Implementation of a Multidisciplinary Educational Strategy Promoting Basal-Bolus Insulin Therapy Improves Glycemic Control and Reduces Length of Stay for Inpatients With Diabetes

Karmon E. Helmle, Anthony L. Dechant, and Alun L. Edwards

IN BRIEF "Quality Improvement Success Stories" are published by the American Diabetes Association in collaboration with the American College of Physicians, Inc. (ACP), and the National Diabetes Education Program. This series is intended to highlight best practices and strategies from programs and clinics that have successfully improved the quality of care for people with diabetes or related conditions. Each article in the series is reviewed and follows a standard format developed by the editors of *Clinical Diabetes*. The following article describes an initiative to increase the use of basal-bolus insulin therapy for hyperglycemia in an inpatient setting and to evaluate its effects on patient outcomes compared to sliding-scale insulin therapy.

Department of Medicine, Cumming School of Medicine, University of Calgary, Calgary, Alberta, Canada

Corresponding author: Karmon E. Helmle, karmon.helmle@albertahealthservices.ca

This article contains supplementary data online at http://clinical.diabetesjournals.org/lookup/suppl/doi:10.2337/cd17-0078/-/DC1

https://doi.org/10.2337/cd17-0078

Describe your practice setting and location.

The intervention was undertaken on two internal medicine inpatient medical teaching units at the Foothills Medical Centre, one of four tertiary care facilities in Calgary, Alberta, Canada. Each medical teaching unit has a patient census of ~20–30 medical patients and employs a multidisciplinary approach to the care of this diverse group of complex patients. Care is provided by three to four medical students, four to five junior residents, one to two senior residents, bedside nursing staff, clinical nurse educators, a clinical pharmacist, a care coordinator, and one internal medicine attending physician. Local discharge data suggest that nearly one-fourth of the medical teaching unit inpatients have diabetes.

Describe the specific quality gap addressed through the initiative.

Failure to recognize and treat inpatient hyperglycemia increases the risk of acute complications, prolongs hospitalization, and increases mortality. Sliding-scale insulin use in the hospital is unfortunately common and involves administering rapid- or short-acting insulin reactively in response to hyperglycemia in the absence of basal insulin. Conversely, basal-bolus insulin therapy integrates the pharmacology of different insulin analogs to more closely replicate physiologic insulin action and aims to proactively anticipate patients' insulin needs to prevent hyperglycemia and hypoglycemia. Data from randomized controlled trials inform recommendations from the American Diabetes Association (ADA), the American Association of Clinical Endocrinologists (AACE), the Endocrine Society, the Society of Hospital Medicine (SHM), and Diabetes Canada promoting the use of basal-bolus insulin therapy over the commonly prescribed sliding-scale insulin in hospitalized patients (1–6). These guidelines recommend starting a basal-bolus insulin protocol in the hospital for patients whose blood glucose is persistently higher than target or for whom it is not safe or reasonable to continue the home diabetes management regimen. At the time

TABLE 1. Insulin Protocol in the Pre- and Post-Implementation Periods

Insulin Protocol	Pre-Implementation, % (*n*)	Post-Implementation, % (*n*)
Basal-bolus insulin therapy	18.9 (6,999/37,031)	36.7 (8,838/24,082)
Exclusive sliding-scale insulin	38.7 (14,331/37,031)	32.0 (7,706/24,082)
Other subcutaneous insulin	42.4 (15,701/37,031)	31.3 (7,538/24,082)

Insulin protocol, reported as the proportion of active orders at each point of care glucose result testing event. Given that patients may be prescribed several different insulin protocols throughout their stay, the active insulin orders were categorized as basal bolus insulin therapy, exclusive sliding-scale insulin, or other subcutaneous insulin at the time of each insulin administration. Other subcutaneous insulin includes all subcutaneous insulin orders not captured in the basal bolus insulin therapy and exclusive sliding-scale insulin groups.

of data collection, Diabetes Canada guidelines recommended a blood glucose target of 4–11 mmol/L (72–196 mg/dL) (3). Current ADA guidelines for diabetes care in the hospital suggest target blood glucose values of 7.8–10 mmol/L (140–180 mg/dL) (4,6), and these narrower targets are endorsed by SHM (5) and AACE (4).

In a basal-bolus insulin therapy regimen, insulin doses are typically calculated taking into account patients' weight and predicted degree of insulin resistance, with approximately half of the insulin being provided as long-acting basal insulin and the other half provided as prandial bolus insulin. The prandial insulin is held if patients have no carbohydrate intake. Additional correction insulin is given as a supplement if glucose control is inadequate, and correction insulin doses are based on patients' insulin resistance. All insulin doses at this institution can be calculated using an insulin calculator found online at www.bbit.ca.

Our project aimed to improve the frequency of basal-bolus insulin therapy prescriptions and to evaluate the impact of this insulin regimen on the patient-related outcomes of glycemic control, hypoglycemia, and length of stay compared to exclusive use of sliding-scale insulin.

How did you identify this quality gap? In other words, where did you get your baseline data?

The quality gap was identified by a resident trainee while rotating through the medical teaching unit on clinical rotation. The problem was then explored in detail with a retrospective audit of the electronic health records of patients admitted to the medical teaching unit throughout a 12-month period. The striking results of the audit prompted the development and implementation of a multidisciplinary educational intervention promoting the merits of basal-bolus insulin therapy compared to exclusive use of sliding-scale insulin, referring to established literature and current clinical practice guideline recommendations. Educational tools included multidisciplinary seminars, pocket cards, and Web-based teaching tools (www.bbit.ca).

Summarize the initial data for your practice (before the improvement initiative).

In the baseline period, 724 patients on insulin, with 12,542 patient-days and 37,031 blood glucose values and insulin administration instances, were analyzed. Because patients had varied insulin prescriptions during their hospitalization, the active insulin orders at the time of blood glucose monitoring were analyzed. Baseline data in insulin-treated patients, summarized in Table 1, indicated that basal-bolus therapy was ordered in only 18.9% of instances (6,999/37,031 insulin administrations). Conversely, sliding-scale insulin was the only active order in 38.7% of instances (14,331/37,031 insulin administrations).

What was the timeframe from initiation of your quality improvement (QI) initiative to its completion?

There was a 12-month period for baseline data gathering and analysis pre-implementation that led to the specific design of an educational strategy and supportive information technology tools. Implementation and data gathering were completed over the course of the next 12 months.

Describe your core QI team. Who served as project leader, and why was this person selected? Who else served on the team?

The project leader was the internal medicine resident trainee who had noted the quality gap in routine practice. Uptake of the educational initiative, we believe, was augmented by the grassroots approach undertaken, as resident colleagues and attending physicians were very invested in the success of the project. The team also included an internal medicine resident with expertise in information design and Web development, who assisted with the development of educational materials and the interactive website, as well as a senior endocrinologist who vetted the educational materials and further facilitated implementation.

Describe the *structural* changes you made to your practice through this initiative.

Educational materials were reviewed by senior residents with their house

staff at the onset of each new rotation monthly. Pocket cards were made available to all multidisciplinary staff.

Describe the most important changes you made to your *process* of care delivery.

Understanding the supporting research and rationale for change were integral to the success of the project. Educational materials were made available such that staff could teach their teams using a train-the-trainer approach. All members of the care team, including nursing and pharmacy staff, were educated on the initiative, which enabled cross-disciplinary accountability and communication that facilitated improved awareness of appropriate and expected insulin ordering practices and glucose targets, as well as early recognition and correction of unwarranted practice variation.

Summarize your final outcome data (at the end of the improvement initiative) and how it compared to your baseline data.

In the post-implementation period, 479 patients on insulin were evaluated, with 6,443 patient days and 24,082 blood glucose values and insulin administration instances. During the 12-month period after implementation, the frequency of basal-bolus versus exclusive sliding-scale insulin prescriptions was evaluated as the primary outcome of interest (Table 1). Basal-bolus prescriptions increased significantly, from 18.7% (6,999/37,031) of orders at baseline to 36.7% (8,838/24,082) of orders in the post-implementation period (P <0.001). The exclusive use of sliding-scale insulin decreased from 38.7% (15,701/37,031) of orders in the pre-implementation period to 31.3% (7,538/24,082) of orders in the post-implementation period.

Secondary outcomes included the percentage of patient-days with a blood glucose within the Diabetes Canada target range of 4–11 mmol/L (72–196 mg/dL), the frequency of hypoglycemic events (blood glucose <4 mmol/L [72 mg/dL]), and length of hospital stay. After implementation, the frequency of in-target days was significantly higher for patients treated with basal-bolus therapy (45%, 2,899/6,443 patient-days in target) compared to those treated with exclusive sliding-scale insulin (32%, 2,062/6,443 patient days) (P = 0.0001), over the duration of their hospital stay. Rates of hypoglycemia were not significantly different between the basal-bolus (3.8%, 915/24,082) and sliding-scale (3.3%, 795/24,082) groups (P >0.05). Importantly, the unadjusted length of stay for patients treated with basal-bolus therapy for the duration of their hospital stay was ~10% shorter than for patients treated exclusively with sliding-scale insulin (28.4 vs. 31.7 days, respectively; P <0.001).

What are your next steps?

Our results prompted the creation of an electronic basal-bolus insulin therapy order set, which is now available in all four adult acute care facilities in Calgary (Supplementary Appendix). We recognize that approaching a complex quality gap requires more than an educational intervention to create and sustain meaningful practice change within a complex organization, so an assessment of ongoing barriers and facilitators has been undertaken. A knowledge translation–based assessment of barriers and facilitators will drive development of specific tools targeting recognized barriers. These tools are now under development and may be found at www.bbit.ca.

An integrated approach centered on knowledge translation, in which sites engage in the co-development of tools, has proven useful in improving engagement and buy-in. Sharing positive patient-related outcomes has promoted ongoing interest in the project. Finally, a train-the-trainer approach has been implemented within the multidisciplinary team to promote sustainability (i.e., nurse champions train nursing staff, physician champions train ordering providers, and pharmacy champions train pharmacy staff).

What lessons did you learn through your QI process that you would like to share with others?

Achieving change within a complex network of providers is very difficult, and having a clinical champion who was able to influence local culture, particularly with resident staff responsible for the entry of most insulin orders, facilitated our success. Furthermore, involving the multidisciplinary team in the development and delivery of education was also important to ensuring that the entire patient care team was aware of the initiative, its merits, and its results. Finally, sharing data outcomes with the multidisciplinary end users allowed celebration of shared successes and fueled further impetus for change.

Duality of Interest

No potential conflicts of interest relevant to this article were reported.

Previous Publication

This study was previously published twice in abstract form: *1*) Helmle K, Dechant A, Edwards A. Implementation of a multidisciplinary strategy promoting basal bolus insulin results in improved glycemic control and shorter length of stay for diabetic inpatients. Presidential poster competition winner, ENDO 2011: The Endocrine Society 93rd Annual Meeting, Boston. Mass., 4–7 June 2011, and *2*) Helmle K, Dechant A, Edwards A. Basal bolus insulin therapy: a "BBIT" of change in hospital diabetes management. Canadian Society of Internal Medicine Annual Scientific Meeting, Oral Postgraduate Research Competition Invited Presentation, Vancouver, British Columbia, Canada, 27–30 October 2011.

Acknowledgments

The authors thank Dr. Jayna Holroyd-Leduc, Sasha Wiens, Deborah Forsyth, and the Calgary Zone Order Sets, Clinical Decision Support, and Clinical Core Design Teams for their contributions to this work.

References

1. Umpierrez G, Smiley D, Zisman A, et al. Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes (RABBIT 2 trial). Diabetes Care 2007;30:2181–2186

2. Umpierrez G, Smiley D, Jacobs S, et al. Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes undergoing general surgery (RABBIT 2 surgery). Diabetes Care 2011;34:256–261

3. Canadian Diabetes Association. Canadian Diabetes Association 2008 clinical practice guidelines for the prevention and management of diabetes in Canada. Can J Diabetes 2008;32(Suppl. 2):S1–201

4. Moghissi ES, Korytkowski MT, DiNardo M, et al. American Association of Clinical Endocrinologists and American Diabetes Association consensus statement on inpatient glycemic control. Diabetes Care 2009;32:1119–1131

5. Schnipper JL, Magee M, Larsen K, Inzucchi SE, Maynard G; Society of Hospital Medicine Glycemic Control Task Force. Society of Hospital Medicine Glycemic Control Task Force summary: practical recommendations for assessing the impact of glycemic control efforts. J Hosp Med 2008;3:66–75

6. American Diabetes Association. Diabetes care in the hospital. Sec. 13 in *Standards of Medical Care in Diabetes—2016*. Diabetes Care 2016;39(Suppl 1.):S99–S104