

MD Scientific's EndoTool

Located in Charlotte, North Carolina, Carolinas Medical Center (CMC) is the 861-bed flagship facility of Carolinas HealthCare System, and comprises a Level I Trauma Center, a research institute, the Levine Children's Hospital, and a rehabilitation facility. In late 2002 and early 2003, CMC's thoracic and cardiovascular surgeons met with members of the nursing and pharmacy staff to discuss ways we could improve the management of blood glucose (BG) in cardiovascular surgery patients. The mean first-morning, post-operative BG had been in excess of 180 mg/dL, and patients under stress with elevated BG are more prone to infections, poor tissue healing, and increased length of hospitalization. Our intent was to develop a procedure that could provide effective and efficient tight glucose control (TGC) and enhance our quality of care. Several options were discussed, including the use of cumbersome, multiple-page order sets with insulin sliding scales and/or formulas, but ultimately, we asked Dr. W. Patrick Burgess, a nephrologist with control mathematics expertise, to develop a computer program to manage blood glucose.

The EndoTool Glucose Management system uses feedback control mathematics, based upon previous BG readings and responses, to regulate the patient's non-linear insulin pharmacokinetics. This patient-specific data is used to calculate the insulin dose needed to control BG and the time for the next BG determination. The program uses a standard insulin drip of 250 units regular insulin in 250 mL sodium chloride 0.9%, and generates patient-specific orders for daily subcutaneous insulin requirements (basal, meal, and correction-scale coverage) when patients resume oral feeding and no longer require an IV insulin infusion.

Implementation and Operation

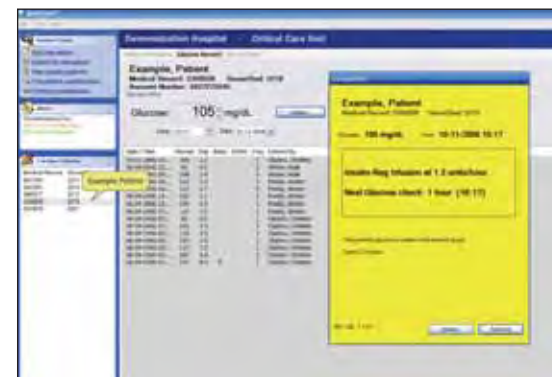
In early 2003, with input from endocrinologists, surgeons, and nursing, EndoTool was implemented in the cardiovascular recovery unit to manage patients with BG greater than 130 mg/dL. Using existing computers, nurses input the required patient data – patient demographics, accounting and medical record identifying numbers, weight, creatinine, and diabetic status (if known) – to set up the patient in EndoTool. The caregiver obtains a BG reading and enters the data into the program. An optional label is then generated with the updated insulin infusion rate and specific patient identifiers. The nurse changes the flow rate on the pump and attaches the label to the patient's MAR. The initial entry of patient information requires about 50 seconds, and subsequent BG entries require less than 15 seconds to obtain the next insulin dose and the time for the next BG determination. The present mean first-morning, post-operative BG is 114 mg/dL (+/- 18), with less than 0.5% of patients experiencing a BG of less than 40 mg/dL while on IV insulin. The majority of those hypoglycemic episodes are associated with late BG determinations.

Because of its proven effectiveness in achieving TGC, along with the favorable response from physicians and nurses the use of EndoTool was expanded to our Carolinas Heart Institute OR and all of our ICUs. EndoTool's goal ranges and parameters are adjustable to fit each unit's specific needs. For example, EndoTool allows the use of either insulin glargine (Lantus) or NPH as the basal insulin for subcutaneous transition orders, depending upon physician preference.

Advantages and Limitations

Using EndoTool, nurses no longer need to calculate insulin doses using sliding scale formulas or tables, and they make fewer calls to physicians for BG control-related issues. A summary of dosage adjustments during a 24-hour period is printed daily for inclusion in the patient's record. There are no multiple-page sliding scale insulin

order sets to review, and the program provides medical record documentation and a platform for a smooth transition from IV to subcutaneous orders when the patients are eating or receiving stable rates of tube feedings. For pharmacists, the order-entry process is much easier with the use of pre-built order sets in Cerner Millennium, and EndoTool has virtually eliminated the difficulty of interpreting physicians' handwritten insulin orders. When patients are transferred from the ICUs, physicians assume management of BG control. That said, EndoTool does not replace the physician's clinical judgment.



EndoTool calculates the insulin dose needed to control patients' blood glucose and determines the time for the next glucose check.

Assessment of Blood Glucose Control

When EndoTool was first implemented, we had two concerns:

- How effective would it be in providing TGC?
- Would its use result in an unacceptable incidence of hypoglycemia?

A recent analysis of data from January 1, 2005, through June 15, 2007, which included 4,296 patients and 171,456 BG readings in multiple care units, revealed the mean BG after four hours on the program was 116 (+/-27) mg/dL. The incidence of hypoglycemia using two-hour BG determinations was 0.06% (BG < 41 mg/dL) and 0.16% (BG < 51 mg/dL). This allowed nurses to change from hourly to two-hour blood glucose monitoring 42% of the time, without an increase in the incidence of hypoglycemia. In fact, the hypoglycemia rate has decreased. This frequency change has resulted in savings of both nursing time and BG monitoring supplies.

In summary, EndoTool has provided safe and effective TGC for our critical care patients and has been widely accepted by both physicians and nurses. EndoTool has eliminated the need for physicians to write and rewrite daily insulin doses until patients are transferred to non-ICUs. EndoTool has also reduced the time nurses spend on calculating and adjusting insulin doses and has virtually eliminated calls to physicians. Pharmacy order entry has been made easier, and errors attributed to handwritten insulin orders are not an issue. Overall, there have been significant improvements in the quality of care in our ICUs. ■

Currently the cardiology clinical specialist with Carolinas Medical Center, Debra A. Miller, PharmD, BCPS, earned her BS in pharmacy from West Virginia University and her PharmD from the University of North Carolina.

The recipient of a BS and PharmD from the Philadelphia College of Pharmacy & Science, Bob Rittase, PharmD, BCPS, FASCP, is currently employed at Carolinas Medical Center and is also an adjunct instructor at the University of North Carolina School of Pharmacy in Chapel Hill.

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