Perioperative Management of Diabetic Patients: Optimising Care with Insulin Pumps and CGM Devices

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KEY POINTS

- Insulin pumps and continuous glucose monitoring devices aim to improve diabetes control with consistent, personalised insulin delivery and real-time glucose monitoring.
- Wide variations with devices and choices include traditional pumps with tubing, discreet patch pumps, and automated closed-loop systems.
- Patients require a patient-centred perioperative strategy with preoperative evaluation, an insulin dosing strategy, and education on glucose management.
- Intraoperative/postoperative care requires continued glucose monitoring and insulin adjustment during and after surgery based on patient status and diet.
- Education and troubleshooting are essential for effective technology use and management of common problems such as blood sugar extremes.

INTRODUCTION

Diabetes is a complex chronic disease, with its management often necessitating multidisciplinary efforts. The advent of insulin pumps and glucose monitoring devices has transformed the landscape of diabetes care, heralding a new era where technological advancements intersect with healthcare. Research has indicated that these technologies not only improve haemoglobin A1c levels but also significantly reduce the risk of severe complications, such as hypoglycaemia and cardiovascular diseases. Perioperative management of diabetic patients using insulin pumps and continuous glucose monitoring (CGM) systems requires a careful multidisciplinary approach to ensure stable blood glucose levels and prevent complications. This tutorial aims to explore the functions and features of insulin pumps and CGM devices to manage perioperative care for diabetic patients effectively.

INSULIN PUMPS

Insulin pumps can be classified into traditional pumps, patch insulin pumps, and hybrid closed-loop systems.
Traditional Insulin Pumps

Traditional insulin pumps are compact devices tethered to the body via tubing. They infuse rapid-acting insulin subcutaneously and are programmed to accommodate basal insulin needs and bolus doses for meal intakes.\(^4\)

Traditional insulin pumps have both advantages and disadvantages for diabetic patients. One of the significant advantages of these pumps is the tailored programming feature that allows for customised insulin delivery based on individual needs. This adaptability is crucial as it helps patients keep their glucose levels within a narrower and safer range. Moreover, these pumps have advanced software that carefully records insulin delivery, which helps in making more informed decisions regarding diabetes management.\(^4\)

However, there are some drawbacks to using traditional insulin pumps. One of the main issues is the physical constraints that they impose. The pump’s constant presence can be a source of discomfort or self-consciousness for some users. Another possible complication is the risk associated with the infusion site. The infusion site can occasionally become inflamed or infected, like any device penetrating the skin. This requires careful attention and may necessitate resiting to avoid further complications.\(^4\)

Patch Insulin Pumps

A more contemporary addition to the pump family, patch pumps,\(^4\) do not use tubing but instead use a direct adhesive method (Figure 1). The advantages of using patch pumps include their minimalist design, which is less conspicuous and allows users more freedom in their daily activities and attire. Additionally, the absence of external tubing in these pumps reduces the risk of occlusion, tubing kinks, risk of getting tangled with the tube, and accidental detachment, thereby ensuring efficacious delivery of insulin and lowering physical barriers for users.\(^4\) However, there are drawbacks to consider. One significant drawback is the reservoir limitations of patch pumps. Due to their compact design, these pumps have a limited insulin capacity, which necessitates more frequent reservoir changes than traditional pumps.\(^4\)

Hybrid Closed-Loop Systems

Tagged as the ‘artificial pancreas,’\(^4,5\) these systems are the most advanced in diabetes care. They are composed of both insulin delivery and CGM devices, which communicate with each other (Figure 2).

These automated insulin delivery systems offer several advantages. These systems can self-regulate by adjusting basal insulin levels in response to CGM readings, which improves the management of diabetes and affords better glycaemic control. By reducing the frequency of episodes of hypo- or hyperglycaemia, these systems promote a more stable glycaemic profile, which is essential for the long-term health of individuals with diabetes.\(^4\)

However, there are also some drawbacks to consider. One major concern is affordability and accessibility as these advanced devices come at a higher cost, which might discourage some potential users from acquiring them. Another drawback is the dependence on CGM data for insulin delivery. Any inaccuracies in the CGM sensor readings might skew insulin delivery, leading to potential risks and management challenges for the user.\(^4\)

GLUCOSE MONITORS

Concurrent with the evolution of insulin pumps, glucose monitoring technologies have also witnessed advancements.

Figure 1. A compact, wearable device that adheres directly to the skin to deliver insulin continuously. The device is controlled wirelessly and eliminates the need for traditional tubing, offering discreet and flexible diabetes management. This image is provided courtesy of Diabetes UK, specifically for Anaesthesia Tutorial of the Week publication.
Self-Monitoring Blood Glucose Devices

These devices rely on fingerstick, or capillary, blood glucose samples (Figure 3). One of the main advantages is that they offer prompt feedback; these tests give users instantaneous readings, allowing for quick therapeutic decisions. It is also a relatively simple procedure that does not require the routine maintenance that devices with higher technology may require. One disadvantage of self-monitoring blood glucose devices is that regular finger pricking required for these tests can be off-putting for some individuals. This can lead to less frequent testing than is optimal, as people may avoid the discomfort associated with the procedure. In addition, factors such as application errors, extreme environmental conditions, extreme haematocrit values, or medication interferences may falsify blood glucose readings.

CGM Systems

CGM systems are a more advanced technology, furnishing users with a constant stream of glucose data (Figure 4). One of the key advantages of CGM systems is their ability to provide comprehensive insights. With continuous readings, these monitors offer users real-time feedback about glycaemic trends, which is crucial for managing their health. Additionally, CGM systems are equipped with alarm systems that alert users of impending hypo- or hyperglycaemic episodes, allowing for proactive interventions and pre-emptive actions to manage glucose levels effectively.

However, there are also drawbacks associated with the use of CGM devices. One such drawback is the need for calibration and accuracy. Periodic calibration is essential to ensure accurate readings, but this process can sometimes be perceived as
tedious and time-consuming. Another issue concerns sensor longevity and comfort. CGM sensors require periodic replacements, which can be a hassle for users. Moreover, some individuals might experience mild irritation at the insertion site of the sensor, which can be a discomforting aspect of using these devices.

CGM devices lack Food and Drug Administration approval and validation in perioperative or inpatient settings. Their accuracy can diminish due to fast glucose level fluctuations, sensor compression, and physiological changes such as hypothermia, low blood pressure, vasoconstriction, swelling, low oxygen levels, and specific drug interactions. Despite these drawbacks, CGM devices are invaluable for many individuals managing their glucose levels.

PREOPERATIVE MANAGEMENT

In the preoperative phase for diabetic patients using insulin pumps, a multifaceted approach is crucial for successful surgery and recovery. Initially, the patient’s insulin pump settings are assessed, focusing on their effectiveness in controlling blood glucose levels. This evaluation includes examining recent blood glucose readings and haemoglobin A1c levels to assess long-term glucose control.

Educating the patient is a pivotal aspect of this phase. It involves instructing the patient on monitoring their capillary blood glucose (CBG) levels, with particular attention to those using CGM systems integrated into their insulin pumps. This education is vital, especially during fasting times and under stress (eg, situations of hypotension, focal or generalised oedema, hypoxemia, and during use of certain medications) to ensure effective management of insulin and glucose levels.

The role of the diabetic care team is integral in this process. A collaborative approach involving endocrinologists, preoperative nursing staff, and anaesthetists is essential. Together, they fine-tune insulin regimens, manage other diabetes medications, and devise a safe anaesthesia plan considering potential diabetes-related complications.

Preoperative tasks include a thorough check of the insulin pump’s functionality, ensuring adequate battery life, insulin supply, and accuracy of the CGM system. Standard fasting guidelines should be adhered to, but surgeries are preferably scheduled early to limit the time patients are nil per os so that patients may resume their regular diet and insulin regimen as soon as possible. If morning surgery is not possible, more intensive glucose monitoring and insulin adjustments may be necessary.

Specific insulin adjustments before surgery may also be necessary. Typically, this involves reducing the basal insulin rate to about 80% of the normal rate or following local guidelines. Reviewing and modifying other antihyperglycaemic medications is equally important. Close blood glucose monitoring is essential, with additional insulin adjustments made based on glucose readings on the day of surgery. The route of insulin administration can be decided based on the type of surgery, metabolic status of the patient, and the ability to continue insulin pump use perioperatively.

Finally, a last check of the insulin pump before surgery is vital. Ensuring that the pump’s battery and reservoir are fully operational is crucial for the surgery and immediate recovery. This comprehensive approach, encompassing assessment, patient education, teamwork, preoperative tasks, specific insulin adjustments, and final checks, is designed to minimise complications and optimise diabetes management during and after the surgical procedure. For further details regarding perioperative insulin management, please refer to Anaesthesia Tutorial of the Week 327 and 402.
INTRAOPERATIVE MANAGEMENT

In managing a diabetic patient undergoing surgery, the approach to insulin delivery and glucose monitoring must be tailored to the individual’s needs. If the patient uses an insulin pump, the healthcare team should assess whether to continue or switch to intravenous insulin administration. Factors that may sway the team to not use a patient’s insulin pump would be if magnetic resonance imaging is needed, as they are not magnetic resonance imaging compatible, or if diathermy is going to be used, as this may interfere with functionality. Should the decision be to continue with the pump, it is crucial to ensure that the device and its insertion site are securely fastened and easily accessible during the procedure.\(^9\)

Adjusting the insulin pump’s basal rate may be necessary to compensate for the stress of surgery and the patient’s fasting state. Establishing protocols for managing potential hyperglycaemia or hypoglycaemia is also essential. These protocols should include guidelines on adjusting insulin dosages and administering treatments to correct any significant deviations from the target glucose range.

Glucose monitoring is another critical aspect of managing diabetes in the surgical context. CGM devices should be continued so long as there is no contraindication, as above with insulin pumps. In scenarios where CGM device use is not possible, CBG should be checked every 1 to 2 hours to closely monitor the patient’s glucose status.

The intraoperative care team can query patients regarding the operation of their devices before the patient receives an anaesthetic. That way, they are informed about how to use the device. If patients cannot provide instructions to their care team, consultation with a device representative should be sought before the patient is anaesthetised.

POSTOPERATIVE MANAGEMENT

During the postoperative phase, the engagement of a multidisciplinary team, comprising diabetic specialist nurses and endocrinologists, is vital. Their expertise is instrumental in fine-tuning insulin therapy and overseeing blood glucose levels along with education of the patient and staff.\(^9\)

Following surgery, it is essential to continue either CGM or regular CBG testing to guide insulin dosing accurately. As the patient resumes their usual diet, preoperative basal insulin rates should be reinstated.\(^9,10\) For insulin dosing, bolus doses should be administered for meals, ensuring that the patient’s carbohydrate intake is considered. Additionally, correction doses may be necessary to manage instances of hyperglycaemia. Given the variable nature of postoperative stress, which can affect blood glucose levels, insulin regimens may require further adjustments. This tailored approach helps manage the body’s unique demands following surgery.

Communication plays a pivotal role in the postoperative management of diabetes. It is important to educate the patient and the healthcare staff about the signs of hypoglycaemia and hyperglycaemia to ensure prompt and effective management of these conditions. Moreover, maintaining clear and thorough documentation of insulin doses and blood glucose readings is imperative. This recordkeeping facilitates better communication among the healthcare team and supports the continuity of care, thereby reducing the risk of complications associated with poor glycaemic control.

SPECIAL CONSIDERATIONS

To manage diabetes effectively during surgeries and the perioperative period, specific considerations must be made regarding insulin pumps and CGM devices:\(^11\)

- Device removal. If there is a need to remove an insulin pump or CGM device, the patient should transition to a basal-bolus insulin regimen. This involves using long-acting insulin to provide a steady level of insulin (basal) and rapid-acting insulin before meals and to correct high blood sugar levels (bolus).
- Elective surgery. Achieving optimal glycaemic control is crucial before elective surgery. This means maintaining blood sugar levels within the target range to reduce the risk of surgical complications.
- Emergency surgery. In emergency situations, if the patient presents with significant hypo- or hyperglycaemia or ketosis, it is essential to correct these conditions before proceeding with the surgery, whenever possible.
- Patient education. The patient must be well informed about managing their insulin pump and CGM device during the perioperative period. They should understand their responsibilities and how to adjust their devices if necessary.
- Hyperglycaemia. Check for infusion site issues, pump malfunctions, and surgical stress. Administer correction doses as necessary.
- Hypoglycaemia. Decrease basal rate and give exogenous glucose either orally if the patient is able or intravenously.

This strategy aims to maintain blood glucose control during times when normal routines are disrupted, such as during surgery, to prevent complications and promote a smooth recovery.
SUMMARY
The perioperative management of diabetic patients using insulin pumps and CGM devices is a critical aspect of diabetes care that demands meticulous planning and coordination. The technological sophistication of these devices offers many benefits, including enhanced glycaemic control and patient autonomy. However, it also requires a careful approach to address potential drawbacks and adapt to the surgical environment’s unique demands. By adopting a patient-centred strategy that encompasses thorough preoperative assessment, vigilant intraoperative management, and diligent postoperative care, healthcare providers can optimise patient outcomes. Education is fundamental in empowering patients and healthcare staff, ensuring a collaborative and informed approach to managing diabetes in the perioperative phase. With the right protocols and communication, complications can be minimised, leading to safer surgical experiences and improved overall care for diabetic patients.

REFERENCES

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