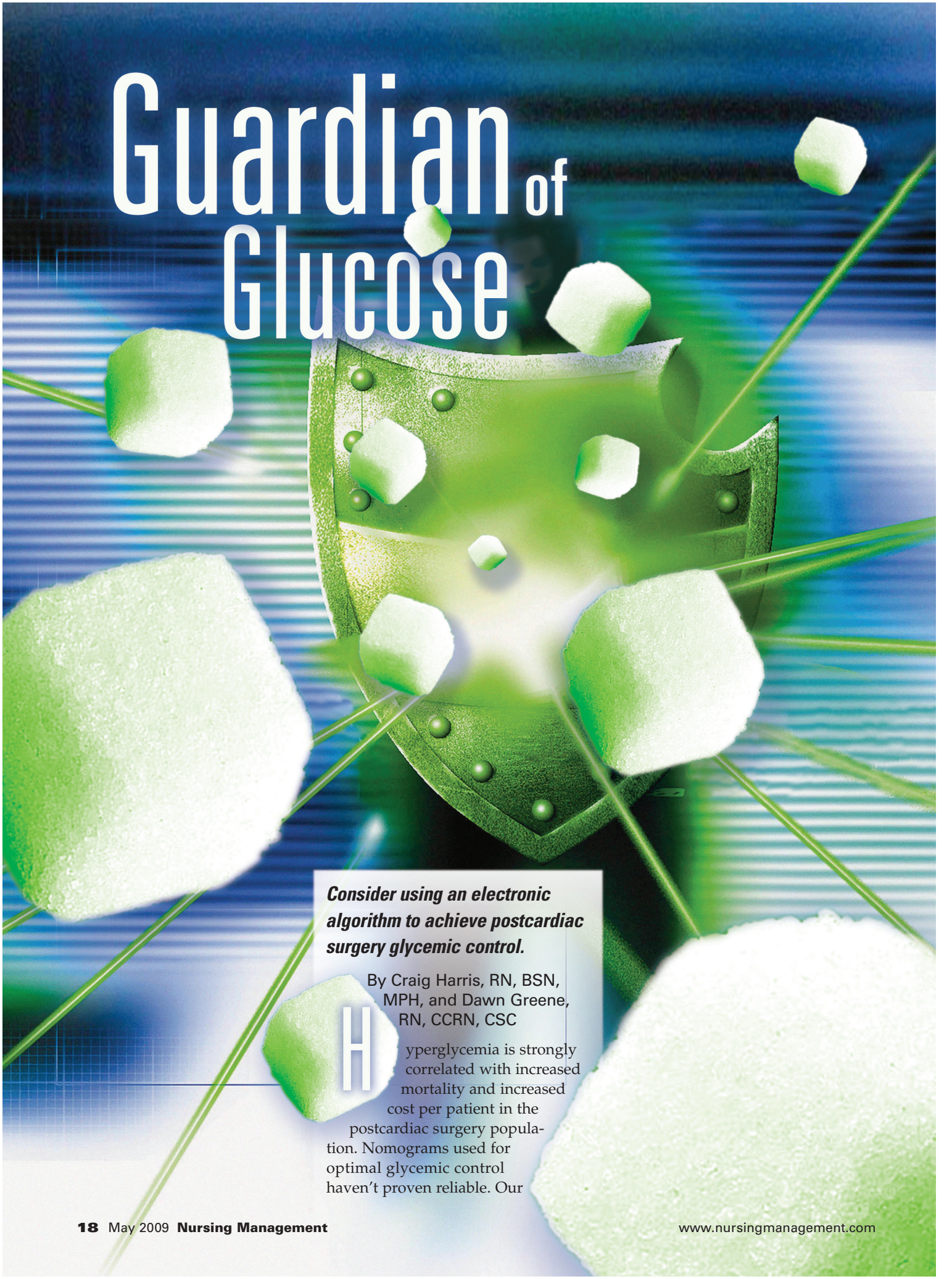
Guardian of Glucose



Consider using an electronic algorithm to achieve postcardiac surgery glycemic control.

By Craig Harris, RN, BSN, MPH, and Dawn Greene, RN, CCRN, CSC

Hyperglycemia is strongly correlated with increased mortality and increased cost per patient in the postcardiac surgery population. Nomograms used for optimal glycemic control haven't proven reliable. Our

trial of a software-based, logarithmic equation program demonstrated optimal glycemic control and time to control in this patient population.

Background

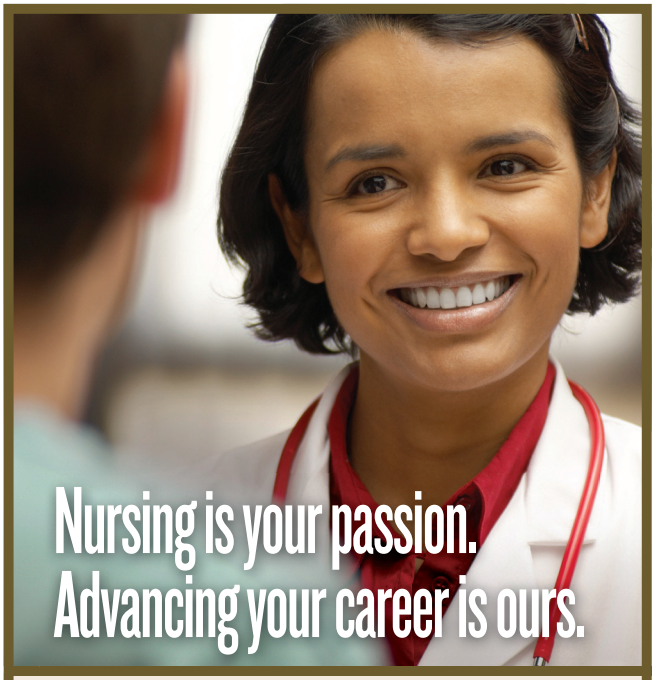
Hyperglycemia has long been recognized as an inhibitor of the normal immune response and healing process. Noteworthy studies, namely the Portland Diabetic Project, have demonstrated that hyperglycemia, not diagnosis of diabetes mellitus, is the major causal factor for increased mortality due to complications such as infection and pump failure.[1,2] Moreover, the Project demonstrates a direct correlation between increased cardiac-surgery mortality and a 3-day average capillary blood glucose (CBG) value of more than 150 mg/dL, and that hyperglycemia is an independent predictor of increased length of stay in this population; between 0.45 and 0.65 days depending on the level of hyperglycemia. Other research following prospective and cohort case studies involving cardiothoracic surgery patients demonstrated that diabetes and postoperative hyperglycemia were independently associated with the development of surgical site infections (SSIs).[3]

Hyperglycemia is a significant issue for any ICU patient, not just the postcardiothoracic surgery patient. In a study of 1,548 patients of a 56-bed predominantly surgical ICU, researchers found that metabolic control was the strongest contributor to patient outcomes.[4] Their analysis indicated that the lowered blood glucose (rather than the insulin dose) was a statistically significant related factor to reduced mortality.

Although we're aware of the importance of glycemic control in our postsurgical patients, national organizations that focus on patient outcomes are advocating for tighter glucose control. The Institute for Health Improvement has identified glycemic control (between 80 mg/dL and 110 mg/dL in critically ill patients) as an improvement measure.[5] The American Hospital Association has specified glucose control in the postcardiac surgery patient by 6 a.m. on postoperative day 1 as a Surgical Care Improvement Project measure.[6]

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The Cardiovascular Recovery Unit (CVRU) at Mission Hospitals is the postanesthesia care unit (PACU) for the Cardiovascular OR. Annually, approximately 1,000 patients recover in this unit. Postoperative (postoperative day 1 for post-open heart patients) patients



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are transferred from the CVRU to the Cardiovascular Progressive Care Unit or to the Cardiovascular ICU (CVICU) if they require ICU care beyond the PACU phase.

We've historically had difficulty achieving optimal blood glucose control (CBG measurement of 71 to 150 mg/dL per the Portland Diabetic Project) in our postoperative cardiac and vascular surgery population. Of the average 1,000 patients treated annually in the CVRU, we were able to achieve optimal control in only 17%, with an average of 9 hours required to achieve control using a nomogram-based order set for continuous insulin infusion titration that's designed specifically for the ICU patient. We observed serial CBG measurements of greater than 150 mg/dL in 80% of our patients and a 3% rate of hypoglycemia (CBG measurement less than 70 mg/dL).

Our trial

We considered several software programs to assist us with glucose control. Collaboratively with Nursing, Pharmacy, Endocrinology, CV Surgery, and Information Technology, we chose one particular software-based tool to trial. Our choice program is a patent-pending, Health Insurance Portability and Accountability Act (HIPAA)-compliant program that derives the patient's unique insulin resistance using a logarithmic equation. The result is continuous insulin infusion titration recommendations and supplemental insulin (also known as "sliding scale") recommendations unique to the patient.

We implemented a 2-month trial from March to May 2007. The only criteria for tool utilization was two or more CBG measurements of more than 150 mg/dL. During this time period, 95 of 198 CVRU patients met the criteria and were managed utilizing the tool. Tool use was continued upon transfer to the CVICU while on continuous insulin infusion.

We experienced a dramatic decrease in CVRU control time from 9 hours to just over 2 hours. Although we hadn't previously collected data on control time in the CVICU, we observed this to be 3.8 hours (which seemed anecdotally a significant decrease). We also observed our percentage of CBGs within the optimal range (71 to 150 mg/dL) to be 80% in the CVRU and 91.5% in the CVICU—a significant change from our prior 17%. The incidence of hypoglycemia also decreased significantly, from an average rate of 3% prior to the trial to less than 1% during the trial.

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Added benefits

In addition to the obvious clinical benefits, simplicity of use, the ability to customize based on service line/patient population, and user support are significant benefits. The tool is simple to use. A basic profile is established for the patient that includes administration of steroids, the patient's serum creatinine, and current insulin infusion rate. Based on this information, the tool recommends an infusion rate and specifies time duration until next CBG measurement. Each subsequent CBG is entered into the software, current insulin infusion rate is verified, and additional calories (such as dextrose infusions) are administered, if applicable. The software then recommends insulin titration and specifies the time increment for subsequent CBG measurement. The software alarms, notifying staff that a CBG is due, and the alarm can't be silenced until the CBG measurement is entered. This prevents staff from "overlooking" a CBG and, thus, prevents hyperglycemic/hypoglycemic spikes.

Training for use of the tool is minimal. Since we utilize an electronic medical record, staff members were accustomed to working with electronic patient-care documentation. The manufacturer provided on-site training. The tool provides administrative reports that simplify data analysis for performance improvement and labor studies. The software provides for customization of insulin management, allowing different service lines to tailor their control and insulin regimens based upon their unique patient population.

Disadvantages

Since the software customizes control to the individual patient, frequent CBGs (every hour or more) are often required until control is achieved. This, along with the insulin titrations associated with the frequent CBG measurements, significantly increases initial nursing time.

Compatibility with existing electronic medical record systems and application delivery systems can be an issue. There's no interface between the tool and our electronic medical record and application delivery system. This requires that nursing staff members manually enter values into the record and

document recommendations using a printed label (which the software generates). The lack of interface with our application delivery system restricted software deployment in each patient room unless manually installed. Therefore, we deployed the software on key computers throughout the unit.

Posttrial validation

Following the trial, we resumed use of our standard, nomogram-based insulin order sets. We recollected CBG data to validate our results and found a return to our pretrial baseline. Optimal blood glucose control was achieved in only 14% of cases (which was down even from our prior rate of 17%), along with a 4% rate of hypoglycemia, an 84% rate of hyperglycemia, and increased control time in our CVRU patients.

Setting a standard

Our trial data provided overwhelming evidence that the tool improves glycemic control and decreases control time in this patient population. In November 2007, we implemented the tool as our standard for continuous insulin infusion in the CVRU and CVICU.

Our hospital uses an acuity-based software system for recommended staffing based on projected workload. Using the indicators within this system, we're able to account for the increased workload required to achieve glycemic control utilizing the tool. This allows us to plan for and justify the additional nursing time required.

The manufacturer has been able to provide interface with our application delivery system since implementation. Additionally, our Information Technology department is working closely with the manufacturer's engineers to develop an interface with our electronic medical record. In the interim, we continue to enter CBG values manually and utilize the software-generated label for documentation of recommendations.

We've also implemented a "softer" lancet, which presents less discomfort to patients from increased fingersticks, and we've minimized using the central line for blood sampling for CBG measurement so as to not increase the potential for central line-related bloodstream infections from frequent line interruptions.

Return on investment

Within our program, we're investigating the tool as a solution in transitioning patient from N.P.O. or continuous enteral nutrition status (and continuous insulin infusion) to intermittent oral intake (and correction dose insulin). The tool is designed primarily for use with steady carbohydrate intake. Although the tool can derive a basal subcutaneous insulin regimen, including prandial and correction dosing, for patients who are eating, we utilized this only in a small group of patients. Utilization of this regimen requires daily evaluation of insulin requirements as the patient's resistance changes.

Since our trial focused specifically on postoperative cardiovascular surgery patients, specific efficacy with other ICU patient populations needs further study. We're also unable to assess the tool's value in the step-down area.

Hyperglycemia is becoming increasingly recognized as a significant factor in increased mortality, particularly in the postcardiac surgery patient. Our experience with standard insulin nomograms and empirical attempts to customize glycemic control hasn't been successful. Several software-based glycemic control programs exist. During our trial with the software-based tool, we observed a 67% improvement in control time, an 84% decrease in hypoglycemia incidence, an 80% increase in CBGs within the optimal range, and an 84% decrease in hyperglycemic values when comparing prior values with the tool values. The projected cost savings from decreased length of stay and mortality (such as prevention of SSIs, and so on) further supports the cost and labor expense associated with the software and increased testing. NM

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