Perioperative hyperglycaemia and its treatment in patients with diabetes mellitus

Polderman, J.A.W.

Publication date
2018
Document Version
Other version
License
Other

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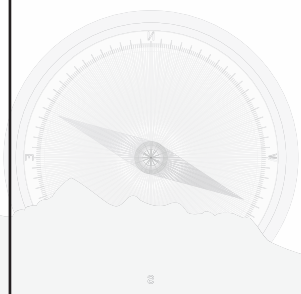
AMBULATORY ANAESTHESIA: OPTIMAL PERIOPERATIVE MANAGEMENT OF THE DIABETIC PATIENT

Polderman JAW, van Wilpe R, Eshuis JH, Preckel B, Hermanides J

Ambulatory Anesthesia 2016;3:13-22



Abstract

Given the growing number of patients with diabetes mellitus (DM) and the growing number of surgical procedures performed in an ambulatory setting, DM is one of the most encountered comorbidities in patients undergoing ambulatory surgery. Perioperative management of ambulatory patients with DM requires a different approach than patients undergoing major surgery, as procedures are shorter and the stress response caused by surgery is minimal. However, DM is a risk factor for postoperative complications in ambulatory surgery, so should be managed carefully. Given the limited time ambulatory patients spend in the hospital, improvement in management has to be gained from the pre-anaesthetic assessment. The purpose of this review is to summarize current literature regarding the anaesthetic management of patients with DM in the ambulatory setting. We will discuss the risks of perioperative hyperglycaemia together with the pre-, intra-, and postoperative considerations for these patients when encountered in an ambulatory setting. Furthermore, we provide recommendations for the optimal perioperative management of the diabetic patient undergoing ambulatory surgery.

Introduction

Diabetes mellitus (DM) is a growing concern worldwide. The current global prevalence of DM was estimated to be 9% among adults aged 18 years or older (1). According to current projections, the prevalence will rise from 387 million people now to 592 million people in 2035 worldwide (2). Patients with DM are more prone to undergo surgical interventions; ~25% of patients with DM will require surgery (3). Given the increasing number of surgical procedures being performed on an outpatient basis (4), DM is one of the most commonly encountered comorbidities in the ambulatory setting. Although a vast amount of research has been done on the negative effects of hyperglycaemia and DM in the perioperative period of major (cardiac) surgery (5–9), evidence regarding DM and ambulatory surgery is sparse. However, it is known that DM is an important risk factor for postoperative complications (such as wound infections or unplanned admissions) in surgical outpatients (10). The recently updated Joint British Diabetes Societies/National Health Service (JBDS/NHS) guideline states that same day admission should be standard of care in patients with DM unless other serious comorbidities are present (11). Therefore, the preoperative assessment plays a major role in the management of DM during ambulatory surgery. Furthermore, intraoperative management of outpatients with DM might require a different approach than in-patients with DM taking into account the short time spent in the hospital, short duration of surgery, and minimal stress response after smaller surgical procedures (12,13). The purpose of this review is to summarize current literature regarding the anaesthetic management of patients with DM in the ambulatory setting. We will discuss the risks of perioperative hyperglycaemia together with the pre-, intra-, and postoperative considerations for these patients when encountered in an ambulatory setting.

Perioperative hyperglycaemia and complications

Tissue damage caused by surgery leads to an increased production of stress hormones (eg, cortisol and catecholamine's), thereby reducing insulin sensitivity and secretion (14). The resulting elevation in blood glucose levels is frequently referred to as stress hyperglycaemia. Since the capacity to respond to the increased insulin demand is reduced or absent in patients with DM, the risk of developing hyperglycaemia during or after surgery is higher. Perioperative hyperglycaemia during major surgery has a significant impact on the occurrence of postoperative complications, including various infections, impaired wound healing, and myocardial infarction (6,7,15–17). Treating perioperative hyperglycaemia has been shown to reduce postoperative infections (15,18). The underlying pathophysiologic mechanisms by which hyperglycaemia leads

to an increase in deleterious outcomes have not yet been fully elucidated (19). However, multiple mechanisms by which hyperglycaemia might contribute to postoperative complications have been proposed. First, clinical studies suggest that hyperglycaemia causes decreased monocyte and neutrophil function, reduced intracellular antibacterial activity, and glycosylation of immunoglobulins resulting in an increased risk of infections (20,21). Second, hyperglycaemia activates pro-inflammatory cytokines, which will lead to a pro-inflammatory state and subsequently to an increased risk of infection and impaired wound healing (22). Third, experimental animal models showed that hyperglycaemia is associated with lower cell count of endothelial progenitor cells and decreased nitric oxide bioavailability leading to decreased endothelial function and contributing to a higher risk of infections, impaired wound healing, and thrombotic complications (19,23). Finally, an increase in glucose leads to upregulation of coagulation factors, thereby promoting a pro-thrombotic state in the perioperative period (24,25). Furthermore, untreated hyperglycaemia can result in severe dehydration, ketoacidosis, and hyperosmolar states (12). When blood glucose levels are persistently elevated, glucose binds to the haemoglobin in erythrocytes (26). The percentage of haemoglobin in the glycosylated form (HbA1c) reflects mean ambient fasting and postprandial glucose levels over a 3–4-month period and reveals whether the patient resides mostly in the normoglycaemic or hyperglycaemic range (27,28). Research suggests that the oxygen carrying capacity of haemoglobin seems to be unaffected by the level of glycosylation (29,30). Nonetheless, several studies demonstrated the association between elevated HbA1c (>53 mmol mol^{-1}) and postoperative complications after non-cardiac surgery (31–35). Furthermore, preoperative hyperglycaemia and elevated HbA1c levels are predictive for postoperative hyperglycaemia after ambulatory surgery (10). These data suggest that improvement of preoperative glucose regulation in patients with DM should be pursued and the surgical procedure even postponed both for better perioperative glycaemic control and prevention of postoperative complications (11). This holds true especially for ambulatory surgery when monitoring of blood glucose is often limited (36). As stated before, hyperglycaemia during major surgery is associated with adverse outcomes (6,15–17). In a prospective cohort study in ambulatory patients, DM was found to be a risk factor for postoperative complications after minor ambulatory surgery, such as postoperative infections or unplanned admission (10). Hyperglycaemia (glucose >7.8 mmol l^{-1}) occurred in 65% of the patients with DM during ambulatory surgery compared to only 5.6% of the patients without DM. Contrary to DM, hyperglycaemia was not associated with postoperative infections, suggesting that long-term glycaemic control is of greater influence than short-term glycaemic control during ambulatory surgery. Unfortunately, only a limited number of patients with DM were included (n=48, 5.3%); thus, the consequences of perioperative hyperglycaemia in patients with DM during ambulatory surgery should still be investigated. Also, postoperative hyperglycaemia

is associated with postoperative complications after major surgery (6). Treating postoperative hyperglycaemia results in significantly less postoperative complications (18). This indicates that perioperative glucose regulation does not end when the patient leaves the recovery room or is discharged to home in the case of ambulatory surgery. Regrettably, no data exist on glycaemic control of DM patients during the first days after discharge following ambulatory surgery.

Preoperative considerations

Preoperatively, the anaesthesiologist should obtain information about the type and duration of diabetes, antidiabetic medications, treatment compliance, and diabetes-related complications. Furthermore, long-term glycaemic control should be established by laboratory measurements (eg, HbA1c, creatinine). When long-term glycaemic control is very poor (HbA1c >69 mmol mol^{-1}), JBDS/NHS guidelines suggest to optimize glycaemic control and postpone the operation if possible (11). In addition, the incidence of hypoglycaemic episodes and the blood glucose level at which symptoms occur should be known. Deliberate management of the antidiabetic therapy is crucial in order to safely ensure adequate perioperative glycaemic control. Temporary cessation of oral antidiabetic therapy and insulin therapy increases the risk of perioperative hyperglycaemia. Meanwhile, fasting – especially in patients on tight glycaemic control or who snack regularly – increases the risk of hypoglycaemia (11). To avoid hyper- and hypoglycaemia, it is important to minimize the disruption of the usual treatment regimen by scheduling DM patients first on the procedure list (11,12). To improve patient adherence to the preoperative management, explicit verbal and written instructions should be provided concerning blood glucose monitoring, therapy adjustments, and fasting times (37). Patients should be instructed to measure their glucose regularly on the day of surgery. Furthermore, they should be advised to bring sugar-containing beverages or buccal sugar cubes with them to treat hypoglycaemia during transit to the surgical facility (13). Postoperative dehydration can be prevented by adequate water consumption until two hours before surgery (12).

Oral antidiabetics

The first-line oral drug for treatment of DM type 2 is metformin, which stimulates glycogen synthesis thereby reducing gluconeogenesis in the liver. It also increases peripheral insulin sensitivity in muscle cells by increasing the transport capacity of the membrane glucose transporters. As metformin does not trigger insulin production, there is virtually no risk of hypoglycaemia when metformin is used as monotherapy (38). Metformin has long been associated with an increased risk of lactic acidosis, which is the reason why

metformin is often withheld prior to surgery. A meta-analysis of 347 studies demonstrated that there is no evidence supporting this association, even in the presence of renal insufficiency (39). Nonetheless, we are still awaiting randomised controlled trials investigating the effects of perioperative continuation of metformin. The JBDS/NHS guidelines recommend continuation of metformin on the day of surgery if the fasting period is short (eg. no more than one missed meal), provided no contrast medium is used and the estimated glomerular filtration rate is greater than 50 ml min^{-1} 1.73$m2^{-1}$ (11).

Sulfonylureas (eg, tolbutamide, gliclazide, and glimepiride) and meglitinides (eg, repaglinide) are not safe to be taken on the day of surgery as they trigger insulin production, which could potentially lead to hypoglycaemia in fasting patients (40). In addition, they interfere with cardiac ischaemic preconditioning (41).

Thiazolidinediones (eg, pioglitazone) are known to cause fluid retention and therefore generally discontinued several days prior to surgery (42). Alpha glucosidase inhibitors (eg, acarbose, miglitol) should be discontinued during perioperative fasting since their only mechanism of action is to impede glucose absorption after meals (43).

Over the past decade, incretin-based therapies, glucagonlike peptide-1 (GLP-1) agonists, and dipeptidyl peptidase-4 (DPP-4) inhibitors, are increasingly used in the treatment of DM 2. GLP-1 is a hormone secreted by the small intestine when food is ingested. When GLP-1 binds with the GLP-1 receptor, the pancreas will start producing insulin in a glucose-dependent matter (44). GLP-1 secretion is counteracted by DPP-4, which rapidly breaks down GLP-1. Current therapeutic applications are DPP-4 inhibitors, which have been developed to slow down the GLP-1 breakdown process, thereby increasing the circulation time of GLP-1. In addition, GLP-1 agonists are a synthetic analogue of GLP-1, which interact with the GLP-1 receptors. Because of a resistance to DPP-4 breakdown and increased half-life, they can be administered once daily or less (45). Incretin-based therapies as monotherapy are unlikely to cause hypoglycaemia because of their glucose-dependent action (42). Perioperative use of incretin-based injectables may occasionally cause hypoglycaemia but almost exclusively when combined with other antidiabetics – for instance, exenatide in combination with sulfonylureas (46,47). Some caution should be taken as GLP-1 agonists may delay restoration of gastrointestinal function after surgery as they slow gastric emptying and gut motility. DPP-4 inhibitors are usually better tolerated than GLP-1 agonists with no significant adverse effects (42,46). In rats, GLP-1 secretion was reduced during isoflurane anaesthesia with restoration of normal function after treatment with a GLP-1 agonist (48). These data suggest that an incretin-based therapy in the perioperative period seems a suitable approach. The most recent

JBDS/NHS guidelines suggest continuing incretin-based therapies, whereas American guidelines were more prudent and advise to withhold incretin-based therapies 12–24 hours before surgery (11–13). Currently, especially when used as monotherapy, continuation during ambulatory surgery seems not to be contraindicated.

Sodium-glucose cotransporter 2 (SGLT-2) inhibitors have recently been introduced as a novel oral antidiabetic agent. These agents block the reabsorption of glucose in the kidney, lowering the glucose threshold by which it is excreted in the urine. They have a low risk of hypoglycaemia as the excretion of glucose ceases when blood glucose levels drop below the threshold (49). However, due to increased diuresis, plasma volume is reduced by 10% after initiation of treatment (50). Furthermore, SGLT-2 inhibitors are associated with diabetic ketoacidosis (51). Due to their noninsulin dependent glucose excretion, extreme hyperglycaemia is usually absent, and nausea and vomiting are the only warning signs of diabetic ketoacidosis (52). In the postoperative setting, it will become quite hard to distinguish between diabetic ketoacidosis and postoperative nausea and vomiting (PONV), especially in the diabetic patient with a glucose level of 10 mmol l^{-1} on SGLT-2 inhibitors. Thus, when in doubt, urine or plasma ketones should be measured. Based on these data, we would suggest stopping SGLT-2 inhibitors on the day of surgery.

Overall, we suggest withholding oral antidiabetics – with the exception of metformin and incretins – 12 to 24 hours before surgery until oral intake is resumed (Table 1).

Table 1: Perioperative management of oral antidiabetics

Drug class	Primary mechanism of action	Main perioperative risks	Recommendation
Biguanides (metformin)	Reduces hepatic gluconeogenesis, increases insulin sensitivity (T½: 6-18h)	None*	Continue. May be withheld in case of renal failure or when using contrast agents.
Sulfonylureas (tolbutamide, gliclazide, glimepiride)	Stimulates insulin release (T½: 2-10h)	Hypoglycemia Interference with cardiac ischemic preconditioning	Withhold on the day of surgery
Meglitinides (repaglinide)	Stimulates insulin release (T½: 1h)	Hypoglycemia	Withhold on the day of surgery
Thiazolidinediones (pioglitazone)	Modulates carbohydrate and fatty acid metabolism, reduces insulin resistance and hepatic gluconeogenesis (T½: 3-8h)	Fluid retention	Withhold 24-48 hours before surgery

Table 1: Perioperative management of oral antidiabetics (*continued*)

Drug class	Primary mechanism of action	Main perioperative risks	Recommendation
Alpha glucosidase inhibitors (acarbose, miglitol)	Reduces intestinal glucose absorption	None	Withhold during fasting
SGLT-2 inhibitors (dapagliflozine)	Reduces glucose reabsorption in kidney	Reduced plasma volume, DKA	Withhold on the day of surgery
DPP-4 inhibitors (sitagliptin)	Stimulates insulin release and inhibits glucagon release (glucose-dependent)	Unlikely	Continue
GLP-1 agonists (exenatide, liraglutide)	Stimulates insulin release and inhibits glucagon release (glucose-dependent)	Unlikely	Continue

Insulin therapy

As insulin requirements differ between patients, numerous different insulin regimens can be encountered. The preferred insulin regimen for patients with insulin-dependent DM is a basal–bolus regimen, as it mimics the physiological insulin production by providing basal doses of long-acting insulin and prandial doses of short- or rapid-acting insulin. Long-acting insulin only, is an alternative regimen used primarily in patients with DM 2. Since long-acting insulin is used to account for insulin demand between meals, perioperative fasting should not lead to hypoglycaemia if the usual dose is continued. Intermediate-acting insulin (eg, neutral protamine Hagedorn) or premixed insulin differs from the long-acting regimens, as they may cause hypoglycaemia in fasting patients because of their peak effect (53) (Table 2). Our recommendations for the preoperative management of various insulin regimens are depicted in Table 3, where we have tried to make the recommendations as uniform as possible for better protocol adherence (54–56). It has been proposed that fasting patients require 50% of their total daily insulin dose because of their fasting state and reduced metabolic demands during anaesthesia. However, due to short operating times and early resumption of oral intake, insulin requirements during ambulatory surgery are probably closer to 100% of the total daily insulin dose. Thus, in agreement with Society for Ambulatory Anesthesia (SAMBA) guidelines, patients on long-acting insulin may take their usual morning or evening dose, irrespective of the duration of fasting (12). However, the newer long-acting insulins Toujeo© and Degludec have a duration of action of 36 to 42 hours compared to 24 hours for Lantus© or Detemir. Therefore, patients on Toujeo© or Degludec require a dose reduction of their original dose the night before surgery (11). Furthermore, caution should be taken in patients with a history of nocturnal or morning hypoglycaemia; also, in these patients, a dose reduction is warranted. Rosenblatt et al showed that administration of 80% of the evening dose of long-acting insulin, compared to 50% or 60%

Table 2: Time to onset, peak effect and total duration of various insulin types

Insulin type	Onset	Peak effect	Total duration
Short- and rapid-acting insulin			
Regular insulin	30-60 min	2-4 hours	6-8 hours
Lispro, aspart, glulisine	5-15 min	30-90 min	4-6 hours
Intermediate acting or premixed insulin			
NPH	2-4 hours	4-10 hours	10-16 hours
NPH / regular (70/30, 50/50)	30-90 min	Dual	10-16 hours
Long-acting insulin			
Glargine, detemir	2-4 hours	None	20-24 hours
Toujeo, Degludec	30-90 min	None	36-42 hours

Table 3: Management of insulin regimens

Insulin regimen	Day before surgery	Day of surgery	Comments
Long-acting insulin (long-acting only, basal component of basal-bolus regimen)	No change	No change	75% of evening or morning dose in case of Degludec/Toujeo, nocturnal or morning hypoglycemia
Intermediate-acting or premixed insulin	No change	50-75% of morning dose	In case of premixed insulins, use the intermediate-acting component only
Short- and rapid-acting insulin	No change	Withhold until resumption of usual intake	
Insulin pump (basal-bolus)	No change	Maintain basal rate ('sleep' rate) [a] until resumption of usual intake	Give correctional insulin boluses via separate injection

[a] Safety measures mentioned in this article should be taken into account when using insulin pumps during surgery

of the evening dose, was a safe and effective strategy without a significant increase in hypoglycaemic events (57). It stands to reason that short-acting mealtime boluses are omitted during fasting. For patients on neutral protamine Hagedorn insulin, the evening meal dose on the day before surgery may be left unchanged, but the morning dose on the day of surgery should be reduced to 50%-75% of the original dose (11,12). Patients using an insulin pump should be instructed to maintain insulin infusion on their usual "sleep" basal rate (12,58). After resumption of regular intake, mealtime boluses can be restarted as appropriate. Although the aetiology of DM 1 and 2 is completely different, the recommended perioperative management is usually the same. However, research on DM 1 patients undergoing surgery is sparse, as DM 1 represents only 10% of the diabetic population. In a retrospective cohort of 209 ambulatory patients with DM, patients with DM 1 presented with higher HbA1c levels and had poor glucose regulation

during ambulatory surgery when compared to patients with DM 2 (59). This suggests that patients with DM 1 are a distinctive group and need a different treatment approach than DM 2. This is partly due to the fact that they rely on an exogenous insulin source for 24 hours per day.

Intraoperative considerations

Despite the abundance of published protocols, few comparative studies have been done on perioperative glucose regulation during ambulatory surgery. Additionally, as mentioned before, protocol compliance for perioperative diabetes regulation is extremely low. Thus, the intraoperative treatment regimen should be as simple as possible – especially for short ambulatory cases – to improve protocol compliance and a uniform treatment of the ambulatory surgical patient with DM. For insulin-naïve patients, a sliding scale regimen was shown to be a simple and effective regimen for perioperative treatment (60). This treatment was effective on the condition that glucose was frequently measured and hyperglycaemia was always treated with a bolus of intravenous insulin. In addition, all guidelines advise managing outpatients on insulin by manipulation of their own insulin regimen and avoiding a continuous insulin infusion when possible (11,12). For in-hospital patients, it has been shown that a basal-bolus regimen with Lantus© once daily plus three mealtime boluses provides better glucose control than a sliding scale regimen (18). However, transferring patients to a basal-bolus regimen on the day of surgery seems unsuitable for ambulatory practice. Hemmerling et al showed no difference in perioperative glucose values when patients were treated with a sliding scale regimen compared to a continuous glucose-insulin-potassium infusion (61). Thus - awaiting evidence on the optimal intraoperative management of DM in ambulatory surgery - the sliding scale regimen seems to be the most suitable option for patients treated with insulin provided they use their regular dose of long-acting insulin. Multiple strategies exist for determining the appropriate insulin dose. Firstly, sliding-scale regimens provide prespecified insulin doses for multiple ranges of blood glucose values above a certain threshold (eg, 10 mmol l^{-1}). This method is widely used due to its convenience in use. However, sliding-scale regimens do not take patients' total daily dose of insulin or body weight into account (62). Therefore, one can also choose to use the patient's usual correction factor (12,13,63). When a continuous insulin infusion is warranted (eg, DM 1 patients), a continuous insulin infusion or glucose–insulin–potassium infusion should be used (64). The fear of hypokalaemia when administering insulin infusion without potassium during short procedures does not seem to be justified (10). Insulin pumps can be continued intraoperatively, especially if the surgical procedure is expected to be of short duration. However, some considerations should be taken into

account (65,66). A preoperative checklist may be used to assess pump functioning, programmed settings, and supplies. The pump infusion set should be placed away from the surgical field. When radiography is being used, the pump should be kept out of range to prevent any possible interference. Potential disconnection of the catheter due to patient movement should be monitored. In order to minimize the risk of hypoglycaemia, correctional doses of insulin should be given by separate intravenous injection and blood glucose levels should be measured hourly. Insulin has long been the sole therapy to treat intraoperative hyperglycaemia. Insulin may be administered either intravenously or subcutaneously during surgery, each with its own advantages and disadvantages. Guidelines recommend using subcutaneous insulin in patients undergoing ambulatory surgery (12,67). Subcutaneous insulin administration is the most convenient and cost-effective strategy (68,69). However, subcutaneous insulin becomes unpredictable during the perioperative period due to the altered perfusion of the subcutaneous tissue (70). Therefore, we recommend using intravenous insulin, as this prevents stacking of subcutaneous insulin and has predictable pharmacokinetics.

Blood glucose target range

According to most guidelines, the optimal blood glucose target range for non-critically ill diabetic in-patients is 5.6–10 mmol l^{-1} (11,12,71). There have been many studies investigating optimal perioperative glycaemic targets in major surgery. Whereas several early interventional studies have shown a beneficial effect of tight intraoperative glycaemic control (33,72,73), most recent studies do not support these findings (74–77). In a recent meta-analysis of six studies (75), a moderate glycaemic target (between 5.6 and 8.3 mmol l^{-1}) was found to be most beneficial in terms of postoperative complications and mortality, as lower targets (less than 5.6 mmol l^{-1}) did not lead to improved outcomes. Moreover, hyperglycaemia in patients with DM might be less detrimental than hyperglycaemia in patients without DM (78). Moderate glycaemic control (between 5.6 and 8.3mmol l^{-1}) might not be an achievable target during the short period of ambulatory surgery. However, when blood glucose rises above 10 mmol l^{-1}, collagen syntheses and leukocyte function are depressed, thereby increasing the risk for postoperative complications (79). Although the ideal target range for surgical outpatients has not been investigated, all guidelines recommend maintaining blood glucose levels below 10 mmol l^{-1} (6,16).

Perioperative hypoglycaemia

Patients with older age, prior history of hypoglycaemia, longer duration of diabetes, and autonomic neuropathy are at an increased risk for perioperative hypoglycaemia (80).

Most conscious patients experience warning signs and symptoms when blood glucose drops below 3.0 mmol l^{-1} (81). The sympathoadrenal response triggered by hypoglycaemia causes neurogenic symptoms, including sweating, tremors, palpitations, and paraesthesia (82). Neuroglycopenic symptoms – that is, those symptoms resulting from glucose deprivation in the brain, such as confusion, weakness, and seizure – will start to arise as the severity of hypoglycaemia increases. Ultimately, profound hypoglycaemia may lead to brain death or cardiac arrhythmic death (83). Patients with poorly controlled or long-standing diabetes may not experience neurogenic symptoms due to autonomic neuropathy (84); in these patients, only neuroglycopenic symptoms are seen. Poor long-term glycaemic control can reduce the threshold for hypoglycaemic symptoms causing patients to experience symptoms at blood glucose levels that are otherwise considered normal (81,82). Hypoglycaemic symptoms in elderly patients are often nonspecific and less obvious due to diminished autonomic responses (85). Hypoglycaemic symptoms are abolished during general anaesthesia and sedation, and hypoglycaemia can only be detected by adequate glucose monitoring (80). In well-controlled diabetic patients, blood glucose levels below 3.9 mmol l^{-1} should be treated promptly (81). This will provide sufficient time to prevent symptoms. Perioperative hypoglycaemia may be treated with 80–100 mL of 20% glucose if venous access is available (11). Otherwise, 1 mg of glucagon may be administered subcutaneously. Blood glucose should be reassessed 15 minutes after treatment (12,13).

Glucose measurement

Blood glucose levels should be regularly measured in order to keep glucose levels stable and within target range. More importantly, regular monitoring allows for early detection of hypoglycaemia. It is advisable to measure blood glucose upon the patient's arrival at the ambulatory facility, before and after surgery, and prior to discharge. Surgery lasting less than two hours may not require intraoperative glucose testing. Intraoperative measurements should preferably be performed every hour when using intravenous rapid-acting insulin for treating hyperglycaemia, as the peak effect of insulin occurs within 20 minutes (Table 2). Evidently, more frequent monitoring is needed in case of hypoglycaemia or considerable fluctuation of blood glucose levels. Perioperative blood glucose levels are most commonly measured using point-of-care capillary glucose devices, as these are convenient and readily available. The difference between capillary and venous glucose is usually small, provided there are no major physiological derangements (19,86). However, practitioners have to keep in mind that the US Food and Drug Administration allows a 15% error margin in monitors and that point-of-care devices typically overestimate blood glucose levels in the hypoglycaemic range (86–88). Thus,

in the hypoglycaemic range, more frequent monitoring and verification with central laboratory tests should be performed (12).

Dexamethasone administration

Resuming oral intake and their own antidiabetic regime is of high priority in surgical outpatients. Dexamethasone is commonly used as an antiemetic for the prevention of PONV to facilitate the abovementioned target (89,90). Intraoperative administration of a single small dose (eg, a mean dose of 4.2 mg) of dexamethasone in surgical outpatients with DM has been demonstrated to raise blood glucose levels by 1.5 mmol l^{-1} (10,91). One could argue that as long as glucose levels are adequately monitored and treated, a single dose of 4 mg of dexamethasone may be administered as part of PONV prophylaxis in patients with DM. However, one has to keep in mind that the peak effect of dexamethasone is 12 hours after administration when ambulatory patients are already discharged home (92). Therefore, we would suggest using dexamethasone as a final option in the multimodal approach for PONV prophylaxis. Furthermore, it is worth pointing out that 8 mg of dexamethasone is not more effective for the prevention of PONV than 4 mg (12).

Postoperative considerations

After surgery, patients should be encouraged to resume their normal caloric intake as soon as possible. Once regular intake is resumed, all discontinued oral antidiabetics can often be safely restarted, provided the patient is not hypoglycaemic. However, caution should be taken if morning medications were used later than usual. Also, if resumption of normal intake is delayed, the patient's usual treatment regimen should be postponed. Hypoglycaemia warrants prolonged observation at least until the peak effect of the last insulin dose has passed. Patients should be instructed to self-monitor their blood glucose levels regularly after discharge and carry adequate hypoglycaemia treatments (eg, 15–20 g of glucose) while traveling from the ambulatory facility (40). Furthermore, they need to be provided with a discharge information letter, including a phone number to contact, if they encounter any problems.

Conclusion

Diabetes is an important risk factor for postoperative complications. Hence, optimal anaesthetic management of patients with DM is crucial. One of the key principles is minimal disruption of the surgical outpatient's treatment regimen. Considering the short duration of surgery and current evidence, the pursuit of strict glycaemic control in every diabetic patient undergoing minor ambulatory surgery may likely be superfluous. However, much is still to be gained by improving pre-anaesthetic care.

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