Journal of Diabetes Science and Technology
Volume 6, Issue 5, September 2012

SYMPOSIUM

Insulin Pump Therapy in the Perioperative Period: A Review of Care after Implementation of Institutional Guidelines

Mary E. Boyle, C.N.P.,[1] Karen M. Seifert, M.S.N.,[2] Karen A. Beer, P.A.,[1] Patricia Mackey, C.N.P.,[1] Richard T. Schlinkert, M.D.,[3] Joshua D. Stearns, M.D.,[4] and Curtiss B. Cook, M.D.[1]

Abstract

Background:

An institutional policy was previously established for patients with diabetes on insulin pump therapy undergoing elective surgical procedures.

Method:

Electronic medical records were reviewed to assess documentation of insulin pump status and glucose monitoring during preoperative, intraoperative, and postanesthesia care unit (PACU) phases of care.

Results:

Twenty patients with insulin pumps underwent 23 procedures from March 1 to December 31, 2011. Mean (standard deviation) age was 58 (13) years, mean diabetes duration was 28 (17) years, and mean duration of insulin pump therapy was 7 (6) years. Nearly all cases (86%) during the preoperative phase had the presence of the device documented—an improvement over the 64% noted in data collected before the policy. Intraoperatively, 13 cases (61%) had the presence of the pump documented, which was higher than the 28% before implementation of the policy. However, documentation of pump status was found in only 38% in the PACU and was actually less than the 60% documented previously. Over 90% of cases had glucose checked in the preoperative area and the PACU, and only 60% had it checked intraoperatively, which was nearly identical to the percentages seen before policy implementation. No adverse events occurred when insulin pump therapy was continued.

Conclusions:

Although some processes still require improvement, preliminary data suggest that the policy for perioperative management of insulin pumps has provided useful structure for care of these cases. The data thus far indicate that insulin pump therapy can be continued safely during the perioperative period.

J Diabetes Sci Technol 2012;6(5):1016-1021

Author Affiliations: [1]Division of Endocrinology, Mayo Clinic, Scottsdale, Arizona; [2]Clinical and Patient Education, Mayo Clinic, Scottsdale, Arizona; [3]Department of Surgery, Mayo Clinic, Scottsdale, Arizona; and 4Department of Anesthesiology, Mayo Clinic, Scottsdale, Arizona

Abbreviations: (CSII) continuous subcutaneous insulin infusion, (PACU) postanesthesia care unit

Keywords: continuous subcutaneous insulin infusion, hospital, inpatient, insulin pumps, perioperative, surgery

Corresponding Author: Curtiss B. Cook, M.D., Division of Endocrinology, Mayo Clinic, 13400 E. Shea Blvd., Scottsdale, AZ 85259; email address cook.curtiss@mayo.edu

Introduction

Continuous subcutaneous insulin infusion (CSII), also known as insulin pump therapy, is common in the ambulatory setting as one method for patients with diabetes mellitus to achieve optimal glucose control. With an estimated 400,000 patients in the United States using insulin pumps,[1] practitioners can encounter patients on this therapy in potentially unfamiliar scenarios. One such situation is when the patient requires hospitalization.[2–5] Another scenario is the patient on CSII who is scheduled for elective surgery.

Data are limited on the use of insulin pumps under surgical conditions. Two case reports indicate that insulin pump use can be maintained during surgery.[6,7] Although some authors have suggested that CSII can be continued intraoperatively,[8–9] others recommend disconnecting the device prior to surgery.[10] Validated strategies for maintaining insulin pump systems during surgery are lacking, best practices do not exist for managing insulin pumps in the perioperative period, and guidelines are limited on the use of CSII during surgery. Moreover, the chain of responsibility for care of the patients during the perioperative period varies between the surgical and anesthesia services. These transitions of care further justify the need for a standardized set of procedures to assure patient safety regarding CSII use.

An analysis of 50 cases involving patients using an insulin pump who underwent surgery at our institution found several aspects of care that needed to be standardized, such as documentation of CSII during the different phases of perioperative management and performance of glucose monitoring.[11] Consequently, a multidisciplinary work group developed a policy and a set of procedures that provided guidance on how best to manage these patients when surgery is being planned.[12] The goal of the policy was to standardize procedures to assure a smooth and safe transition for the insulin-pump-treated patient as he/she was transferred throughout the phases of perioperative care. The policy was implemented in March 2011, and this review summarizes its core elements, steps toward implementation of the policy, and preliminary experience on its impact on perioperative care of the patient on an insulin pump.

Overview of Policy and Procedures

When constructing the policy, management of CSII therapy in the surgical patient was conceived as occurring in four phases: preadmission, preoperative, intraoperative, and postanesthesia recovery.[12] At our facility, the preadmission nurse is now required to notify the endocrinology service about the case through an electronic distribution list at least 24 h before the surgical procedure. An endocrinology provider attempts telephone contact with these patients to review pump settings, to remind them to bring pump supplies in the event of a postoperative admission, and to ask them to insert the infusion set outside the planned surgical field.

Documentation of the status of the insulin pump connection, whether the pump is infusing, and the location of the insertion site (to document that it was placed outside the surgical area) must now be recorded during the preoperative and postanesthesia recovery phases of care. An order should be placed during preoperative care permitting continued use of the device. Intraoperative documentation of the insulin pump, if continued, is required. If the pump has been disconnected, alternative insulin orders should be placed, and the device should be labeled and stored with the personal belongings of the patient.[12] For these three phases of care, a checklist was developed to facilitate compliance that eventually was adapted for use in the institutional electronic medical record in September 2011.[12] Finally, glucose checks are required in all three phases. Intraoperatively, glucose must be monitored hourly for procedures lasting 60 min or longer.[14] Our institution does have a dedicated inpatient diabetes management team. This team generally is called to the postanesthesia care unit (PACU) to assist with the transition of care into the hospital if the patient is admitted.

Implementation of Policy and Procedures

Perioperative, surgical, and anesthesia staff cannot be expected to become "pump experts." Although endocrinology staff are available for consultation even during the procedure, the responsibility for care rests with the surgeons and anesthesiologist during the perioperative period. Therefore, successful implementation of the new policy and its accompanying procedures required clear communication and education to all the medical staff involved in the care of patients on insulin pumps who underwent surgery. The policy was presented to the Surgical Operations Subcommittee and to the Department of Anesthesiology to increase awareness of the new policy and procedures as well as to allow for input and feedback from the medical staff responsible

for implementing the policy. Several education sessions were provided for the perioperative staff, including the preoperative, intraoperative, and PACU staff (e.g., nurses and surgical technicians). The nursing education specialist met with key individuals (i.e., the unit-based educators and informatics technology nurses) in the surgical department to explain the policy and the role of various staff members in the surgical services department. Follow-up education was provided as needed. The informatics nurses assisted in the development of applications within the electronic medical record to ensure that the necessary information (i.e., blood glucose readings, insulin pump location, infusion rate) was documented.

Methods

After establishing the policy on perioperative management of patients with diabetes receiving CSII therapy, we next sought to review adherence to its requirements by examining whether key measures were being conducted.[12] This article is a review of patients on CSII who underwent elective surgery after implementation of the policy and its accompanying procedures. Comparisons with prepolicy findings are highlighted. The study was approved by the Mayo Clinic Institutional Review Board.

Patient Selection

A registry was developed of diabetes patients on CSII who were undergoing elective surgical procedures.[11] Patient information was entered into the registry whenever a patient on CSII became known to the endocrinology service, either before the planned surgery date or during the subsequent inpatient stay if the patient required postsurgical hospitalization. Our hospital does not provide care for pediatric or obstetric patients. Thus all patients were adults 18 years of age or older. Cases were reviewed from March 1, 2011, (policy go-live date) through December 31, 2011.

Data Extraction

The electronic medical record of each patient in the registry was reviewed, and relevant data were abstracted. Records were reviewed pertaining to the preadmission, preoperative, intraoperative, and PACU phases of care. The perioperative period was defined as the time from admission to the preoperative unit to discharge from the PACU (as previously described), and the duration of the preoperative, intraoperative, and PACU phases was determined (**Figure 1**).[12] Additionally, we calculated the duration of the surgical procedure itself. Each phase of care was reviewed to determine whether the required insulin pump policy procedures had been accomplished.

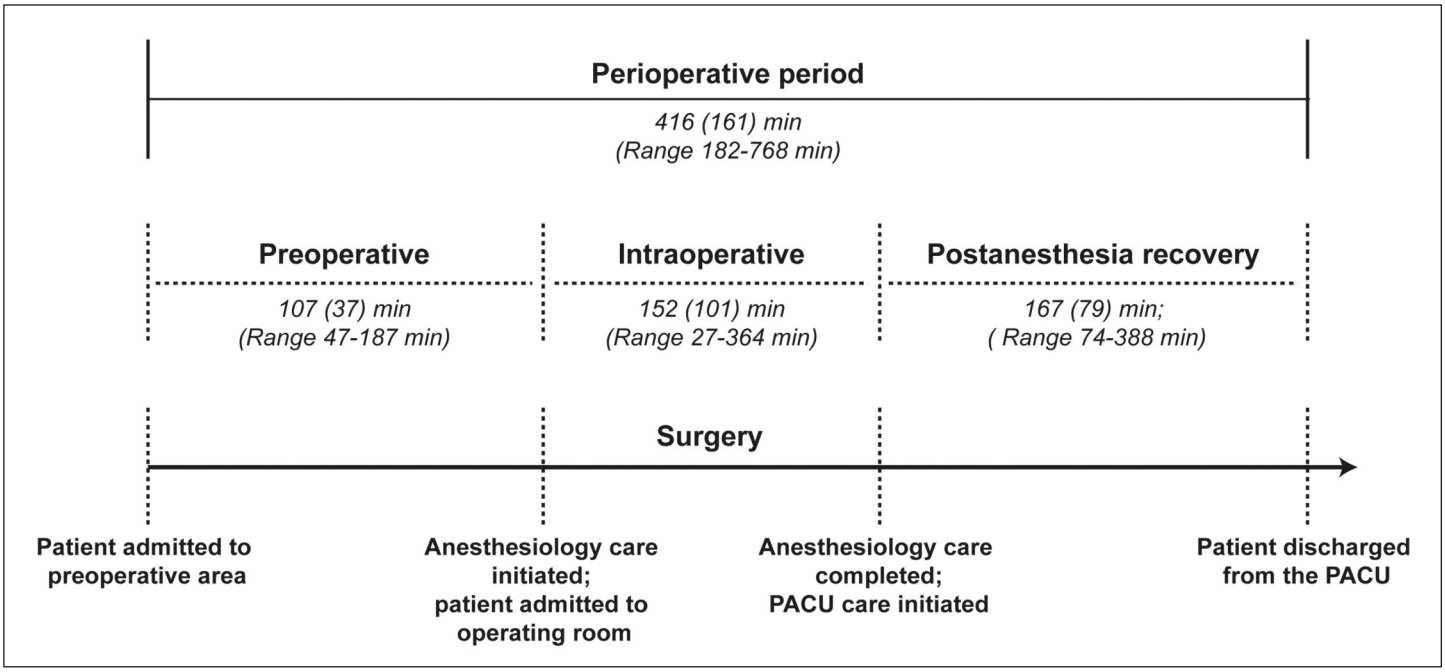

Figure 1. Definitions and durations of different phases of perioperative care for patients with diabetes on insulin pump therapy. Data are shown as mean (standard deviation) and range. Modified from *Endocrine Practice*, Volume 18, Nassar AA, Boyle ME, Seifert KM, Beer KA, Apsey HA, Schlinkert RT, Stearns JD, Cook CB, Insulin Pump Therapy in Patients with Diabetes Undergoing Surgery, 49–55, 2012, with permission from the American Association of Clinical Endocrinologists.[11]

Finally, we noted any patient complications or adverse events that were recorded specifically associated with the insulin pump.

Data Analysis

Because several patients may have undergone more than one surgical procedure within the study period, each surgical case (not the individual patient) was treated as an independent observation and unit of analysis. We noted the proportion of patient care measures that were documented. If more than one glucose measurement was obtained during a given perioperative phase, values were averaged. Data are reported as mean (standard deviation) or number (percentage), where applicable. Differences in mean glucose levels between the different perioperative phases were evaluated using paired *t* tests.

Results

Patient and Surgical Characteristics

From March 1, 2011, to December 31, 2011, 20 patients on insulin pump therapy underwent a total of 23 elective surgical procedures (**Table 1**). The range of experience that patients had with insulin pumps was from just a few months to 28 years (not shown). Three patients underwent 2 procedures; 1 other patient had a pancreas transplant and was not included in this analysis because the insulin pump device was discontinued intraoperatively.

Most procedures were orthopedic (n = 7), general surgical (n = 6), vascular (n = 3), or neurosurgical (n = 2); the rest were single procedures of other types. The average duration of each phase of care is shown in **Figure 1**. Thirteen patients (57%) were admitted after their procedures. The average procedure time was 100 (87) min for the 23 cases and ≥60 min in 20 cases.

Table 1.
Characteristics of 20 Patients on Insulin Pump Therapy Undergoing 23 Surgical Procedures

Characteristic	Value[a]
Age, years	58 (13)
Male sex, number (%)	11 (55)
White race, number (%)	2 (10)
Type 1 diabetes mellitus, number (%)	17 (85)
Diabetes mellitus duration, years	28 (17)
Insulin pump therapy duration, years	7 (6)
Hemoglobin A1c, %	7.2 (0.7)
Body mass index, kg/m^2 [a]	30.9 (8.3)

[a] Values are mean (standard deviation) unless indicated otherwise.

Adherence to Recommended Procedures

Documentation of expected procedures following implementation of the policy is shown in **Table 2**, with prepolicy data listed for comparison. All but 1 case had documentation of preadmission telephone contact by the endocrinology service (**Table 2**). In 2 cases, the plan was for the patient to disconnect from the pump for the surgical procedure. In the other 21 cases, CSII was scheduled to continue, and the status of the pump was noted as being present in the preoperative area in 18 (86%). Intraoperatively, 13 (62%) of the 21 cases had the presence of the pump documented and remained on therapy throughout the procedure. In the PACU, compliance with documentation was lower than for the other two phases of care, with the insulin pump documented as being present in only 8 (38%) of the 21 cases expected to receive such treatment. No adverse events were noted in any of the 23 cases, including those of the 13 who clearly remained on pump therapy intraoperatively.

In addition to examining whether pump therapy was documented intraoperatively, we also examined other insulin therapies that may have been administered.

Table 2.
Performance of Key Perioperative Insulin Pump Policy Measures for 20 Patients on Insulin Pump Therapy Undergoing 23 Surgical Procedures

Procedure	Pre-policy[a] Number (%) N = 50[b]	Post-policy Number (%) N = 23[b]
Preadmission contact made by endocrinology service	—	22 (96)
Pump status documented in preoperative area	32 (64)	18 (86)[c]
Remained on pump intraoperatively	8 (16)	13 (62)[c]
Pump status mentioned in PACU	30 (60)	8 (38)[c]
Glucose monitoring performed		
Preoperative area	47 (94)	21 (91)
Intraoperatively	30 (60)[d]	12 (60)[e]
PACU	48 (96)	21 (91)

[a] Data from Reference 13.
[b] Total number of cases unless indicated otherwise.
[c] N = 21 eligible cases with insulin pump not disconnected preoperatively.
[d] N = 46 cases with intraoperative times ≥60 min.
[e] N = 20 total cases with intraoperative times ≥60 min.

Of the 50 cases examined before the policy was introduced, there were 8 cases that clearly remained on the insulin pump (**Table 2**), but 30 did not have any documentation of any hyperglycemia treatment provided intraoperatively, 9 received correction insulin doses, and 3 received insulin drips (not shown). Post-policy, there were 13 instances where the patients definitely remained on the insulin pump (**Table 2**), but 8 had no documentation of any insulin therapy, 1 was placed on an insulin drip, and 1 received a single correction bolus; 5 of the cases that definitely had insulin pump treatment documented intraoperatively also received single correction doses of insulin (not shown).

Glucose Monitoring

Intraoperative glucose monitoring was predominantly point-of-care testing. In 2 cases, additional arterial glucose measurements were taken during the intraoperative period. Nearly all 23 surgical cases had at least one glucose level checked during the preoperative and PACU phases of care (**Table 2**). Of the 20 cases with intraoperative times lasting ≥60 min, more than one-half had glucose monitoring conducted per policy requirements, with a mean value of 207 (75) mg/dl (range 122 to 373 mg/dl). For all cases, the mean glucose level was 156 (65) mg/dl (range 71 to 328 mg/dl) preoperatively and 172 (44) mg/dl (range 101 to 331 mg/dl) in the PACU, but there was no significant difference between the preoperative and PACU mean glucose values ($p = .28$; paired t test).

Hypoglycemia was rare. Before the policy was implemented, only 1 patient had hypoglycemia (values of 51 and 59 mg/dl) while in the preoperative area, and none had low glucose values in the PACU. After the policy was instituted, no patients had hypoglycemia in either the preoperative or the PACU area. Among the limited intraoperative glucose readings available for review, no hypoglycemia was detected either pre- or post-policy (not shown).

Discussion

Data on use of CSII in the perioperative period, although limited,[6,7] suggests that insulin pump technology can be used safely in this setting. To date, there have been no published consensus guidelines on the management of patients with diabetes using an insulin pump who are scheduled to undergo surgical procedures. In a previous paper,[13] we reported that insulin pumps appeared to be used intraoperatively without any adverse events, but data were too limited to draw definite conclusions about safety. Documentation of the devices during the surgical phase of care was incomplete, and glucose monitoring was not occurring consistently.

Consequently, a multidisciplinary institutional workgroup believed the devices could be allowed perioperatively then developed guidelines on how to manage these patients when surgery is being planned.[12] The essential processes the group emphasized were preadmission contact with the patient to review the plan for use of the insulin pump, documentation of the status of the pump during the three perioperative phases of care, and the need to monitor glucose levels. Assessment of compliance with necessary procedures would allow for an evaluation of how the patient was being managed and a better determination of safety of use. The policy was implemented in March 2011, and this article represents an early analysis of how the policy has impacted the care of the patient with diabetes on CSII therapy who is undergoing a surgical procedure.

Data indicate that telephone contact was achieved with nearly 100% of the anticipated surgical cases before admission for the procedure. This contact allowed a plan to be developed on management, and in two instances, the plan was for the patient to disconnect from the insulin pump upon arrival at the preoperative area. Nearly all the cases (86%) admitted to the preoperative area with an insulin pump had the presence of the device documented—an improvement over the 64% noted in our prior study.[11] During the intraoperative phase, 13 cases (62%) had the presence of the pump documented, which also was higher than the 16% prior to the implementation of the policy.[11] In the PACU, adherence with documentation of the status of the pump was only 38%, which was much less than the 60% seen previously.[11] It is unclear why PACU documentation of the insulin pump was lower than before the policy went live. This change likely had to do with staff being unfamiliar with where and how to record the information, which indicates the need for ongoing education. Nonetheless, no adverse events were associated with the care of any of the patients, in particular, the ones who clearly sustained CSII therapy during surgery.

Glucose measurements obtained in all the perioperative phases were primarily the result of point-of-care testing. More than 90% of cases had glucose checked in the preoperative area and in the PACU, whereas only 60% had it checked intraoperatively for procedures lasting 60 min or longer, which is nearly identical to what was seen prior to the policy.[13] Our goal is to have the glucose levels of 100% of such cases checked during the

perioperative phases of care. During an institutional review of surgical care provided to all diabetes patients, it was discovered that only two glucose monitors were available for use among 17 operating suites. Thus it is possible that there were not enough monitors available for the staff to perform glucose measurements in a timely fashion. Increased access to glucose monitors is necessary, and each surgical suite should be equipped with a glucose monitor to allow for timely acquisition of blood glucose measurements. Glucose control overall did not rise significantly from the preoperative to the postoperative time. Additionally, hypoglycemia was uncommon even before the policy was implemented, at least among the cases where glucose monitoring was conducted. However, the current sample size is too small to allow us to arrive at any conclusions about the effectiveness of CSII in managing intraoperative hyperglycemia, particularly because the status of the insulin pump during the procedure was not documented in several cases.

The main limitation of this study was the small sample size. As noted from our experience with inpatient insulin pump management,[2–5] data accrual will have to occur over a more prolonged period of time to assess safety and to allow us to more fully assess the impact of the policy on the care of patients using insulin pumps. This preliminary analysis was needed, however, to determine whether there were any safety issues immediately evident and to identify areas that require ongoing improvement through staff education. Because there are few patients on insulin pump therapy undergoing elective surgical procedures at our institution, many staff members may interact with them infrequently. The unfamiliarity of health care providers with the technology, along with the complex nature of CSII, will require ongoing education of the perioperative staff to assure that correct processes are followed. Finally, the set of procedures put in place for perioperative insulin pump use are intended for only elective surgical cases.

Although some areas still require improvement, these preliminary data suggest that the policy and set of procedures put in place to assist both patients and hospital staff with perioperative management of insulin pumps has provided a positive structure for management of these cases. No adverse events occurred that were related to CSII use, and the data thus far indicate that insulin pump therapy can be continued safely throughout the perioperative period. It is not clear how the procedures outlined and reviewed here of transitioning outpatient CSII to the perioperative period would function in the absence of a specialty endocrinology team. Assessment is needed on how well these steps might work in other types of institutions (e.g., community hospitals). Ongoing data collection and analysis continue as we strive to develop consensus guidelines for insulin pump patients in the surgical arena.

References:

1. Juvenile Diabetes Research Foundation. JDRF and BD collaborate to improve insulin pump delivery. http://www.jdrf.org/index.cfm?fuseaction=home.viewPage&page_id=47980498-1321-C834-030811F5029F3DA2. Accessed December 23, 2011.
2. Cook CB, Boyle ME, Cisar NS, Miller-Cage V, Bourgeois P, Roust LR, Smith SA, Zimmerman RS. Use of continuous subcutaneous insulin infusion (insulin pump) therapy in the hospital setting: proposed guidelines and outcome measures. Diabetes Educ. 2005;31(6):849–57.
3. Leonhardi BJ, Boyle ME, Beer KA, Seifert KM, Bailey M, Miller-Cage V, Castro JC, Bourgeois PB, Cook CB. Use of continuous subcutaneous insulin infusion (insulin pump) therapy in the hospital: a review of one institution's experience. J Diabetes Sci Technol. 2008;2(6):948–62.
4. Bailon RM, Partlow BJ, Miller-Cage V, Boyle ME, Castro JC, Bourgeois PB, Cook CB. Continuous subcutaneous insulin infusion (insulin pump) therapy can be safely used in the hospital in select patients. Endocr Pract. 2009;15(1):24–9.
5. Nassar AA, Partlow BJ, Boyle ME, Castro JC, Bourgeois PB, Cook CB. Outpatient-to-inpatient transition of insulin pump therapy: successes and continuing challenges. J Diabetes Sci Technol. 2010;4(4):863–72.
6. Reis JP, Pignatelli D, Madeira D, Castedo JL, de Oliveira MC. Subcutaneous insulin pump therapy in a diabetic patient submitted to major surgery. Postgrad Med J. 1988;64(750):335.
7. White WA Jr, Montalvo H, Monday JM. Continuous subcutaneous insulin infusion during general anesthesia: a case report. AANA J. 2004;72(5):353–7.
8. Ahmed Z, Lockhart CH, Weiner M, Klingensmith G. Advances in diabetic management: implications for anesthesia. Anesth Analg. 2005;100(3):666–9.
9. Hata TM, Moyers JR. Perioperative patient assessment and management. In: Barash PG, Cullen BF, Stoelting RK, Cahalan MK, Stock MC, eds. Clinical anesthesia. Philadelphia: Lippincott, Williams, and Wilkins; 2009, 581.
10. Glister BC, Vigersky RA. Perioperative management of type 1 diabetes mellitus. Endocrinol Metab Clin North Am. 2003;32(2):411–36.
11. Nassar AA, Boyle ME, Seifert KM, Beer KA, Apsey HA, Schlinkert RT, Stearns JD, Cook CB. Insulin pump therapy in patients with diabetes undergoing surgery. Endocr Pract. 2012;18(1):49–55.
12. Boyle ME, Seifert KM, Beer KA, Apsey HA, Nassar AA, Littman SD, Magallanez JM, Schlinkert RT, Stearns JD, Hovan MJ, Cook CB. Guidelines for application of continuous subcutaneous insulin infusion (insulin pump) therapy in the perioperative period. J Diabetes Sci Technol. 2012;6(1):184–90.