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Evaluation and Comparison of Two Computerized IV Insulin-Treatment Protocols Using Patient Data from the ICU

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Abstract

We retrospectively compared two computerized IV insulin-treatment protocols, eProtocol-insulin and Glucosafe, in-silico using ICU data. We used clinical data from eProtocol-insulin supported cohorts to simulate patient models in Glucosafe. The amounts of insulin recommended by these protocols were compared and evaluated at different blood glucose ranges. Results indicated that Glucosafe consistently provided better dosing suggestions for managing insulin in ICU patients.

Introduction

Intravenous (IV) insulin-treatment protocols to manage blood glucose in critically ill patients in the ICU vary widely. They have different heuristics or use modeling techniques that are not based on reproducible methods. These protocols will generate different dosing recommendations which may lead to different patient outcomes. An efficient method for comparing different protocols, before using them in clinical trials, would be valuable.

Methods

We selected two computerized IV insulin-treatment protocols for comparison; eProtocol-insulin[1] and Glucosafe[2]. eProtocol-insulin is an heuristic rule-based protocol used for managing ICU patient blood glucose at Intermountain Healthcare. Internally, eProtocol-insulin assumes a linear rate of change in glucose in response to changes in IV insulin. Glucosafe is a more complex, physiologic model-based, decision support system for blood glucose control. It calculates insulin sensitivity based on blood glucose measurements, amount of insulin given and various nutritional inputs. The model also considers insulin saturation effects and glucose absorption rate when recommending insulin doses.

We evaluated these two protocols retrospectively using clinical data from 408 patients managed with eProtocol-insulin. We collected patient demographic data including gender, age, weight and height. We extracted 20,362 instances of ICU patient blood glucose values, IV insulin doses and recommended by eProtocol-Insulin. Other clinical data used by Glucosafe included medications, types of diabetes and types of nutrition received by patients. We then compared the amount of insulin recommended by eProtocol-insulin and Glucosafe within different blood glucose ranges; low (below 80 mg/dL), target (80-110 mg/dL), and high (above 110 mg/dL).

Results & Discussion

At the low blood glucose range, a lower insulin dose is preferred to prevent hypoglycemia. At the high blood glucose range, a higher insulin dose is preferred (to lower blood glucose to the normoglycemic range faster). In the low range, 61.8% of Glucosafe's recommendations were lower than eProtocol-insulin. In the target range, 62.6% of Glucosafe's recommendations were lower than eProtocol-insulin. In the high range, 66.0% of Glucosafe recommendations were higher than eProtocol-insulin. Paired Wilcoxon rank sum tests showed that insulin doses compared within the different blood glucose ranges were different and statistically significant ($p < 0.01$). Glucosafe produced more favorable recommendations, overall.

Conclusion

We expect that our proposed analytical framework will allow credible in-silico comparisons of different protocols.

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