SPA 2007 PBLD Goals

The Perioperative Management of a 14 year old Type I Diabetic Undergoing Cataract Surgery using Insulin Pump Therapy

After discussing this case, the participant should:

1) understand the unique implications of the type I pediatric diabetic who is undergoing surgery.

2) be able to identify operative cases appropriate for continuing insulin pump therapy.

3) have an understanding of insulin pump therapy including types of insulin used, the basics of insulin bolus delivery and basal rate infusions, and the current pump technology available.

14 year old girl with type I diabetes mellitus presents for extraction of cataract, and detailed eye exam as an outpatient. She was diagnosed with diabetes 4 years ago, and has used an insulin pump for 1 year. A letter from her endocrinologist states that she is "under excellent control with a hemoglobin A1C value of 6.7 and she manages her own pump settings quite well." The endocrinologist suggests maintaining the patient's usual pump settings during the perioperative period. The surgeon states that the case will take approximately 2 hours, and he would prefer general anesthesia for a patient in this age group. Two hours ago, the patient awoke with a glucose level of 80, for which she drank some apple juice, and reduced her insulin pump basal rate to 50% of usual dose because she was "afraid she would become hypoglycemic without eating breakfast." Her glucose level is now 227. (t=0 mins.) How should you, as her anesthesiologist, proceed?

1) What criteria should be used for determining whether or not a case is appropriate for insulin pump therapy use in the perioperative period?

2) What differences between type 1 and type 2 diabetics are significant during the perioperative period?

3) What is the significance of the patient being concerned that she may become hypoglycemic by missing breakfast?

4) What questions should you ask the patient about her typical basal rate of insulin and bolus calculations?

5) What type of insulin is generally used for insulin pump therapy? How quickly does this insulin act? How long does it last?

6) Should a glucose level of 227 be treated prior to induction of general anesthesia?

7) What are ideal glucose levels during the perioperative period?

8) How do you change the basal rate of infusion or give a bolus of insulin via the pump?

9) Should the patient's intravenous fluids contain dextrose?

10) Does the case warrant antiemetic prophylaxis?

The decision to give a calculated bolus of insulin via her insulin pump is made and the patient undergoes an uneventful general anesthetic induction and intubation. A follow-up intraoperative glucose level 30 minutes later (t= 30 mins) is 269.

11) What could account for this unexpected increase in glucose levels? Is an increase in the basal rate or an additional bolus more appropriate at this point?

12) What type of analgesia should be given to this patient? Is there a benefit to providing a regional technique instead of opioid therapy?

The patient is given short acting opioids for analgesia and ondansetron for nausea prophylaxis. One hour after the case begins, the patient's glucose level is 189 (t=60 mins). No further changes in pump settings are administered at that time. A glucose level near case conclusion (t= 120 minutes) is 195. The case ends uneventfully, the patient is extubated and transported to PACU. She meets criteria for stage 1 recovery discharge within 30 minutes and is requesting food. A glucose level at that time (t=150 minutes) is 210. The patient administers a correction bolus of insulin as well as enough insulin to cover the carbohydrates in the popsicle that she eats. Five minutes after consuming the popsicle, she vomits. She requests to turn her pump off since she was unable to ingest the glucose from the popsicle properly and she feels quite nauseated.

13) Is turning the pump off appropriate at this time? Should dextrose be added to her intravenous fluids? Should blood or urine be assessed for presence of ketones?

13) What other antiemetic prophylaxis should be given? Should steroids (i.e. Decadron) be considered?

Metoclopramide is given. After 60 minutes (t=210 mins.), her glucose level is 88. She then feels better and successfully eats her popsicle, as well as a sandwich, for which she administers a calculated insulin bolus.

14) What criteria should be met before patient is discharged home?

Model Discussion

Insulin pump therapy has become a common method for diabetics to manage their glucose levels. Patients who use insulin pumps are presenting for surgery more frequently. There is evidence that "tight" perioperative glucose control promotes improved postoperative wound healing, decreased infection rate, and decreased morbidity.[1-4] It is therefore advisable that anesthesiologists, who will be responsible for perioperative glucose management, become familiar with the general principles of insulin pump management.

In the United States, commercially available insulin pumps deliver insulin via a subcutaneous catheter. This catheter site is changed by the patient every 2-4 days. Most patients use their abdomen, buttocks, or flanks for catheter insertion. The subcutaneous insertion site can be moved if the site that is typically used by the patient is in near proximity to the surgical field. Typically, ultra short acting insulin is used (i.e. insulin lispro (Humalog) or Insulin aspart (NovoLog)). [Table 1] A basal rate, or continuous infusion of insulin, is administered, as well as pre-prandial boluses based upon the patient's calculations of the amount of carbohydrates ingested. Insulin pump infusion sets typically have a disconnect site that allows patients to bathe. This disconnect site should ideally be accessible to the anesthesiologist during the case for both inspection, and deliberate disconnection if the decision to discontinue pump therapy is made. It is imperative to realize that a subcutaneous catheter that becomes dislodged, but is not kinked, will continue to attempt to deliver insulin without setting off any pump alarms. The only sign of a dislodged catheter may be glucose levels that are increasing inexplicably. The pump *will* alarm if an obstruction to flow exists.

Currently available insulin pumps do not have the capability of measuring blood glucose levels. Therefore, frequent glucose monitoring (i.e. every 30 minutes) is recommended during the perioperative period to follow trends and to optimize glucose control. Insulin pump users (or their parents or caretakers) are generally well versed in pump therapy and management and should be able to provide information that will help the anesthesiologist perform perioperative basal rate changes and administer appropriate boluses.

To select cases appropriate for insulin pump therapy, a few general principles should be followed. Ideally, patients should be undergoing outpatient surgery that will allow them to return to oral intake relatively quickly postoperatively. (<2 hours case length) [5] There should be no large fluid shifts, deliberate hypothermia or deliberate hypotension anticipated. These conditions will alter subcutaneous absorption of insulin. These more complex cases should be managed with intravenous infusions of insulin +/- glucose rather than subcutaneous pump therapy.

The majority (90%) of all diabetics are type 2 diabetics. However, the younger the patient, the more likely they are to have type 1 diabetes. Type 1 diabetics are more likely to have had diabetes for a longer period of time, and are therefore more likely to exhibit end organ complications of diabetes (renal, cardiovascular, microvascular, gastroparesis, and neuropathy) at a younger age. Because type 1 diabetes is an autoimmune disorder, these patients are more prone to other autoimmune disorders, especially of the thyroid.

Type 1 diabetics are also more prone to ketosis and should have ketone levels monitored more aggressively. The pathophysiology of type 1 diabetes is a relative deficiency of insulin. The pathophysiology of the type 2 or the pregnant diabetic is a resistance to insulin. Therefore, the amount of insulin required is typically much higher in type 2 diabetics. The sensitivity to a given amount of insulin is much higher in type 1 diabetics. Both type1 and type 2 diabetics may use insulin pumps, however, the anesthesiologist can expect much higher dose requirements in type 2 diabetics.

The keys to successfully perioperative insulin pump use are:

a) to clarify that basal rates are correctly programmed and
b) to be able to administer boluses for correction of hyperglycemia.

A few questions should always be asked of the insulin pump patient prior to induction of anesthesia.

1) What is the patient's basal rate profile? Most patients will have different basal rates at different times of day. Typical rates are 0.1-2.0 units insulin per hour. Some patients have different basal profiles for different activity levels or times of stress, menstrual cycle, or illness. The anesthesiologist should note any upcoming hourly basal rate changes greater than 30% that will occur during the perioperative time period. The basal rate may need to be adjusted for a change in activity during this perioperative day. For example, if a patient has a decrease in basal rate at a particular time because exercise usually occurs at that time, the basal rate may need to be increased since exercise will not be occurring. See table 2 for a typical basal rate profile of a type 1 diabetic.

2) What happens if the patient fasts? If the patient becomes hypoglycemic when missing a meal, the basal rate is set too high and will likely need adjustment during fasting. A patient who suffers frequent bouts of hypoglycemia may not be able to detect symptomatic low glucose levels as easily as someone who only rarely becomes hypoglycemic. The typical adrenergic response to hypoglycemia becomes blunted and the patient may not experience tachycardia, diaphoresis or tremors. These patients need to be monitored frequently, even when awake in the postoperative period. On the other hand, the patient who does frequently experience hypoglycemia may be able to function when awake much better than one whom rarely experiences it and is frightened by it. This sort of information can help the anesthesiologist decide formulate discharge criteria.

3) What is the patient's correction factor? I.e. How much does one unit of insulin typically lower the patient's blood glucose? If the patient does not know this detail, some pumps will have the information stored under the *bolus wizard set-up* menu as a *sensitivity* value. Alternatively, the following formula may be used to estimate this correction factor:

1500/units of insulin in 24 hour period = amount that one unit of insulin will lower blood glucose.

This correction factor should be used when calculating the amount of insulin bolus to

be given to correct undesired hyperglycemia during the perioperative period.

E.g. Intraoperative glucose = 250 on a 70 kg man who averages 50 units of insulin per day. 1500/50= one unit of insulin will decrease glucose approximately 30g/dl. Intraoperative glucose goal = 100g/dl.

250-100= 150 150/30 = Administer 5 units of insulin via pump.

4) **How long does it typically take the patient to notice the peak results of a bolus given via insulin pump?** The peak action of ultra short acting insulin varies considerably in different patients. [Table 1] (0.5-2.5 hours) This specific individual information can help the anesthesiologist to manage a pump successfully.

5) **Can the patient provide a quick demonstration of pump functions?**

The following information should be noted by the anesthesiologist:

a) how to stop or disconnect the pump in the event that hypoglycemia or a change in route of insulin administration warrants the discontinuation.

b)how to administer a bolus of insulin via the pump in the event that undesired hyperglycemia warrants treatment.

c)how to change the basal rate of insulin infusion.

d) the location of a help line phone number. Insulin pump companies supply a 24 hour hot line which is printed on the pump. The representatives can help the anesthesiologist with the above functions in a clear and concise fashion.

The metabolic response to surgery and anesthesia should be taken into account when calculating changes in insulin pump therapy. Stress and trauma, especially surgical, cause increased secretion of substances that are counterregulatory to insulin. Epinephrine, glucagon, and cortisol induce a catabolic state that not only increases glucose levels, but predisposes the type I diabetic patient to ketoacidosis.[6,7] It is for this reason that exogenous administration of steroids for antiemetic prophylaxis should be avoided in light of the many other antiemetic options available.

The use of intravenous dextrose during the perioperative period is controversial. Some feel that its use is imperative in type I diabetics whose potential for developing ketoacidosis is compounded by the catabolic state described above and the lack of metabolic substrate available during a period of fasting.[8] However, for relatively short outpatient cases for which perioperative pump therapy is being considered, the addition of dextrose may only complicate treatment based on glucose trends and therefore may be avoided.

The key to making appropriate treatment options via the insulin pump is to closely follow trends in glucose levels. The time of peak onset of ultra short acting insulin (1-3 hours) should be taken into account to avoid "stacking boluses" which can result in hypoglycemia. A change in the basal rate is not effective in correcting hyper/hypoglycemia quickly and is less likely to be performed intraoperatively than the delivery of a bolus.

In summary, a patient who uses insulin pump therapy may benefit from maintaining this route of insulin administration during the perioperative period. The process of attempting to convert to intermittent subcutaneous injections or to intravenous therapy preoperatively is likely to be more complicated and less likely to allow tight glucose control. The anesthesiologist, who is the physician responsible for the patient during the perioperative period, should have some degree of familiarity with the concepts of insulin pump therapy in order to allow diabetic patients to maintain the best perioperative glucose control. This discussion session introduces the anesthesiologist to these concepts and provides a primer of questions to be asked of the insulin pump user.

References

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