The Perils of Inpatient Hyperglycemia Management: How We Turned Apathy Into Action

Carrie C. Lubitz, MD; Jane Jeffrie Seley, GNP, MPH, MSN, CDE; Cristina Rivera, MD; Naina Sinha, MD; and David J. Brillon, MD

Abstract

As the number of Americans with pre-diabetes and diabetes continues to grow, so too will the number of patients who come into the hospital with hyperglycemia. Although tight glycemic control has been a well-established goal in the outpatient setting, it has only recently gained heightened interest in the inpatient arena. There is a growing body of knowledge supporting the benefits of strict glycemic control in hospitalized patients, yet there is little or no formal didactic training for health care professionals in inpatient management of patients with diabetes. Despite widespread inpatient hypoglycemic and hyperglycemic events, there are few systems in place for effective diabetes care and management.

In January 2006, the American Association of Clinical Endocrinologists, the American College of Endocrinology, and the American Diabetes Association convened a meeting titled “Improving Inpatient Diabetes Care: A Call to Action Consensus Development Conference,” which concluded that facilitating these changes required a paradigm shift that involves modifying both individual and institutional beliefs and practices that have been status quo for decades. One of the key consensus recommendations was the formation of an interdisciplinary steering committee to identify deficits, develop strategies, and facilitate the implementation of interventions to improve inpatient care. This article illustrates the planning and implementation of a systems-wide model to conquer inpatient hyperglycemia in an academic medical center.

Introduction

Although tight glycemic control has been a well-established goal in the outpatient setting for many years, it only recently gained heightened interest in the inpatient arena. This shift is in response to a growing body of knowledge supporting the benefits of strict glycemic control in hospitalized patients, including significant reductions in morbidity and mortality after myocardial infarction and postcoronary artery bypass grafting and in the critically ill.1–3

Despite mounting evidence for stricter inpatient glycemic control, many hospitals remain reluctant to make it a top priority. The issue has become a global public health concern, as highlighted by a recent series of articles in the New York Times,4 which contended that money is the driving force because hospitals are reimbursed more for treating the complications of diabetes than for its prevention. Still, increased attention to preventing inpatient hyperglycemia can have monetary benefits. A hospital program to reduce hyperglycemia in the intensive care unit setting was associated with significant cost savings in addition to improvements in inpatient morbidity and mortality.5

Although thought to be a gross underestimate of the true prevalence, an estimated 12.4% of patients discharged in 2000 carried a diagnosis of diabetes.6,7 With an estimated 20.8 million Americans with diabetes and another 41 million with pre-diabetes, the number of hospitalized patients with hyperglycemia will continue to grow.8

Poor glycemic control is known to be a significant factor in increased nosocomial infection, length of stay, and mortality; however, there is little or no formal didactic training in inpatient management of patients with diabetes.9 Furthermore, although inpatient hypoglycemic and hyperglycemic events are widespread, there are few systems in place for the
appropriate timing of blood glucose monitoring, insulin administration, and delivery of meal trays for diabetic patients. Laboratory, nursing, and food service personnel often fail to communicate with each other in the development of policies and procedures that coordinate optimal delivery of care. Physicians and nurses frequently share a common belief that poor glycemic control over a short period of time is not detrimental, but rather is an unavoidable consequence of acute illness and hospitalization. Regular sliding-scale insulin use without the use of basal insulin is still passed on through the ranks, even though it has been shown that inpatients treated with a sliding scale alone are three times more likely to have blood glucose levels > 300 mg/dl.9 Fear of hypoglycemia and the belief that short-term hyperglycemia is not harmful continue to overshadow efforts to bring blood glucose levels into recommended target ranges in the inpatient setting. In the case of inpatients with hyperglycemia, this often leads to clinical inertia.

In January 2006, the American Association of Clinical Endocrinologists, the American College of Endocrinology, and the American Diabetes Association convened a consensus conference titled “Improving Inpatient Diabetes Care: A Call to Action Consensus Development Conference.” The purpose of this meeting was to identify barriers to improving hyperglycemia in the inpatient setting and possible solutions. It was agreed that facilitating these changes required a paradigm shift that involves modifying both individual and institutional beliefs and practices that have been the status quo for decades. One of the key consensus recommendations was the formation of an interdisciplinary steering committee to identify deficits, develop strategies, and facilitate the implementation of these interventions. This article illustrates the planning and implementation of a systemwide model to conquer inpatient hyperglycemia.

Background
In autumn 2004, NewYork-Presbyterian/Weill Cornell Medical Center in New York City hired a full-time diabetes nurse practitioner to coordinate improving the care of inpatients with diabetes. Case finding was accomplished through point-of-care testing data that alerted the diabetes nurse practitioner to patients on target units with critical blood glucose levels. Unit-based classes educated physicians and nurses about the benefits of improved glycemic control and effective approaches to facilitating change. An 8-hour course was developed and is offered twice a year to nursing and other health care professionals. In addition, a monthly diabetes resource nurse committee offered continuing education for nurses. Before long, it became obvious that inpatient hypoglycemia and hyperglycemia could not be tackled patient by patient, but instead required a systems approach. With this in mind, an advisory group was formed, and a full-time dedicated inpatient endocrinologist was hired to create an inpatient diabetes team.

Formation of Advisory Council
To investigate the root causes of poor glycemic control and develop strategies for improved care of inpatients with diabetes, the Diabetes Care Council was established. Representatives from information technology, point-of-care testing, nursing, nutrition, primary care, adult and pediatric endocrinology, maternal/child health, pharmacy, and house staff from the medicine and surgery departments were included on the advisory board. It became clear at early meetings that communication and interaction among the disciplines was vital to understanding responsibilities and achieving success. An interdisciplinary approach was used to identify problems, establish goals, and implement change.

Our primary initial goal was to generate a problem list and establish priorities. Areas in need of improvement were brainstormed, and three core obstacles were selected that would have the most immediate and prolonged impact on inpatient glycemic control: 

- coordination of blood glucose checks, insulin administration, and meal tray delivery; 
- staff education related to use of diabetes medications in hospitalized patients; and  
- electronic medication order sets to facilitate appropriate prescribing of insulin.

Coordination of glucose monitoring, insulin administration, and meals.
Before our intervention, night nurses frequently checked blood glucose levels between 5:00 and 6:00 A.M., and insulin was given either immediately or several hours later, when trays were delivered. Trays were delivered by room number regardless of diabetes status, making it virtually impossible to follow the same guidelines recommended to outpatients, who are generally asked to take prandial insulin just before meals. In an effort to optimize the timing of glucose monitoring, insulin administration, and meal tray delivery, hospital-wide guidelines were established as follows:

- Night nurses check morning blood glucose levels after 7:00 A.M. 
- Dietary staff notifies nurses of tray arrivals so they can prepare insulins. 
- Patients on diabetic meal plans receive their trays before other patients.

Dietary and nursing staff partnered in the formulation of these guidelines and assisted in staff training. Modifying nursing and dietary routines required ongoing training and support. Daily point-of-care blood glucose testing data were then reviewed to evaluate the efficacy of these and other practice changes.

House staff education: appropriate use of diabetes medications. Training of house staff is a vital component of an interdisciplinary approach to diabetes care.10,11 After the introduction to the pathophysiology of diabetes and basic pharmacotherapy in medical school, there is minimal formal instruction in the management of diabetic patients.10,12 Furthermore, many of the treatment recommendations taught in medical school are now outdated.

The pretest, intervention, and posttest model of education has been used to implement screening and prevention programs and new equipment use and in evaluation of a continuous quality improvement curriculum.13-15 Applying a paired-measures design, a brief education module directed at inpatient hyperglycemia management was used to assess improvement in
knowledge base. Each house staff member attended a session taught by the inpatient diabetes team and consisting of a 10-minute 20-question pretest, a 40-minute lecture, and a 10-minute posttest. The lecture focused on the consequences of poor glycemic control, proper ordering of a diabetic diet, use of oral agents in the hospital, and the basal–bolus approach to insulin management, and the quiz presented practical clinical scenarios.

The pilot cohort consisted of 33 participants, including all postgraduate year levels. Results of our initial analyses are listed in Table 1. Medical house staff had a significantly better initial knowledge base ($P < 0.001$); however, there was no significant difference in posttest scores or the mean difference between medical doctors and surgeons. Overall, house staff had significant improvement in scores after the educational module (mean difference between post- and pretest scores of 4.6 and 6.3 for the medical and surgical house staff, respectively). Interestingly, postgraduate year level was not correlated with knowledge base.

**Revision of electronic insulin orders.** Insulin aspart and insulin lispro have been shown to improve postprandial hyperglycemia, reduce the rate of mild hypoglycemic episodes, and improve patient convenience compared with regular human insulin in type 1 diabetic patients in the short term.$^{7,16–18}$ Compared with human regular insulin therapy, mealtime therapy with insulin lispro reduces postprandial hyperglycemia and may decrease the rate of mild hypoglycemic episodes in patients with type 2 diabetes.$^{20}$ Even so, use of supplemental regular insulin remains ubiquitous in the inpatient arena.

The advisory group reasoned that regular insulin was ordered more frequently because dosages were pre-filled in the electronic order set. By contrast, rapid-acting insulin analogs had been intentionally left blank to individualize dosages. In truth, this became an overwhelming barrier to ordering insulin analogs. To solve this problem, user-friendly rapid-acting insulin analog order sets based simply on whether the patient was eating or NPO (nothing per os) were created to make it easier for house staff to order the appropriate dose and type of insulin and thus improve patient safety and quality of care. This required collaboration among information technology, nursing, endocrinology, and house staff. After removing regular insulin from the formulary and discouraging its use as a prandial insulin, we compared medical-surgical patients in January 2004 ($n = 380$) to patients on the same units ($n = 406$) in January 2005 and found a 69% reduction in hypoglycemic episodes over the 1-year period.

**Future Goals and Recommendations**

As New York Presbyterian/Weill Cornell Medical Center continues to tackle initial core obstacles to inpatient hyperglycemia management, the advisory committee meets monthly to evaluate progress, identify new barriers, and develop new strategies. The process of designing metrics to evaluate outcomes of our program is underway. For example, length-of-stay data will be reviewed as they correlate to each patient’s daily mean blood glucose levels. In addition, pharmacy data will be monitored to evaluate trends of insulin usage as an critical performance indicator. The process of designing metrics to evaluate outcomes of our program is underway.

<table>
<thead>
<tr>
<th>Table 1. Test Results for House Staff</th>
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<tr>
<td><strong>House staff</strong> (All PGYs)</td>
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<tr>
<td>Mean pretest score</td>
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<td>Medical ($n = 15$)</td>
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<td>Surgical ($n = 18$)</td>
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Data are the means ± SE, unless otherwise indicated. PGY, postgraduate year.

An interdisciplinary approach was paramount in overcoming initial significant resistance to change. The vital element to the success of the program was the creation of a shared vision across disciplines. Inclusion of staff in the development and implementation process produced a sense of pride and personal satisfaction in the shared ultimate goal of better patient care and management. Improved inpatient glycemic control is a difficult but surmountable task that can be achieved one fingerstick at a time.

**References**


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