

Intensive Care Unit Insulin Delivery Algorithms: Why So Many? How to Choose?

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Abstract

Objective:

Studies showing improved outcomes with tight glycemic control in the intensive care unit (ICU) have resulted in a substantial number of new insulin delivery algorithms being proposed. The present study highlights mechanisms used in the better-known approaches, examines what might be critical differences among them, and uses systems theory to characterize the conditions under which each can be expected to perform best.

Methods:

Algorithm dose ($\Delta I/\Delta G$) and step (response to a persistent elevation in glucose) response curves were calculated for written instruction algorithms, developed at the Providence Heart and Vascular Institute (Portland [P] protocol), the University of Washington (UW), and Yale University (Y), together with similar curves for the Glucomanager (GM) and proportional integral derivative (PID) computer algorithms. From the simulated curves, different mechanisms used to adjust insulin delivery were identified.

Results:

All algorithms increased insulin delivery in response to persistent hyperglycemia, but the mechanism used altered the algorithm's sensitivity to glucose, or gain, in the GM, UW, and Y protocols, while leaving it unchanged for the P protocol and PID algorithm.

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Abbreviations: (GM) Glucomanager, (ICU) intensive care unit, (IU) international unit [of insulin], (MPC) model predictive control, (P) Portland, (PID) proportional integral derivative, (UW) University of Washington, (Y) Yale

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Abstract cont.**Conclusions:**

The increase in insulin delivery in response to persistent hyperglycemia observed with all the algorithms can be expected to bring subjects who respond to insulin to targeted glucose ranges. However, because the PID and P protocols did not alter the insulin delivery response curves, these algorithms can be expected to take longer to achieve target glucose levels in individuals who are insulin resistant and/or are exposed to increased carbohydrate loads (e.g., glucose infusions). By contrast, the GM, UW, and Y algorithms can be expected to adapt to the insulin resistance such that the time to achieve target levels is unchanged if the time for insulin to act does not change. If the insulin resistance is accompanied by a longer time for insulin to act, the UW, Y, and GM algorithms may increase the risk of hypoglycemia. Under these conditions, the longer time required for the PID and P protocols to achieve a target glucose level may be a reasonable trade-off for no increase in the risk of hypoglycemia.

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