Improving Outcomes for Diabetic Patients Undergoing Vascular Surgery

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Abstract

Improving management of inpatients with diabetes undergoing vascular surgery requires collaboration among many health care practitioners. This article describes a performance improvement project that implemented two evidence-based algorithmic order sets to guide perioperative glucose management for diabetic patients undergoing vascular procedures and utilized a certified diabetes educator (CDE) to educate health care practitioners. Results showed statistically and clinically significant reductions in infection and differences in mean blood glucose between pre- and postintervention groups, including a direct relationship between glucose control and the level of involvement of a CDE in patient care.

Diabetes affects approximately 18.2 million people in the United States, resulting in an estimated $132 billion annually in direct and indirect costs. The number of adults with diagnosed diabetes has increased 61% since 1991.[1,2] Because life spans are becoming longer and the incidence of diabetes increases exponentially with age, health care providers will be treating an escalating number of type 2 diabetic patients over the next several decades, with projections that this population will more than double by 2050. In the United States, substantial resources are needed to improve both the acute and long-term management of patients with diabetes and to address the growing epidemic and its increasing impact on health care expenditures.

The primary emphasis of most diabetes research has been directed toward optimal glycemic control and its role in preventing long-term complications. Until recently, there have been few studies emphasizing the importance of hyperglycemia management in the acute care setting. Most acute care studies have targeted glucose control in surgical patients with diabetes and in critically ill hyperglycemic patients.

Initial studies in the late 1990s focused on implementing insulin infusion protocols that maintained glucose levels at < 200 mg/dl postoperatively in open-heart surgery patients. Intravenous (IV) insulin protocols resulted in a reduction in mortality and sternal wound infections.[3–6] Latham, et al.[7] found that the rate of surgical site infection correlated with the degree of postoperative hyperglycemia in cardiothoracic surgery patients.

A more recent study[8] in which blood glucose in critically ill patients was controlled to 80–110 mg/dl demonstrated a reduction of 34% in overall in-hospital mortality and significant reductions in morbidity. Morbidity measures included reductions in bloodstream infections by 46%, acute renal failure requiring dialysis or hemofiltration by 41%, median number of red blood cell transfusions by 50%, and critical illness polyneuropathy by 44%. Additionally, patients receiving intensive insulin therapy were less likely to require prolonged mechanical ventilation and intensive care. Umpierrez et al.[9] found that hyperglycemia is an important marker of poor clinical outcome and mortality in patients who are not critically ill and are admitted to general medicine and surgery wards.

Historically, sliding scale insulin orders have prevailed as the primary inpatient physician order, despite the fact that there is no scientific basis for their use. Queale et al.[10] demonstrated

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that, when used without a basal dose of intermediate-acting insulin, sliding scale insulin regimens actually increase rates of hyperglycemia and appear to provide no benefit in controlling glucose.

These studies prompted our health care providers to question traditional patterns of inpatient hyperglycemia management.

This article will describe our experience with a performance improvement project designed to improve the surgical management of patients with diabetes in an academic, community hospital. As a result of the Lehigh Valley Hospital and Health Network (LVHHN) response to the first Institute of Medicine report,[11] several multidisciplinary, targeted initiatives to improve care and reduce medical errors were designed and implemented. These initiatives were called Primum Non Nocere (PNN), or First Do No Harm, and were quality improvement projects emphasizing systems approaches.[12] Within the PNN initiative, we embarked on plans to improve the management of diabetic inpatients undergoing surgery. With increasing evidence pointing to the importance of improving hyperglycemia management in the acute care setting, we sought to develop approaches to improve perioperative hyperglycemia management beyond the walls of critical care. This article describes how our project was developed and implemented, what our outcomes were, and what we learned from our experience.

Needs Assessment

Given the broad task of improving the surgical management of patients with diabetes, the first step was to examine available hospital surgery data. Approximately 23% of all inpatient hospitalizations at LVHHN had a primary or secondary diagnosis of diabetes, which is significantly higher than the 16% incidence rate for all Pennsylvania hospitals.[13] More specifically, data showed that 16% of all patients from our top 30 surgical diagnosis–related groups had primary or secondary diagnosis of diabetes. Additionally, these diabetic patients stayed in the hospital an average of 2.7 days longer than nondiabetic patients.

Considering these data, we performed a retrospective review of 63 randomly selected charts to determine why there was an increased length of stay (LOS) in the diabetic surgical population. As expected, multiple comorbidities were present in this population, which contributed to increased LOS. However, the chart review revealed an average blood glucose of 215 mg/dl, variation in medical management, a low frequency of glucose monitoring, and a high frequency of treatment using sliding scale insulin regimens without basal dosing. Additionally, of the 63 cases, 17 had hospital-acquired infections, including wound, urinary tract, and intravenous access line. These findings provided us with sufficient evidence to know there was room to improve medical management of surgical patients with diabetes.

We decided to focus our performance improvement efforts on the vascular surgery population because we determined that 30% of these patients had diabetes and an average LOS 3.5 days longer than a similar group of nondiabetic vascular surgical patients. While the cardiothoracic population at our institution also has a high incidence of patients with diabetes, we chose not to focus on this population because we had implemented IV insulin infusion orders with improved outcomes several years earlier.

Program Design

An interdisciplinary team was formed to establish interventions designed to improve perioperative (pre-, intra-, and postoperative) glucose control to improve clinical outcomes of diabetic patients undergoing vascular procedures. Representatives from endocrinology, vascular surgery, pharmacy, anesthesia, nursing, care management, and diabetes education comprised the team.

After an extensive review of literature and national benchmarking, we designed and approved two evidence-based algorithmic order sets to guide perioperative diabetes management. The first order set addressed the use of IV insulin infusion (Figure 1), and the second addressed the administration of subcutaneous insulin or oral medication. Both order sets were designed by members of our interdisciplinary team.

Existing published protocols and examples from benchmark institutions were reviewed and analyzed. The clinical expertise of staff was sought to obtain feedback on our former protocols in order to include changes that would ensure achieving glucose control in a timely manner without sacrificing safety. Particular attention was paid to including clear guidelines for initiation and titration, with special consideration that IV insulin was rarely used on our medical-surgical floors in the past. Additionally, the titration design was based on a suggestion to not only adjust rates based on current glucose values, but also to titrate based on where the previous values were. The subcutaneous order set was designed to encourage the temporary initiation of intermediate- or long-acting insulin instead of the traditional ineffective sliding scale insulin. Another key consideration in the development of both order sets was to make them fairly automatic, allowing for individualization by physicians as needed to cover standing orders that would reduce phone calls to physicians as well as standardize care based on evidence findings at the time.

It was recommended that all prospective vascular surgeries with duration of ≥ 2 hours, including carotid endarterectomies, abdominal aortic aneurysm repairs, and peripheral vascular bypasses, use the IV insulin infusion order set. This order set directed that IV insulin begin at any point perioperatively when blood glucose rose above 180 mg/dl and be maintained postoperatively until the patient tolerated oral intake. The target blood glucose range was 120–180 mg/dl.

Since project implementation, we have revised the IV insulin order set based on new evidence-based literature. The new order set initiates IV insulin to begin when blood glucose rises above 150 mg/dl with a target glucose of 90–130 mg/dl.

The use of IV insulin was feasible for staff because most vascular surgery patients receive care in specialized monitored medical-surgical vascular rooms or critical care units. On medical-surgical units, nursing support staff performed the hourly glucose measurements for patients on

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DOCTOR'S ORDER SHEET

DRUG INTOLERANCES: REACTIONS:

DRUG ALLERGIES: REACTIONS:

☐ NONE KNOWN ☐ HYPERSENSITIVITY PROTOCOL

DATE & TIME ORDER WRITTEN	UNIT CLERK INITIALS & TIME	NURSE SIGNATURE AND TIME	HT / WT	DOCTOR'S ORDERS — WRITE WITH BLACK BALL POINT PEN ONLY

INSULIN INFUSION PROTOCOL FOR <u>NPO</u> ADULTS WITH DIABETES OR HYPERGLYCEMIA *NOT TO BE USED FOR DKA OR HHS (Use Adult DKA or HHS Admission Orders for patients in DKA or HHS) **Page 1 of 2**

Weight (kg) = | **Insulin concentration 1.0 unit per 1 ml in NSS**

1. Select indication/starting protocol desired for Insulin Infusion Protocol
   - ❒ **Surgical Management of Known Diabetes** (indicated for major surgery Type 1 DM and Type 2 DM on oral antidiabetic medications or insulin requiring) See reverse side for starting guidelines.
   - ❒ **Critically Ill Diabetes Management** (i.e. mechanically ventilated, sepsis, acute MI, acute CVA, post-trauma or burns, receiving TPN or continuous tube feeding) See reverse side for starting guidelines.
   - ❒ **Critically Ill Hyperglycemia Management "Non-Diabetes"** (i.e. mechanically ventilated, sepsis, acute MI, acute CVA, post-trauma or burns, receiving TPN continuous tube feeding) See reverse side for starting guidelines.
2. **When IV insulin started**, initiate IV of 1000 ml D5 1/2 NSS with 20 meq KCL at 100 ml/hr **<u>OR</u>** ❒1000 ml D5 _______ @ _______ ml/hr **<u>OR</u>**
   ❒ 1000 ml _______ @ _______ ml/hr (dextrose not needed if on tube feedings)
3. Prime IV tubing with 25 ml of the insulin infusion solution (1 unit/ml) prior to piggybacking insulin infusion into primary line.
4. Discontinue all previous insulin and oral antidiabetic medications orders when the protocol is started **<u>OR</u>** on the am of surgery.
5. Obtain HgA1C if not previously obtained this admission.
6. Obtain weight and record.
7. Check bedside capillary glucose every 1 hour when insulin drip started. Follow <u>Maintenance of IV Insulin Infusion</u> parameters for insulin adjustments.
8. If tube feeding **<u>OR</u>** TPN is stopped, turn off insulin drip. Check BG in 1 hour and restart at 0.5 unit / hour if BG greater than or equal to 150 mg/dl.
9. When discontinuation criteria met **(see reverse)**, obtain orders for:
   a. Subcutaneous insulin or oral DM medication to start 1 hour before stopping IV insulin
   b. Discontinuation of IV insulin infusion
   c. Ongoing diabetes medication therapy

M.D./D.O.

"Authorization is hereby given to dispense the generic or chemical equivalent unless specified as brand necessary by the physician."

Figure 1. Order set for IV insulin infusion for NPO adults with diabetes or hyperglycemia.

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DOCTOR'S ORDER SHEET

DRUG INTOLERANCES: REACTIONS:

DRUG ALLERGIES: REACTIONS:

☐ NONE KNOWN ☐ HYPERSENSITIVITY PROTOCOL

DATE & TIME ORDER WRITTEN	UNIT CLERK INITIALS & TIME	NURSE SIGNATURE AND TIME	HT / WT	DOCTOR'S ORDERS — WRITE WITH BLACK BALL POINT PEN ONLY
			INSULIN INFUSION PROTOCOL FOR NPO ADULTS (CONTINUED)	Page 2 of 2

MAINTENANCE OF IV INSULIN INFUSION GUIDELINES – NOT APPROPRIATE FOR DKA OR HHS

IF CURRENT GLUCOSE IS BELOW 70 mg/dl:	
– Give 25 ml of 50% Dextrose slow IV push **– Reduce infusion by 1/2 current rate*/** **	Recheck Blood Glucose in 15 minutes.
If repeat glucose below 70 mg/dl again – Repeat Dextrose as above – Reduce infusion by 1 unit (1 unit = 1 ml)*	Recheck Blood Glucose in 15 minutes.

*** If Infusion rate at 0 units/hr, check glucose every 1 hr x 2; then every 2 hr x 2; then every 4 hr. Restart infusion at 0.5 units/hr when Blood Glucose greater than 150 mg/dl and resume guidelines below.**

**** Anytime glucose drops more than 100 mg/dl within one hour, cut rate in half and check BG in 15 minutes after this change. Follow guidelines thereafter:**

If Current BG is between 70–90 mg/dl	**Change Insulin Rate**	**Obtain**
And if last BG was less than 70 mg/dl	Keep rate the same	BG in 1 hour
And if last BG was 70–90 mg/dl	Lower rate by 0.5 units (= 0.5 ml)	BG in 1 hour
And if last BG was 91–130 mg/dl	Lower rate by 1.0 units (= 1 ml)	BG in 1 hour
And if last BG was 131–180 mg/dl	Lower rate by 1.5 unit (= 1.5 ml)	BG in 1 hour
And if last BG was greater than 181 mg/dl	Lower rate by 2.0 units (= 2 ml) or **	BG in 1 hour or 15 min.**
If Current BG is between 91–130 mg/dl	**Change Insulin Rate**	**Obtain**
And if last BG was less than 90 mg/dl	Keep rate the same	BG in 1 hour
And if last BG was 91–130 mg/dl	Keep rate the same	BG in 2 hours
And if last BG was 131–180 mg/dl	Lower rate by 0.5 unit (= 0.5 ml)	BG in 1 hour
And if last BG was greater than 181 mg/dl	Lower rate by 1.0 unit (= 1 ml) or **	BG in 1 hour or 15 min.**
If Current BG is between 131–180 mg/dl	**Change Insulin Rate**	**Obtain**
And if last BG was less than 130 mg/dl	Increase rate by 0.5 units (= 0.5 ml)	BG in 1 hour
And if last BG was 131–180 mg/dl	Increase rate by 1.0 units (= 1 ml)	BG in 1 hour
And if last BG was 181–240 mg/dl	Lower rate by 0.5 unit (= 0.5 ml)	BG in 1 hour
And if last BG was greater than 241 mg/dl	Lower rate by 1.0 unit (= 1 ml) or **	BG in 1 hour
If Current BG is between 181–240 mg/dl	**Change Insulin Rate**	**Obtain**
And if last BG was less than 180 mg/dl	Increase rate by 1.5 units (= 1.5 ml)	BG in 1 hour
And if last BG was 181–240 mg/dl	Increase rate by 2.0 units (= 2 ml)	BG in 1 hour
And if last BG was greater than 240 mg/dl	Increase rate by 1.0 units (= 1.0 ml)	BG in 1 hour
If Current BG is greater than 240 mg/dl with negtive, trace, or small ketones	**Change Insulin Rate**	**Obtain**
And if last BG was less than 240 mg/dl	Increase rate by 1.5 units (= 1.5 ml)	BG in 1 hour Check urine for ketones
And if last BG was greater than 240 mg/dl	Increase rate by 2.0 units (= 2 ml)	BG in 1 hour Check urine for ketones
If last BG was greater than 240 mg/dl x 2 or more checks	Double the current rate hourly until glucose decline greater than 100 mg/dl in 1 hour**	BG in 1 hour
If Current BG is greater than 240 mg/dl with moderate or large urine ketones present	**Change Insulin Rate**	**Obtain**
Any glucose greater than 240 with moderate or large urine ketones (double void when possible)	Double the current rate hourly until glucose decline greater than 100 mg/dl in 1 hour**	BG in 1 hour Check urine for ketones
If Current BG is greater than 240 mg/dl after doubling rate 3x	**CALL MD**	

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IV insulin, which made the nursing workload more realistic.

For vascular procedures lasting < 2 hours, such as amputations, a subcutaneous/oral medication order set was initiated. This order set provides guidelines for preoperative insulin or oral medication adjustments. These guidelines also recommend postoperative initiation of background insulin (intermediate- or long-acting) in conjunction with short- or rapid-acting insulin correction dosing based on the patient's insulin sensitivity factor.

To promote successful implementation of the order sets, an inpatient certified diabetes educator (CDE) provided multiple educational sessions for nursing and physician staff. Educational sessions were provided for nursing staff on all shifts on the medical-surgical unit, where most patients receive care after vascular surgery, as well as for nursing staff in preadmission, operating room, recovery, and the critical care/monitored units receiving vascular surgical patients. Attending physicians and residents in the departments of internal medicine, family practice, and surgery also received educational presentations regarding the order sets and program goals.

Based on the premise that academic detailing[14] has been shown to be more effective in changing traditional practice patterns than didactic educational sessions alone, the project design involved CDE intervention with the surgeons or consulting medical physicians. The CDE helped to guide implementation of the appropriate order set to improve diabetes care throughout patients' hospital stay.

As the project progressed, the CDE reviewed daily operating schedules and worked with physicians to place appropriate diabetes order sets. The CDE followed patients as closely as possible throughout their hospitalization and advised physicians on methods to improve or maintain glucose control on a case-by-case basis. Educational emphasis was placed on avoiding sliding scale insulin regimens that have no efficacy without background insulin and on suggestions for alternative strategies for glucose control. Periodic educational and progress updates were published in internal physician newsletters and reviewed at appropriate department and section meetings.

Program Evaluation

Program evaluation was designed to measure clinical data from pre- and postintervention groups. To demonstrate efficiency and clinical effectiveness of improved glucose control in our vascular surgery population, a comparative change analysis was done using pre- and postintervention data. The intervention included implementation of the preprinted order sets, education of health care providers regarding the new guidelines, and CDE case involvement.

Preintervention data were retrospectively collected on 90 randomly selected charts for diabetic vascular surgery patients undergoing procedures for 1 year before the program. Postintervention data were collected prospectively on 144 diabetic patients scheduled for vascular surgeries for 1 year postimplementation, ending in May 2002. Outcome measures included perioperative glucose values, operative procedure length, length of stay, hospital-acquired infections (defined by new positive cultures ≥ 72 hours after admission), and readmissions for wound-related infections within 30 days of discharge. Process measures were also recorded, including appropriate initiation of IV insulin guidelines, administration of medications, and any deviations from the order sets.

During program implementation, the research team realized that, because of multiple job requirements, the amount of time the CDE could work with physicians and patients on a day-to-day basis would vary. A decision was made to categorize patients into three groups based on the CDE's degree of involvement with each case. The degree of involvement with patients and the clinical teams caring for them was categorized as minimal, moderate, or maximal. Minimal involvement was defined as little or no contact (< 30% of the patient's stay) between the CDE and the patient and/or clinical teams during the patient's hospital stay. Moderate was defined as CDE involvement during 30–65% of the patient's stay. Maximal involvement was defined when the CDE frequently visited the patient and clinical team (> 65% of the patient's hospital stay).

Demographic data for both preintervention and postintervention groups were examined. There were no significant differences in race, age, or sex between the groups (Table 1), and distribution of the types of vascular surgery procedures was comparable in both groups (Table 2).

There was a 19.8% decrease ($P < 0.001$) in the total rate of infections between pre- and postintervention group. Even when multiple infections in the same patient were accounted for, total patients with infections decreased by 14.2% ($P = 0.002$). Urinary tract infection was the only infection type with a statistically significant difference pre- to postintervention ($P = 0.009$). There were no significant differences for other specific infection types, but the drop in respiratory and blood infections approached significance ($P = 0.074$ and $P = 0.056$) (Table 3). The difference in mean blood glucose was statistically significant between the pre- and postintervention groups ($P < 0.0001$). Although clinically important, the reduction in overall LOS by 0.9 days postintervention was not statistically significant ($P = 0.385$). The difference in readmissions between the pre- and postintervention groups was not significant ($P = 0.356$) because of a relatively small sample size of readmissions (Table 4).

When the postintervention group was further stratified by degree of CDE involvement, the difference in average

Table 1. Demographics for Pre- and Post-Intervention Groups

Variable	Preintervention ($n = 90$)	Postintervention ($n = 144$)	P value
Age (years)	69.6 ± 10.7	70.0 ± 10.8	0.782
Female	34 (38%)	62 (43%)	0.508
Male	56 (62%)	82 (57%)	0.508

Table 2. Types of Procedures of Pre- and Postintervention Groups

Description of Procedure	ICD-9 Code	Preintervention (*n* = 90)		Postintervention (*n* = 144)		*P* value
		Total	Percent	Total	Percent	
Head and neck endarterectomy, not otherwise classified	38.12	18	20.2	38	26.4	0.265
Vascular shunt and bypass, not otherwise classified	39.29	11	12.4	30	20.8	0.092
Below-knee amputation, not otherwise classified	84.15	11	12.4	13	9.0	0.433
Toe amputation	84.11	10	11.2	11	7.6	0.366
Revision renal dialysis shunt	39.42	6	6.7	0	0.0	0.003*
Amputation stump revision	84.30	5	5.6	6	4.2	0.753*
Amputation through foot	84.12	5	5.6	10	6.9	0.673
Above-knee amputation	84.17	4	4.4	3	2.1	0.433*
Abdominal aorta resect w/replacement	38.44	3	3.4	7	4.9	0.745*
Angioplasty/atherectomy	39.50	2	2.3	1	0.7	0.561*
Aorta-iliac-femor bypass	39.25	2	2.3	4	2.8	1.000*
Other miscellaneous		13	13.3	21	14.6	0.974

*Fisher's exact test used. ICD-9, International Classification of Diseases, 9th revision.

Table 3. Infections in Pre- and Postintervention Groups

Infection Type	Preintervention (*n* = 90)	Postintervention (*n* = 144)	*P* value
Stool*	1	2	0.902
IV site*	1	1	1.000
Respiratory*	4	1	0.074
Blood*	3	0	0.056
Wound*	5	2	0.111
Urinary tract	10	4	0.009
Total infections	24 (26.7%)	10 (6.9%)	< 0.001
Total patients with infections	19 (21.1%)	10 (6.9%)	0.002

*Fisher's exact test used

Table 4. Glucose Control and LOS in Pre- and Postintervention Groups

Variable	Preintervention (*n* = 90)	Postintervention (*n* = 144)	*P* value
Glucose (mean 6 SD)	186.91 6 80.3	172.46 6 68.3	<0.0001
LOS in days (mean 6 SD)	9.6 6 8.3	8.7 6 7.1	0.385
Readmissions because of wound issues	13 (14.4%)	15 (10.4%)	0.356

blood glucose was significant ($P < 0.001$) between the preintervention group and the postintervention groups with moderate and maximal CDE involvement. There is no difference between the preintervention group and the postintervention group with minimal CDE involvement. Total infections were significantly different ($P = 0.002$) between the pre- and each of the postintervention groups (Table 5).

To evaluate the safety of more aggressive insulin management, we examined prevalence of hypoglycemia in each of the groups. Hypoglycemic events were broken into two groups and evaluated separately because our hospital policy requires treatment when blood glucose is < 70 mg/dl, and clinical hypoglycemia is defined as blood glucose < 50 mg/dl.

In the preintervention group (n = 90), there were a total of 128 blood glucose measurements < 70 mg/dl, and 28 of these were < 50 mg/dl. Data from the postintervention group (n = 144) revealed a total of 120 glucose results < 70 mg/dl, with 21 of those < 50 mg/dl. Furthermore, of the 21 glucose readings < 50 mg/dl in the postintervention group, 9 occurred in patients receiving subcutaneous insulin or oral medications rather

Table 5. CDE Involvement

Variable	Preintervention	Postintervention			*P* value
		Minimal Involvement	Moderate Involvement	Maximal Involvement	
Number of patients	90	43	70	31	
LOS in days (mean ± SD)	9.6 ± 8.3	7.7 ± 8.3	10.1 ± 6.6	7.1 ± 6.2	0.149
Glucose* (mean ± SD)	186.9 ± 80.3	184.9 ± 71.7	171.3 ± 69.6	159.4 ± 56.4	< 0.001
Readmissions because of wound issues	13	7	5	3	0.394

*All post hoc comparisons of glucose results were significant at $P < 0.001$, except for pre- versus postintervention with minimal CDE involvement.

than IV insulin. All hypoglycemic events were appropriately treated without adverse effects. These data provided comforting evidence that the new insulin protocols did not raise the risk for hypoglycemia in our project.

Summary and Conclusions

The goal of this project was to evaluate interventions designed to improve clinical outcomes for diabetic inpatients undergoing vascular procedures. Our results showed that implementation of evidence-based diabetes order sets in conjunction with education by a CDE can improve clinical outcomes for diabetic patients undergoing vascular procedures.

Separate from clinical measures, we made several observations that may be useful when embarking on a similar process-improvement endeavor. One observation was that physician support improved as our clinical data began to demonstrate positive outcomes, indicating that internal and external data are important to successfully implementing practice change. Likewise, a project of this nature clearly requires a physician champion and administrative support to facilitate change processes.

An additional observation relevant to successfully managing diabetic patients undergoing vascular surgery is that lower patient-to-nurse ratios and the use of support staff made the labor-intensive approach to frequent blood glucose monitoring and IV insulin titration more feasible outside of the critical care environment. Vascular surgery patients who had abdominal aneurysm repairs or carotid endarterectomies were typically placed in a critical care setting where a 1:1 or 2:1 patient-to-nurse ratio exists. IV insulin infusions in this setting are fairly routine. However, other vascular surgery patients are typically placed on medical-surgical nursing units that have a 6:1 or higher patient-to-nurse ratio or sometimes in a specialized monitored medical-surgical room with a 4:1 patient-to-nurse ratio. The post-surgical patients with IV insulin who went to the monitored or general medical-surgical area posed an initial concern in terms of staffing workload and patient safety.

It was a challenge to effectively educate a large number of health care professionals to ensure competence with the use of the IV insulin infusion guidelines. Clinical experience, ongoing education, and increased awareness of the importance of glucose control helped to alleviate concerns, and gain acceptance for and facilitate adherence to the new diabetes management guidelines. Changing historical indifference to hyperglycemia in the acute care setting and gaining acceptance of the new order sets required persistence.

We also learned that improving outcomes and changing practitioner patterns required dedicated time to accomplish one-on-one ongoing education and feedback. The Task Force on Community Preventive Services of the Department of Health and Human Services and the Centers for Disease Control and Prevention strongly recommends case management for diabetic patients because it is highly effective in improving glycemic control.[15] Our study results showed that there were increased benefits when the CDE was more involved in the case management of patients. Therefore, it could be possible that our outcomes could have been even better with a greater allocation of effort from the CDE.

As a result of our project, we have been working to continually improve the management of our inpatients with diabetes. As mentioned earlier, we revised order sets as a result of project evaluation and new evidence-based literature. Both the IV insulin order sets and adult general management orders were revised to have lower glucose control targets and to be more user-friendly. Additionally, we are working to incorporate these order sets into a computer-assisted physician order entry system. This will make it easier for physicians to access the appropriate order sets by eliminating the need to physically locate paper order sets.

Health care professionals are becoming more acutely aware of the need to tightly control blood glucose in hospitalized patients with diabetes. This is evident through a recent consensus report from the American College of Endocrinology and the American Association of Clinical Endocrinologists calling for more aggressive in-hospital glucose control because of its impact on morbidity and mortality.[16] Additionally, the American Diabetes Association published a comprehensive technical review, written by the Diabetes in Hospitals Writing Committee, supporting the need to work collaboratively to improve inpatient management of hyperglycemia in acute care settings.[17] Our performance improvement project supports this stance and describes methods of overcoming barriers to achieving improved glucose control in non–critically ill vascular surgery patients. We will continue our efforts to improve the inpatient management of our patients with diabetes.

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