and STAR-Belgium (green line) controllers, for whole cohort

Conclusions

The STAR-Belgium controller is the best clinical protocol for TGC in this study. We have shown it is highly effective and safe. Pilot trials are currently underway to assess its control performance in real clinical conditions.

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