Barriers to Implementing an Insulin Order Form In a Non-ICU Medical Unit

Sally A. Arif, PharmD, BCPS, and Alisa K. Escaño, PharmD, BCPS, CDE

ABSTRACT

Objective: We sought to evaluate barriers to the implementation of a standardized subcutaneous (SQ) insulin order form in a non-ICU medical unit.

Research Design and Methods: An insulin task force comprising physicians, nurses, dietitians, and pharmacists developed and implemented an SQ insulin order form in a community-based teaching hospital. A prospective observational study was conducted to identify difficulties in adopting the form and to delineate requirements for staff education. The main outcome measure was utilization of the form.

Results: The development of a standardized SQ insulin order set for the medical inpatient unit was intended to include a more physiological approach to the control of hyperglycemia. During an eight-week pilot period, only 9% of physician orders included basal, bolus, and correctional-dose (BBC) components of the order form. Because of a limited patient size and low utilization of the order form, it is difficult to determine whether use of the form succeeded in decreasing the occurrence of hyperglycemia. Experience gained from the initial implementation indicates that teaching personnel how to use the form and how to combine long-acting and short-acting insulins to prevent or control hyperglycemia are necessary for the form to gain acceptance.

Conclusion: The extent to which the medical staff used the SQ insulin order form was modest. Clinician acceptance and education about hyperglycemia early on are essential for the successful adoption of a standardized tool into clinical practice.

INTRODUCTION

The number of reported cases of diabetes mellitus is rapidly increasing each year in the U.S. and has grown to epidemic proportions. According to the Centers for Disease Control and Prevention (CDC), the number of people with diabetes increased from 20.8 million in 2005 to 23.6 million in 2007.¹ The highest prevalence has been seen in adults 20 to 60 years of age.¹

Cowie et al. examined the prevalence of both diagnosed and undiagnosed diabetes, as well as prediabetes, using fasting and two-hour oral glucose tolerance tests.² In persons 20 years of age and older, the crude prevalence of total diabetes was 13%, and diabetes remained undiagnosed in approximately 40% of these patients.³ Furthermore, approximately 30% of the study patients were found to have prediabetes. Non-Hispanic African-Americans and Mexican-Americans, combined, had a 70% to 80% higher prevalence of diabetes compared with non-Hispanic Caucasians.²

In both diabetic and nondiabetic patients, hyperglycemia is associated with numerous harmful effects on the body. Complications that can occur in uncontrolled hyperglycemia include shifts in fluid and electrolyte balance and impaired immune system responses, resulting in difficulty overcoming infections.³–⁶ Studies have suggested that mildly elevated blood glucose levels raise the risk of thrombosis because of mechanisms such as enhanced platelet aggregation and interleukin-6 (IL-6)–induced elevations in plasma fibrinogen.⁷–¹⁰

HYPERGLYCEMIA IN THE HOSPITAL

A study published by Umpierrez and colleagues in 2002 was conducted to determine the prevalence of hyperglycemia in the hospital. It was reported that 223 of 1,886 patients (12%) admitted for hyperglycemia had newly diagnosed hyperglycemia and 495 patients (26%) had a known diagnosis of diabetes.¹¹ Hyperglycemia was defined as a random blood glucose concentration of 200 mg/dL or a fasting blood glucose level above 126 mg/dL. Incidentally, hyperglycemia was determined to be an independent marker of mortality in hospitalized patients with undiagnosed diabetes.

In the 12% of patients with newly diagnosed hyperglycemia, which was related to an unknown diagnosis or a related illness or to patients receiving corticosteroids, there was an 18-fold increase in in-hospital mortality associated with poorly controlled blood glucose. Patients with hyperglycemia, with or without diabetes mellitus, were at an increased risk of in-hospital mortality, postoperative infections, and complications from infections, neurological events, admission to an intensive-care unit (ICU), and increased length of stay (LOS).¹¹

Patients with a secondary diagnosis of diabetes also have a longer hospital LOS if blood glucose levels remain uncontrolled. In an observational study, published in 2007, Clement noted that hyperglycemia and diabetes-related admissions accounted for an increased LOS of an average of four days more than in patients without hyperglycemia or diabetes as a secondary diagnosis.¹²

Hyperglycemia in hospitals may be poorly controlled for a number of reasons.¹³ For instance, it may be perceived as a consequence of stress and acute illness; as a result, treatment may be delayed until blood glucose levels are well above 200 mg/day for fear of the occurrence of hypoglycemia. In addition, oral acceptance for publication November 23, 2009.

Disclosure. The authors have no financial or commercial relationships to report in regard to this article.

Dr. Arif is Assistant Professor of Pharmacy Practice at the Arnold & Marie Schwartz College of Pharmacy and Health Sciences, Long Island University, in Brooklyn, New York, and an Internal Medicine Clinical Specialist at James J. Peters Veterans Affairs Medical Center in Bronx, New York. Dr. Escaño is Director of the PGY-1 Pharmacy Residency Program and an Internal Medicine Clinical Specialist at Inova Fairfax Hospital in Falls Church, Virginia.
Barriers to Implementing an Insulin Order Form

Antidiabetic medications are often withheld upon admission, and sliding scale insulin (SSI) therapy alone is prescribed to manage hyperglycemia. As a common practice in glycemic management, SSI therapy has been ineffective as the sole method of treating hyperglycemia and is associated with little success and suboptimal glycemic control.14 A study at the Johns Hopkins Hospitals by Queale et al. found that 76% of patients who were admitted with a secondary diagnosis of diabetes mellitus were prescribed an SSI regimen as the sole method of reducing blood glucose.15 Of that group of patients, 23% had at least one hypoglycemic episode (blood glucose below 60 mg/dL) and 40% had at least one hyperglycemic episode (blood glucose above 300 mg/dL). Compared with patients who did not receive any medications for hyperglycemia, those receiving SSI regimens alone had a three-fold increased risk of hyperglycemia (blood glucose above 300 mg/dL). The authors concluded that SSI regimens appeared to provide no benefit when they were prescribed as the only method of glucose control in hospitalized patients with hyperglycemia. When SSI regimens are used without a standing dose of intermediate-acting insulin, the rate of hyperglycemic episodes may increase.15

Some have claimed that SSI therapy alone is a reactive method of controlling hyperglycemia without any consideration of the individual patient’s insulin sensitivity or blood glucose response. SSI therapy is often ordered as a one-size-fits-all remedy, resulting in a potential increased risk of hypoglycemic occurrences related to dose stacking.26,27 The use of a physiological approach to control hyperglycemia has been proposed for all hospitalized patients with consistently uncontrolled hyperglycemia regardless of their diabetes classification. The use of basal–bolus–correctional (BBC) insulin has long been the treatment of choice for patients with type-1 diabetes mellitus.28-31 BBC insulin therapy consists of providing a combination of a long-acting or an intermediate-acting (basal) insulin with a short-acting or rapid-acting (bolus) insulin to maintain euglycemia.

- Basal insulin is used to suppress hepatic glucose output and to decrease the occurrence of ketogenesis and unchecked gluconeogenesis, thus controlling and maintaining blood glucose levels during times of fasting.
- Bolus insulin is a dose of short-acting or rapid-acting insulin that is taken before each meal to manage the postprandial glucose peaks that occur with each meal.
- Correctional insulin is the traditional SSI method that is tailored to each patient based on insulin sensitivity to blood glucose lowering. This scale is designed to manage hyperglycemia that occurs only on top of basal–bolus therapy as a result of stress or illness.

BBC insulin has been effective in controlling hyperglycemia in hospitalized type-2 diabetic patients.32-35 In RABBIT 2 (a Randomized study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients with Type-2 Diabetes), the primary outcome was the difference in mean daily blood glucose with BBC insulin compared with traditional SSI therapy.25 Overall blood glucose levels were lower in the BBC arm (166 mg/dL) than in the SSI arm (193 mg/dL) by day 10 of the hospital stay (P < 0.001) despite the administration of increasing insulin doses to meet glycemic goals. With SSI therapy only, blood glucose levels remained higher than 40 mg/dL in 14% of patients by day 10 of their hospital stay. Glycemic control rapidly improved after these patients were switched to BBC therapy. Patients receiving BBC therapy had a higher insulin dose, on average, than those treated with SSI alone, yet the BBC patients had a lower incidence of hypoglycemia.23

The development of a safe and effective method of ordering BBC must be a priority in any health care institution caring for patients predisposed to hyperglycemia. The use of an SQ insulin order set, according to a study by Magee, would increase the ease of ordering and would establish a safer practice for prescribing insulin.36 The use of a preprinted order set would also help to reduce transcription errors by decreasing readers’ misinterpretation of ambiguous abbreviations such as “u” for units and “q.d.” for daily, as recommended by the Joint Commission.29

In this article, we describe our experience with the creation and adoption of a comprehensive SQ insulin order form using a collaborative interdisciplinary approach.

DEVELOPMENT OF THE ORDER FORM

The medical inpatient service at Inova Fairfax Hospital, a level 1 trauma, community-based teaching hospital with 833 beds, has approximately 20 hospitalists; 2,200 private attending physicians; 1,600 nurses; and 89 decentralized staff and clinical pharmacists. During the pilot period in which the order form was first used in 2005, the mean LOS was 10.6 days per patient with type-2 diabetes on the medical floor. The mean age of these patients was 68.8 years (49% women, 51% men).

Until November 2005, physician preference determined whether SQ insulin was ordered. At the time of the study, electronic charting and computerized prescriber order entry (CPOE) were not available. Insulin orders were handwritten and placed into the patient’s paper chart. The insulin orders were then electronically scanned, sent to the pharmacy for order entry, and dispensed to the hospital floors.

A task force, comprising dietitians, nurses, pharmacists, and physicians who supported the SQ insulin order form, including endocrinologists and hospitalists, was assembled. The first step of the task force was to create the SQ insulin order form before the pilot period. Baseline glycemic control in the patient population, as well as evidence-based findings, were presented and discussed to help identify target blood glucose levels. The task force also discussed the potential barriers for initiating appropriate insulin therapy as well as the published clinical data and national guidelines supporting tight glucose control.29 Glycemic targets for non-ICU patients were established based on guidelines for management of diabetes mellitus by the American College of Endocrinologists (ACE), the American Association of Clinical Endocrinologists (AACE), and the American Diabetes Association (ADA).7,28

After a preliminary version of the SQ insulin order form was produced, we obtained feedback from collaborating physicians, nurses, dietitians, and pharmacists about optimization of the patient dietary orders, nothing by mouth (NPO) orders, and the development of insulin dosing guidelines to improve the form before its adoption. The final version of the
order form was created, and an eight-week pilot period was selected to begin, during which time the form would be used on an inpatient medical/endocrine floor.

The final version of the order form contained these measures derived from published guidelines (Figure 1, p. 39):27–29

- predefined target blood glucose values for non-ICU patients set at a fasting blood glucose between 80 and 140 mg/dL or a non-fasting blood glucose below 180 mg/dL
- options for the physician to select either a carbohydrate diet of 75 g of carbohydrates per meal or to specify tube-feeding orders if applicable

**SELECTION OF INSULIN: BASAL, BOLUS, OR CORRECTIONAL**

Basal insulin, given as intermediate-acting Neutral Protamine Hagedorn (NPH) or long-acting glargine (Lantus, Sanofi-Aventis) to suppress hepatic gluconeogenesis, was not to be withheld unless specified by the physician.

Bolus insulin, offered as rapid-acting insulin aspart (Novolog, Novo Nordisk), was to be given within 15 minutes before or 15 minutes after a meal. For tube feedings, various insulin regimens were available, depending on whether the feedings were continuous, bolus, or cyclic. Under this section of the form for ordering insulin (see Figure 1), an instruction was given to nurses to withhold bolus insulin if the patient’s regimen was NPO for any reason.

Correctional insulin (formerly, SSI) is indicated to treat preprandial or stress-induced hyperglycemia above 140 mg/dL. To provide physicians with the option of tailoring correctional-dose insulin therapy for their patients, our order form provides the option of using of a low, medium, or high correctional-dose insulin algorithm, based on the patient’s total daily insulin requirements. There is also an option for physicians to write their own scale, based on the patient’s insulin sensitivity factor. The physician may then choose either a rapid-acting insulin analogue or regular insulin. This component of insulin is indicated for correcting preprandial hyperglycemia above the pre-meal blood glucose target of 140 mg/dL. To provide physicians with the option of tailoring correctional-dose insulin therapy for their patients, our order form recommends the use of a low, medium, or high correctional-dose insulin algorithm based on the patient’s total daily insulin requirements.

Hypoglycemia, defined on our form as a blood glucose level below 70 mg/dL, or any blood glucose level below 80 mg/dL with symptoms, was to be treated with the hypoglycemia order set. The order set was built into the order form and included directions to notify the physician.

**IMPLEMENTING THE ORDER FORM**

Before the start of the pilot period, the initial approach to informing physicians about the SQ insulin order form consisted of a Dear Physician letter, written by the chairman of the Department of Medicine, to be distributed to all attending physicians. Mandatory training programs were established for both pharmacy and nursing staff members on the pilot floors.

Insulin doses that were drawn directly from vials on the medical floor were required to be double checked with another nurse to minimize medication errors before administration. The pharmacy was to place all forms of insulin vials, except for concentrated regular insulin (e.g., Humulin R-U-500, Lilly), in the automated dispensing units on the medical floors for improved insulin dose tracking and medication administration safety. Units that were dispensed were tracked via automated dispensing machines. To do this, the nurses had to enter the exact amount of insulin, in units, that they were removing from the vial before the insulin was given to the patient. Pharmacy technicians inspected the insulin vials every two weeks to ensure that each vial in the automated dispensing machines did not exceed their expiration date of 28 days.

During the pilot period, nationally recognized endocrinologists developed hospital-wide, hyperglycemia-awareness educational programs. Individuals in each discipline conducted in-hospital instruction directed toward the nurses and pharmacists. Educational aids included posters on diabetes and hyperglycemia as well as insulin case studies.

For eight weeks (from November to December 2005) after the SQ insulin order form was adopted, data were collected and analyzed for patients whose insulin was prescribed in accordance with instructions on the form. The analysis, which included the appropriate use of each component of the form by the prescriber, was made possible by scanner technology and the ability to save all order forms received by the pharmacy.

To capture the impact of further staff education designed to increase usage of the form, a second pilot period was conducted over a 16-week period, from June to September 2006. The hospital’s institutional review board approved the study and waived the requirement for obtaining patient consent.

Even though it was recommended that all insulin orders be submitted using the SQ insulin order form during the pilot period, it was anticipated that complete compliance would not be possible because use of the form was not mandatory. If the physician used the order form to manage hyperglycemia, the components of the form used were measured (Figure 2). Ideally, all three components (basal, bolus, and correctional-dose) would be needed for adequate control of hyperglycemia, however, full BBC insulin regimens were used in only 9% of patients throughout the eight-week pilot period.

In most cases, only the correctional-dose section of the order form was used to prescribe insulin, accounting for 48% of orders received by the pharmacy. Six months after the order form was introduced into clinical practice, the use of all three components (BBC) improved to 12% over a 16-week evaluation period.

**LESSONS LEARNED: INCREASING THE USE OF THE ORDER FORM**

The initial process of implementing the SQ insulin order form helped to identify key areas for improvement to help strengthen educational campaigns designed to increase compliance in using the form in the hospital. As for the lack of use of the form during our pilot period, we found that the challenges and barriers to successful order form implementation could be eliminated by changing the current practice culture for managing hyperglycemia and by exploring effective teach-
Barriers to Implementing an Insulin Order Form

Figure 1  Subcutaneous (SQ) insulin order form at Inova Fairfax Hospital. ac = before meals; BG = blood glucose; dl = deciliter; hs, HS = at bedtime; hrs = hours; IM = intramuscular; ml = milliliter; MD = physician; NPH = Neutral Protamine Hagedorn; NPO, nothing by mouth; PO = by mouth.

[Image of the insulin order form is shown here.]
order form was also revised to include a reference page to highlight the definitions of basal, bolus, and correctional-dose insulin. Dosing recommendations and a list of all formulary insulin products, including their pharmacokinetic profiles (onset, peak, and duration), were also provided.

To remind physicians about the form’s availability, nurses on the medical wards placed stickers in the orders section of charts belonging to patients receiving insulin. If the physician chose to use a regular order form to prescribe insulin, the prescription was still accepted by pharmacy and nursing staff.

Point-of-care blood glucose testing devices are also associated with improved patient outcomes. These devices help to capture data in real time and aid prescribers in identifying patients with difficult-to-control blood glucose levels. To demonstrate glycemic outcomes for our patients, the task force also recommended initiating the continuous uploading of blood glucose values on the medical floor utilizing these devices. This procedure would automatically make blood glucose results available the hospital’s computer system and allow for the rapid detection of hypoglycemia and hyperglycemia in the patients receiving insulin.

To what extent the form would need to be used to achieve the optimal effect on glycemic control is unknown. However, use of the form for all insulin orders via CPOE will become mandatory. Another step would be to create an inpatient diabetes management team, consisting of an endocrinologist, a medicine hospitalist, a nurse practitioner, and a pharmacist to be consulted by internists for patients with difficult-to-control hyperglycemia. Nevertheless, clinician acceptance is crucial for the successful adoption of order form sets, especially in institutions that employ teaching services for the regular care of patients. The insulin order set is also vital for teaching residents and students the proper way to manage hyperglycemia while eliminating the outdated SSI approach.

CONCLUSION

Using an interdisciplinary approach, we developed and implemented an SQ insulin order form as a way to improve glycemic control in hospitalized patients with hyperglycemia. In creating the form, we required input from all disciplines to ensure that it was well received by the staff upon initiation.

Key barriers to successful implementation and utilization of the form included the need to adjust educational strategies to include discipline-focused in-services, competency assessments, teaching tools for insulin dosing to make the form easy to use, and further revisions to the form. We determined that the ideal patient in our hospital who should receive basal–bolus–correctional (BBC) insulin would have blood glucose levels consistently above the nonfasting target range of 180 mg/dL.

Use of this insulin order form is strongly recommended upon hospital admission for all patients with type-1 or type-2 diabetes as follows: (1) if they are using insulin at home, (2) if their blood glucose levels are poorly controlled (above 180 mg/dL) while they are taking oral agents, and (3) if oral diabetes medications are to be withheld in the hospital.
Barriers to Implementing an Insulin Order Form

BBC “Cheat Sheet”

How to Dose Sub-Q Insulin for the BBC Form

Step 1: Determine which type of patient should use the BBC Form

A. Immediately at the time of admission
   - All patients with type 1 diabetes
   - Patients with type 2 diabetes if...
     - They are on insulin at home
     - They are poorly controlled (blood glucose >180 mg/dL) while on oral agents
     - The patient’s oral diabetes meds will be held in the hospital & requiring glycemic control

B. During hospitalization
   - Any patient with blood glucose levels consistently above the non-fasting target range of 180 mg/dL

Step 2: Determine Hospital Insulin Regimen

<table>
<thead>
<tr>
<th>Patient Type</th>
<th>Pre-admission Regimen</th>
<th>Hospital Sub-Q Insulin Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NPO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eating meals/ bolus tube feeds **</td>
</tr>
<tr>
<td>Type 1 DM</td>
<td>Insulin Only</td>
<td>Basal Only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Basal &amp; Bolus</td>
</tr>
<tr>
<td>Type 2 DM</td>
<td>Insulin Only</td>
<td>Basal Only</td>
</tr>
<tr>
<td></td>
<td>Oral Meds</td>
<td>Basal Only-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* calculated basal dose by 1/3</td>
</tr>
<tr>
<td></td>
<td>Oral Meds &amp; Insulin</td>
<td>(d/c oral meds)</td>
</tr>
<tr>
<td>Non-Diabetic</td>
<td>Glucose &gt;180</td>
<td>Basal Only</td>
</tr>
<tr>
<td>Post-Surgical</td>
<td>IV insulin Drip</td>
<td>Basal Only-</td>
</tr>
<tr>
<td>Patient</td>
<td></td>
<td>* calculated basal dose by 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d/c oral meds)</td>
</tr>
</tbody>
</table>

Step 3: Determine Total Daily Dose (TDD) for insulin

How (choose one)

<table>
<thead>
<tr>
<th>TDD Dose Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDD = 0.4 units x Wt in Kg</td>
</tr>
<tr>
<td>Adjust down to 0.3 units x Wt in Kg for patients hypoglycemia</td>
</tr>
<tr>
<td>risk factors including:</td>
</tr>
<tr>
<td>o kidney failure</td>
</tr>
<tr>
<td>o type 1 diabetes (especially if lean)</td>
</tr>
<tr>
<td>o frail/low body weight/malnourished elderly</td>
</tr>
<tr>
<td>o insulin naïve patients</td>
</tr>
<tr>
<td>Adjust up to 0.5-0.6 units (or more if patients requires) x Wt in Kg for those with hyperglycemia risk factors including: obesity &amp; high-dose glucocorticoid treatment</td>
</tr>
</tbody>
</table>

or #2 Insulin drip-based estimate

TDD requirement is calculated by taking 80% of last stable IV insulin rate/hr x 24 hrs.

or #3 Insulin preadmission requirements

Restart total daily dose of insulin required at home & adjust as necessary

Definitions: Basal- Long acting insulin (Lantus Preferred/NPH), Bolus- Mealtime/prandial insulin (Novolog Preferred/Regular), Correctional- will be given in addition to basal and bolus to correct hyperglycemia due to illness/stress (Novolog/Regular). Always use same type of insulin for Bolus and Correction.

* See step 2 to calculate basal dose
** Continuous tube feed patients will not receive bolus insulin and will be managed with basal & correctional.

Figure 3 Physician insulin order form (pocket tool) at Inova Fairfax Hospital. BBC = basal–bolus–correctional; d/c = discontinue; dl = deciliter; DM = diabetes mellitus; hrs = hours; IV = intravenous; mg/dl = milligrams per deciliter; Kg = kilograms; Sub-Q = subcutaneous; Wt = weight.
By teaching residents and medical students the BBC method of insulin therapy for inpatients, we are encouraging the practice to be performed in the outpatient setting. We hope that this strategy might produce better glycemic control and reduce the incidence of future hyperglycemia-related complications after patient discharge.

Acknowledgment: We extend our appreciation to these members of the Inova Fairfax Hospital Insulin Task Force for their dedication and participation in developing and adopting the SQ insulin order form for daily clinical practice: Peter Ross, MD; Mary Dixon, RN; Karen Harriman, RN, CFNP; CDE; Grace Hoeymans, RN, MSN; Gill Abernathy, RPh, MS, BCPS; Chris Althoff, RN, MSN, OCN; Tiffany Gunderman, RN; Chris Hohenstein, RN; Melissa Hewitt, RN; and Stacey Townsend, RD.

REFERENCES