

Overview of Glycemic Control in Critical Care: Relating Performance and Clinical Results

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Abstract

Background:

Hyperglycemia is prevalent in critical care and tight control can save lives. Current ad-hoc clinical protocols require significant clinical effort and produce highly variable results. Model-based methods can provide tight, patient specific control, while addressing practical clinical difficulties and dynamic patient evolution. However, tight control remains elusive as there is not enough understanding of the relationship between control performance and clinical outcome.

Methods:

The general problem and performance criteria are defined. The clinical studies performed to date using both ad-hoc titration and model-based methods are reviewed. Studies reporting mortality outcome are analysed in terms of standardized mortality ratio (SMR) and a 95th percentile ($\pm 2\sigma$) standard error ($SE_{95\%}$) to enable better comparison across cohorts.

Results:

Model-based control trials lower blood glucose into a 72-110 mg/dL band within 10 hours, have target accuracy over 90%, produce fewer hypoglycemic episodes, and require no additional clinical intervention. Plotting SMR versus $SE_{95\%}$ shows potentially high correlation ($r=0.84$) between ICU mortality and tightness of control.

Summary:

Model-based methods provide tighter, more adaptable *one method fits all* solutions, using methods that enable patient-specific modeling and control. Correlation between tightness of control and clinical outcome suggests that performance metrics, such as time in a relevant glycemic band, may provide better guidelines. Overall, compared to the current one size fits all sliding scale and ad-hoc regimens, patient-specific pharmacodynamic and pharmacokinetic model-based, or one method fits all control, utilizing computational and emerging sensor technologies, offers improved treatment and better potential outcomes when treating hyperglycemia in the highly dynamic critically ill patient.

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Abbreviations: (MAGE) mean average glycemic excursion, (MPC) model predictive control, (ROD) risk of death, (SMR) standardized mortality ratio

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