Blood Glucose Monitoring in Critical Care

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Abstract
Maintaining critically-ill patients’ blood glucose levels within the normoglycemic range has been shown to reduce mortality and morbidity, but it has not been achieved consistently using existing insulin infusion protocols. This study examines blood glucose monitoring in an intensive care unit (ICU) and how blood glucose levels change in response to therapy. Our findings confirm the commonly observed poor compliance of blood glucose levels and motivate for more effective glycemic control.

Introduction
Strict control of patients’ blood glucose levels within the normoglycemic range (i.e., 80-110 mg/dL) has been shown by randomized controlled clinical trials to reduce mortality and morbidity in critical care. Its implementation, however, has been limited by protocols that generate rapid, seesaw-like changes in blood glucose level and maintain patients within the target range for only a less-than-desirable fraction of time. Our approach to better glycemic control in critical care involves use of laboratory values, medication records, and other clinical information from MIMIC II, a comprehensive and integrated ICU database, to track patients’ glycemic states.

Method
We first examined blood glucose monitoring by direct observation in the coronary care unit, medical intensive care unit, and surgical intensive care unit at a tertiary teaching hospital. Then we identified all the patients whose clinical information was stored in MIMIC II and who had received IV insulin in these ICUs. After extracting and integrating these patients’ clinical data, we examined how blood glucose levels had changed over time in response to insulin therapy in 3117 patients.

Results
Blood glucose levels are routinely measured during intensive care. Of the 17242 patients we have laboratory values for in the MIMIC II database, 93.63% had blood glucose measurements. Once a decision to initiate antihyperglycemic therapy was made, caregivers would follow a hospital-specific protocol and measure blood glucose levels at predefined time intervals: 1 hour when the patient was on IV insulin, 4 hour when the patient was dosed according to a sliding scale. The usual method of measurement is by a fingerstick glucose meter. Figure 1 shows the typical course of a patient’s glycemic state over time in response to IV insulin therapy.

![Figure 1. Typical glycemic state trajectory over time. The infusion protocol used has a target range (marked by the pink band in the figure) of 101 -150 mg/dL for blood glucose.](image)

Conclusion
Blood glucose monitoring is an integral part of critical care, as evidenced by the high percentage of patients having routine measurements. Figure 1 shows the two key features of glycemic state over time: 1) the proportion of time in which blood glucose is within the normoglycemic range is small; 2) IV insulin induces seesaw-like changes in blood glucose levels. These observations verify what we have found in the literature. In addition, changes in the blood glucose level lag the IV insulin administration on the order of a couple of hours. This observed delay should be quantitatively taken into consideration during the development of new insulin infusion protocol.

References