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Use of Insulin Pumps in the Perioperative Patient

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Abstract

Diabetic patients who may require surgery can present a challenge in the perioperative arena. Maintaining glycemic and metabolic control can prove to be difficult, especially in the type I diabetic who utilizes an insulin pump. Special attention to how these patients are monitored, as well as criteria for maintaining those on insulin pumps and appropriate patient selection, presents its own set of challenges. This paper will examine one such individual who will be undergoing a total knee replacement (TKR) who has been managed with an insulin pump for the past 33 years. Current guidelines and practices as it pertains to this type of patient will be examined and evaluated. With the growing number of those individuals who are on continuous insulin therapy, along with the increasing number of operative procedures, we hope to gain insight as to how to care for these patients, taking into consideration safety and positive outcomes.

Background

At least 1.4 million people are diagnosed with diabetes each year, and that number continues to increase (American Diabetes Association, 2014). According to the Centers for Disease Control (CDC), there are 29.1 million people living with diabetes or 9.3% of the United States population (CDC, 2014). From the year 1980 to 2014, the number of adults in the United States, ages 18-79, with newly diagnosed diabetes more than tripled from 493,000 to over 1.4 million in 2014 (CDC, 2015). While it is not known specifically how many are utilizing insulin pump therapy, it is estimated that it may be between 20-30% of people in the United States (Partridge, Perkins, Mathieu, Nicholls, & Adeniji, 2016). Of those with Type I diabetes, insulin pump therapy is the most effective method of treatment for diabetic control.

The use of continuous subcutaneous insulin infusion, or CSII, has been in existence for more than 20 years and its usage has increased in the management of the patient with type I diabetes. Insulin pumps work by mimicking normal physiology of insulin or basal-bolus regimen. Because a Type I diabetic is void of insulin, the insulin pump ensures that they are receiving small doses of short acting insulin continuously over a 24-hour period. An advantage to using the pump is the amount of insulin given is more accurate and precise. This leads to improving HgA1C levels as well as fewer swings in blood sugars. These fewer swings in glucose levels are due to the elimination of long-acting insulins. The pump also provides the individual with more flexibility with scheduling of meals and can prevent or reduce sudden drops in blood glucose. The disadvantages to the pump are increased risk of weight gain, the risk of diabetic

ketoacidosis, should the catheter come out, and the nuisance of being attached to a pump on a continual basis (American Diabetes Association, 2015).

Managing glycemic control and metabolic control can be difficult in an individual with type I diabetes. It is well established that stress such as surgery and anesthesia can invoke a neuroendocrine response leading to the release of counter regulatory hormones. This can lead to peripheral insulin resistance, increased hepatic glucose production, impaired insulin secretion, potential hyperglycemia and in extreme circumstances, ketosis. In addition to this counter-regulatory hormone excess, fasting and volume depletion can contribute to metabolic decompensation. This response is of course dependent on the complexity of the surgical procedure and whether or not there exist any surgical or postsurgical complications. Likewise, having diabetes, despite tight control prior to hospitalization, can pose adverse surgical outcomes. Hyperglycemia can inhibit host defense mechanisms, which can lead to infection, impaired wound healing, as well as cardiac and renal complications. Examining what policies and procedures exist, along with managing blood sugars during surgery and criteria for proper patient selection will be examined in the literature review.

Case Report

Patient JB is a 56-year-old Caucasian male who presents to the clinic for a pre-op physical prior to having a right TKR, which is scheduled in the next 30 days. He reports that he has always had knee problems due to arthritis and has just completed a left TKR this previous December. He states that the surgery and rehab went well and was only hospitalized for one day. His only problem during surgery was nausea associated with

the anesthesia but otherwise he tolerated it well. He currently has pain to the right knee, which he scores at a 5-6 on a 1-10 scale. The pain does get as low as a 4 and as high as a 10. He has been taking Ibuprofen 350mg tabs, utilizing 6-8 tabs/day. He has tried ice packs, but this has not alleviated the pain.

The patient's past medical history is significant for hypertension, hyperlipidemia, and type I diabetes since the age of 23. He is currently on Losartan 10mg daily, Novolog insulin pump with usual dosage of about 70U/day, Simvastatin 80 mg daily, Aspirin 81 mg daily and a multivitamin. He has no known food or drug allergies. He currently is employed full-time as a construction worker and smokes 1 pack of cigarettes per week with a 30-pack year history. Alcohol intake is approximately 1-2 drinks per night. He has managed his diabetes well with carbohydrate counting and states that he has a healthy diet and eating plan.

On review of systems, HEENT: denies any visual changes and does receive annual eye exams. He reports that he is hard of hearing to both ears but currently does not wear hearing aids. Cardiovascular: denies chest pain or palpitations. Respiratory: denies SOB, or cough. Gastrointestinal: denies GI complaints such as nausea, diarrhea or constipation. GU: denies dysuria, difficulty with starting his stream or polyuria. Neurological: denies peripheral neuropathy. Endocrine: denies polyuria and polydipsia. Again, patient has an implanted insulin pump and controls his blood sugars and insulin dosing using carbohydrate counting. States he keeps his blood sugars between 100-160.

On physical exam, his blood pressure is 158/94, heart rate 76, resp 20, temp 98.8. Labs and diagnostics ordered during this visit included a CBC, CMP, HgA1C and EKG. Lab work revealed HgA1C of 6.0, CBC revealed mild iron deficiency anemia with RBC

of 3.0, Hct: 34.5, Hgb: 12.0, MCV: 90.7. CMP was within normal limits. The EKG showed normal sinus rhythm. A CXR was deferred since it was done in December prior to the last surgery. HEENT exam was negative. Cardiovascular exam revealed regular heart rate and rhythm without gallops or murmurs. Pedal pulses were noted to bilateral feet. Respiratory exam was without significant findings. Abdomen was soft and nontender and insulin pump was noted to the right lower quadrant. Skin was warm, dry and well pigmented without any open ulcers or lesions.

Assessment and Plan: Reviewed the preoperative labs with the patient. Instructed him on taking an Iron supplement daily and reviewed that his anemia was probably due to blood loss from his previous surgery. Hypertension was also addressed with instructions to continue to monitor blood pressure at home. JB states he does have a blood pressure cuff and that his pressure typically runs in the 130's/80's. Discussed that the current guidelines for blood pressure management for his age is no greater than 140/90. JB verbalized understanding of the instructions. Reviewed that the HgbA1C was under good control for his surgery. Patient did not reveal the plan with regards to his insulin pump and whether or not he would continue on the pump or be transitioned to intravenous insulin.

Literature Review

The management of this patient's diabetes, which included an insulin pump, in the perioperative setting sets the stage for this literature review. A literature search was conducted to evaluate the current recommendations and guidelines. Utilizing the University of North Dakota Harley French Library website, a systematic search of literature was conducted. The databases utilized were CINAHL and PubMed with key

word search terms of *Insulin Pump, Type 1 Diabetes,* and *Perioperative.* The search resulted in a total of 12 articles. After reviewing the articles and eliminating those that were published greater than eight years ago and those that were not focused on the perioperative setting exclusively, there were 10 articles that were relevant to this case. There were noted to be key elements that were consistent amongst all 10 articles.

Need for Policy/Procedural Guidelines

Insulin pumps are becoming more widely used and with this technology, it becomes necessary for current prescribers and future prescribers to have treatment and procedure protocols in place. This becomes even more vital when a patient will be undergoing surgery. The Society for Ambulatory Anesthesia (SAMBA, 2010) first addressed this concern in a consensus statement in 2010. It was prompted by a common dilemma in the ambulatory setting due to the number of patients with an implanted pump that required surgery. Some anesthesiologist were hesitant about managing such a patient, however, these patients were found to be typically the most knowledgeable, motivated and involved in their care and thus, the easiest to manage. The consensus statement did state some guidelines for management. Their recommendations were for basal rate dosage to be that of a "sick day" or "sleep" rate. It was also suggested that intraoperative glucose levels should be maintained less than 180mg/dl with blood glucose monitoring occurring every 1-2 hours. However, these recommendations were based solely on a literature review, which they stated was sparse and of limited quality.

In a retrospective study conducted by Corney et al. (2012), they evaluated both Type 1 and Type 2 diabetics who utilized pumps during their surgical procedures. In order to implement the study they first reviewed the recommendations from the American

Diabetes Association, as well as the American College of Clinical Endocrinologists to establish their policy and procedure guidelines. One component of the guidelines was the implementation of staff and practitioner education. Their success was attributed to adequate training and provision of resources. They also defined what population would be most appropriate to participate and how those patients would also be monitored. They concluded that insulin pump therapy during surgery is a safe option, however, it is critical that healthcare professionals in this field be competent to manage such patients. Likewise, in a study conducted by Boyle et al. (2012), they evaluated outcomes of care after implementation of an institutional policy. When developing their policies, they broke them down into four phases: preadmission, preoperative, intraoperative and post anesthesia recovery. A preadmission nurse was to notify endocrinology about the upcoming case at least 24 hours before the procedure. Patient and provider reviewed pump settings as well as instructing the patient to bring supplies in case of hospitalization. Specifics of documentation during the procedure were also listed. This included pump connection, infusion of the pump, and location of insertion site. Blood sugars were also monitored in all three phases with intraoperative monitoring occurring every hour. An inpatient diabetes management team was also involved in the post anesthesia care unit to assist with that patient's transition should they be admitted to the hospital. Their findings suggested that insulin pump technology could be safely used in this setting. Utilizing a multidisciplinary team was monumental in developing guidelines and successful compliance with necessary procedures.

Estimating risk and safety standards is an important component when developing policy and procedures. Important factors to consider are the length of the surgery, time

of day that the surgery is performed, with preference placed in the early morning, and the individual patient risk factors. In an article published by Dhinsa, Khan, and Puri (2010) it was suggested that utilizing resources such as the World Health Organization's Surgical Safety Checklist, which has been rolled out nationwide, was a good starting point. The checklist was initiated in 2007 in an effort to decrease the number of surgical deaths and address safety concerns. It is a way to ensure that the surgical team consistently follows vital safety steps in order to minimize the most common and avoidable risks. This tool, which continues to be in use today, can serve as the framework for developing hospital policies and guidelines by addressing safety points from the perioperative period through the postoperative period.

Clinical practice guidelines have an important role in delivering quality patient care. It is vital to evaluate what the current standards are and how these affect outcomes. Mathioudakis & Golden (2015) addressed elements of quality improvement by reviewing clinical practice guidelines. The organizations that were reviewed were the Endocrine Society, American College of Physicians, the American Diabetes Association and the Society for Ambulatory Anesthesia. After careful examination, they found that there was significant variability amongst agencies. Variability ranged from glucose management, to identifying patient population, to when to transition a patient from an insulin pump to intravenous insulin. They also noted that these differences and contraindications in the guidelines are likely to create variable practices, which may have implications on patient outcomes. They identified that there needs to be more concrete detail about care protocols as well as decision support.

Intraoperative Glucose Management

The management of the patient with diabetes in the surgical setting requires a customized approach for each individual. It is important to take note of their blood glucose control and how well they have been managed prior to surgery. It is also necessary to examine their HgA1C, as well as cardiac and renal function. Different types of anesthesia may also affect glucose homeostasis during surgery. Minor changes in blood glucose during surgery are to be expected and are however, not an indication to stop the insulin pump.

In an article published by Vann (2009), a review of the impact of glucose control as well as the effects of hyper/hypoglycemia and fluctuations of blood glucose were examined in order to strategize how to manage blood sugars during surgery. They found that despite the large numbers of diabetic surgical patients, there was very limited data on monitoring glucose control during routine ambulatory surgery. It was also found that glucose control with an insulin pump infusion was superior to insulin boluses in maintaining a stabilized glucose. Management of the diabetic patient during surgery needs to be a step-wise approach in order to minimize the fluctuations of hypo and hyperglycemia. First step is to assess the patient's diabetic medications and usual glucose control. The next step is on the day of surgery the patient should have their blood sugars checked every 1-2 hours. Anesthetic management should aim at a stress-free environment for the patient, which should include the type of anesthetic, pain management and control of nausea and vomiting. They concluded that anesthesiologists, especially in the ambulatory setting, are able to provide the ideal environment for the patient with diabetes and have the greatest impact on blood sugar management.

Data on the management of blood sugars during the perioperative period is limited with much of this information being underreported. A multidisciplinary work group reviewed current information regarding the documentation of blood glucoses and the use of insulin pumps in a case report by Boyle et al. (2012). They mention that although continuous insulin pumps have been used in surgery, the experience of practitioners and staff has been underreported and therefore a comprehensive set of recommendations has not yet been developed. They analyzed 50 surgical cases from the year 2006-2010 who were on pump therapy during surgery and noted a wide variation on how they were managed. Documentation of the status of the pump was unclear and inconsistent and glucose monitoring only occurred in 60% of the cases despite anesthesia time of nearly three hours. Recognizing the need for standardization, the group did develop procedural guidelines for monitoring. Blood glucose levels need to be checked in the preoperative phase and both anesthesia and the surgical team should be notified if there is a critical value. Blood glucose levels are then checked hourly during the surgery and corrective doses of insulin are given at the direction of the anesthesiologist. Post anesthesia blood glucose is checked in the recovery room and hourly if applicable. They also developed a sample preoperative insulin pump checklist to ensure that documentation was happening from preop to post anesthesia. In an article published by Ferrari (2008), it was found that rapid acting insulin analogues have enabled more precise glucose control by way of constant infusion. Insulin pumps, which utilize rapid acting insulin, most closely simulate the normal physiologic insulin delivery and therefore reduce the episodes of hypo and hyperglycemic events. They mention that now with the emergence of “smart pumps”, which can be programmed to deliver corrected doses of

insulin, there will be better control over blood glucose levels in which fluctuations during surgery may be uncertain.

Proper Patient Selection

Just as important as having set protocols and guidelines in place to direct care, so is defining which patient would be most appropriate when deciding on keeping the CSII or utilizing intravenous insulin. In a commentary in the American Journal of Medicine (2015), Bhatt & Reynolds note that although insulin pump users are competent in self-care as outpatients, it is inappropriate to expect them to respond to the rapidly changing insulin requirements that may occur when they are experiencing an acute illness or a procedure. Such factors such as sedation with pain medication and even altered mental status can affect and compromise their self-care skills. This is an important consideration when evaluating a patient preoperatively to determine if continued pump use is safe. Discussion with the patient is important because many are fearful of relinquishing their diabetes control to hospital staff especially if they have limited knowledge of that individual's unique insulin needs. Contrary to this, many staff have limited experiences with insulin pumps and due to the multiple types that may exist, this may also prove to be a challenge.

Looking at involving a diabetes inpatient specialist and a multi-disciplinary approach early on may help minimize some of these concerns. In an article by Dhatariya et al (2012), a clinical pathway was designed for those having elective surgery and CSII. This process started with the primary care provider. Ensuring that adequate HgA1C with a recommendation of no higher than 8.5% was a starting point. For those patients who did not have adequate control, a referral to the diabetes specialist team was made. Other

factors taken into consideration were other co-morbidities and how engaged and involved the patient was in their care. The team approach carried through to the recovery phase as well. There were specific instructions and guidelines for staff to follow. Inpatient education by the diabetes specialist team to both patient and staff was a key to the success. This also led to decreased length of stay.

As previously mentioned, an important component to patient selection for CSII is the ability of the hospital, including providers and staff, to care for this type of patient. Before even considering the continuation of this therapy, it is important to ensure that education, protocols and involvement of the diabetes team occurs. It is also important to note that insulin pump therapy is not considered appropriate for those with visual or cognitive impairments and loss of manual dexterity. Partridge et al (2016) state that early involvement with the diabetes team allows for a definitive management plan to be established prior to surgery and will also inform hospital staff as to the competency of the patient in regards to their ability to manage the pump. This being said, it should be assumed that during the hospitalization period, the patient (or parent/guardian) will take responsibility of the pump during the stay. The exception to this would be during the period of surgery when other hospital staff would take on this obligation. It is important to establish this understanding with the patient prior to signing consent. They also add that for major surgery or emergent surgery, insulin pump therapy is not appropriate and pump discontinuation should be advocated. In these cases, IV insulin should be initiated.

With insulin pump therapy becoming an increasingly used modality in the care and management of the Type 1 diabetic and the emergence of use in the management of Type 2 diabetes, it is becoming increasingly important for healthcare professionals to

become familiar with this treatment modality. Due to the many complications associated with diabetes, the need for surgery becomes more and more necessary. How the care of these patients is addressed then becomes the issue. Key factors to be aware of when considering whether or not to have a patient continue on CSII during surgery are the following:

- There needs to be facility policies and guidelines in place to direct staff.
- There still exists much needed research to establish standardized clinical guidelines as practice has been based only on recommendations, provider comfort level, and literature review.
- Staff education, to include providers and nursing, both in the perioperative setting and the inpatient setting is critical
- Criteria needs to be determined in order to establish which patients are most appropriate to continue on CSII. This may include not only patient's ability to manage but also the type and length of the surgical procedure being performed.

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