NARRATIVE REVIEW ARTICLE

Society for Ambulatory Anesthesia Updated Consensus Statement on Perioperative Blood Glucose Management in Adult Patients With Diabetes Mellitus Undergoing Ambulatory Surgery

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This consensus statement is a comprehensive update of the 2010 Society for Ambulatory Anesthesia (SAMBA) Consensus Statement on perioperative blood glucose management in patients with diabetes mellitus (DM) undergoing ambulatory surgery. Since the original consensus guidelines in 2010, several novel therapeutic interventions have been introduced to treat DM, including new hypoglycemic agents and increasing prevalence of insulin pumps and continuous glucose monitors. The updated recommendations were developed by an expert task force under the provision of SAMBA and are based on a comprehensive review of the literature from 1980 to 2022. The task force included SAMBA members with expertise on this topic and those contributing to the primary literature regarding the management of DM in the perioperative period. The recommendations encompass preoperative evaluation of patients with DM presenting for ambulatory surgery, management of preoperative oral hypoglycemic agents and home insulins, intraoperative testing and treatment modalities, and blood glucose management in the postanesthesia care unit and transition to home after surgery. High-quality evidence pertaining to perioperative blood glucose management in patients with DM undergoing ambulatory surgery remains sparse. Recommendations are therefore based on recent guidelines and available literature, including general glucose management in patients with DM, data from inpatient surgical populations, drug pharmacology, and emerging treatment data. Areas in need of further research are also identified. Importantly, the benefits and risks of interventions and clinical practice information were considered to ensure that the recommendations maintain patient safety and are clinically valid and useful in the ambulatory setting.

What Other Guidelines Are Available on This Topic?

Since the publication of the SAMBA Consensus Statement for perioperative blood glucose management in the ambulatory setting in 2010, several recent guidelines have been issued by the American Diabetes Association (ADA), the American Association of Clinical Endocrinologists (AACE), the Endocrine Society, the Centre for Perioperative Care (CPOC), and the Association of Anaesthetists of Great Britain and Ireland (AAGBI) on DM care in hospitalized patients; however, none are specific to ambulatory surgery.

How Does This Guideline Differ From the Previous Guidelines?

Previously posed clinical questions that were outdated were revised to reflect current clinical practice. Additional questions were developed relating to the perioperative management of patients with DM to include the newer therapeutic interventions. (Anesth Analg 2024;XXX:00–00)

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According to the National Diabetes Statistics Report, 37.3 million people in the United States have diabetes mellitus (DM), representing 11.3% of the population.[1] Of those with DM, 8.5 million (23%) of adults remain undiagnosed while an additional 96 million individuals have prediabetes.[1] The rising prevalence of DM (diagnosed and undiagnosed), as well as prediabetes, increases the risk of perioperative hyperglycemia.[2,3] Since the publication of the Society for Ambulatory Anesthesia (SAMBA) Consensus Statement for perioperative blood glucose (BG) management in the ambulatory setting in 2010,[4] several recent guidelines have been issued by the American Diabetes Association (ADA),[5] the American Association of Clinical Endocrinologists (AACE),[6] the Endocrine Society, the Centre for Perioperative Care (CPOC),[7] and the Association of Anaesthetists of Great Britain and Ireland (AAGBI)[8] on DM care in hospitalized patients; these guidelines include recommendations not specifically applicable to ambulatory surgery.

METHODS

The 2010 SAMBA Consensus Statement was updated to address several novel therapeutic interventions that have since been introduced to treat DM, including new hypoglycemic agents and the increased prevalence of insulin pumps and continuous glucose monitors (CGM). Previously posed clinical questions that were outdated were revised due to advances in clinical practice, and new questions were developed relating to the perioperative management of patients with DM to include newer therapeutic interventions. This updated consensus statement was approved by the SAMBA Board of Directors.

A systematic review of the literature pertaining to perioperative BG management in adult patients with DM undergoing ambulatory surgery was conducted according to the protocol recommended by the Cochrane Collaboration. We searched MEDLINE, EMBASE, and the Cochrane Controlled Trials Register, from January 1980 to January 2022. The search was conducted by a reference librarian familiar with the Cochrane Collaboration (Amy Knehans, Penn State Health, Hershey, PA), using the following search terms: "prediabetic state," "diabetes mellitus," "diabetes mellitus, type 2," "diabetes mellitus, lipoatrophic," "diabetes mellitus, type 1," "noninsulin-dependent diabetes mellitus with deafness," "DM1, OR DM2 AND perioperative care," "perioperative Nursing," "insulin," "carbohydrate drinks," "dexamethasone," "oral hypoglycemics," "noninsulin injectables," "antidiabetic agents," "insulin, short-acting," "insulin, long-acting," "sodium-glucose transporter 2 inhibitors," "glucose intolerance," "insulin infusion systems," "glycated hemoglobin A," "dipeptidyl-peptidase IV inhibitors," " glycemic or metabolic control or diabetes control," "blood sugar," "HbA1c," "hypoglycemia," "hyperglycemia," "carbohydrate drinks," "blood glucose/metabolism," "point-of-care testing," "diabetes complications AND ambulatory surgery," "ambulatory surgical procedures," "outpatient surgery," "ambulatory anesthesia," "day surgery," "office-based surgery," "in-office surgery," and "same-day surgery." The senior author hand-searched articles in addition to the described search performed by the librarian.

The search was limited to the English language and human trials. Duplicate articles were deleted. Citations were excluded for the following: population other than adult, article/study did not discuss BG management, not perioperative period, and not ambulatory/outpatient surgery. The resulting titles were screened by 2 authors independently (N.R. and E.D.) using the abovementioned exclusion criteria; if consensus was not achieved, a tie-breaker screening vote was made by a third author (G.J.). In the next step, abstracts and full-text articles were reviewed again by 2 independent authors (N.R. and E.D.). Any disagreement was adjudicated by a third author (GJ). The reason for exclusion in this step was recorded. The final selected articles were reviewed by the entire task force to make recommendations.

The Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) for Systematic Reviews was used to define the quality of evidence and to grade recommendations and formulate the current set of guidelines.[9–11] The strength of evidence was graded as "high": high-powered randomized clinical trials or meta-analyses and the panel reached uniform near unanimous consensus; "moderate": lower-level evidence, but despite the absence of higher-level studies, there is uniform consensus that the recommendation is appropriate (it is assumed that these recommendations may be modified as higher-level evidence becomes available); "low": lower-level evidence, and there is nonuniform consensus that the recommendation should be made (this suggests to the practitioner that there could be more than 1 approach to the question in statement); and "very low": a major disagreement among the task force members (the level of evidence is not pertinent in this category, because experts can disagree about the significance of high-level trials). This highlights a major interpretation issue in the data and directs practitioners to the manuscript for an explanation of the controversy.

The strength of recommendations was graded either as "strong" or "conditional." A strong recommendation was offered when the desirable effects of an intervention clearly outweighed or clearly did not outweigh the undesirable effects, and the task force believed that all or almost all clinicians would choose the specific action or approach. A conditional

recommendation was offered where most—but not all—clinicians would choose the action or approach. Overall, the recommendations were formulated by the task force, using the modified Delphi method to collate rounds of individual comments on the evidence and draft recommendations, followed by roundtable discussions and then further Delphi rounds to achieve final consensus.[12,13] In addition, the GRADE-Adolopment framework for new guidelines, which involves using previous guidelines work was also utilized.[14]

The benefits and risks of interventions and clinical practice information were considered to ensure that the recommendations maintain patient safety and are clinically valid and useful in the ambulatory setting.

The task force addressed the following questions on preoperative management.

1. What preoperative information specifically related to glycemic control should be obtained about patients with diabetes?
2. How are preoperative oral antidiabetic and noninsulin injectable therapy managed?
3. How are preoperative insulin therapy and insulin pumps managed?
4. Is there a preoperative hemoglobin A1C (A1C) level or blood glucose concentration above which one should postpone ambulatory procedures?
5. How should preoperative hyperglycemia be managed?
6. Are preoperative carbohydrate drinks appropriate for patients with diabetes?

The task force addressed the following questions on intraoperative management.

7. What is the optimal intraoperative blood glucose concentration?
8. How should the optimal blood glucose concentrations be maintained?
9. What is the optimal perioperative blood glucose monitoring? How should continuous glucose monitors be managed?
10. How should perioperative hypoglycemia be identified and managed?
11. How should insulin pumps be managed in the ambulatory setting?
12. Should an insulin-naïve patient receive insulin to optimize blood glucose concentrations?
13. Should patients receive long-acting insulins in ambulatory surgery facilities?
14. Is intravenous dexamethasone appropriate in patients with diabetes?

The task force addressed the following questions on postoperative management.

15. What are the discharge considerations for outpatients with diabetes?
16. What advice should be given to patients with diabetes for glucose control and medication management after discharge home?

The task force addressed the following miscellaneous questions.

17. What are the other considerations specific to glycemic control in outpatients with diabetes?
18. What are the areas for future research regarding perioperative blood glucose management in adult patients with diabetes undergoing ambulatory surgery?

RESULTS

The electronic literature search yielded 1074 results. After applying the exclusion criteria in the title screening phase, 340 titles were included for abstract screening and 177 passed through to the full-text screening phase. Of these 177, 79 titles were included for final review. After the final review, 29 titles were excluded for reasons outlined in the Figure. The remaining 50 articles and additional high-quality articles from inpatient and critical care literature were used for making recommendations. The 50 articles consisted of 23 narrative reviews, 3 systematic reviews, 2 randomized controlled trials, 3 guidelines/position statements, 5 retrospective studies, 8 prospective observational studies, 2 case reports, and 4 prospective cohort studies.

Overall, the literature pertaining to perioperative BG management in patients with DM undergoing ambulatory surgery remains sparse and of limited quality. The panel of experts therefore used a combination of general principles of DM management, pharmacology and physiology, high-quality evidence from inpatient and critical care patient population studies, clinical experience and judgment specific for the ambulatory setting.

DISCUSSION

The taskforce recognizes that recommendations based on inpatient and critical care literature may not always be applicable to the ambulatory setting. A pragmatic approach is necessary with a primary aim of maintaining patient safety, while considering factors that can influence efficiency of the ambulatory facility (Table 1). The goals of managing BG in patients with DM undergoing ambulatory procedures are avoidance of hypoglycemia, maintenance of BG in target range, adequate BG monitoring, and expeditious resumption of oral intake and patient's medication regimen.

The procedures performed in the ambulatory setting are minimally invasive with negligible fluid

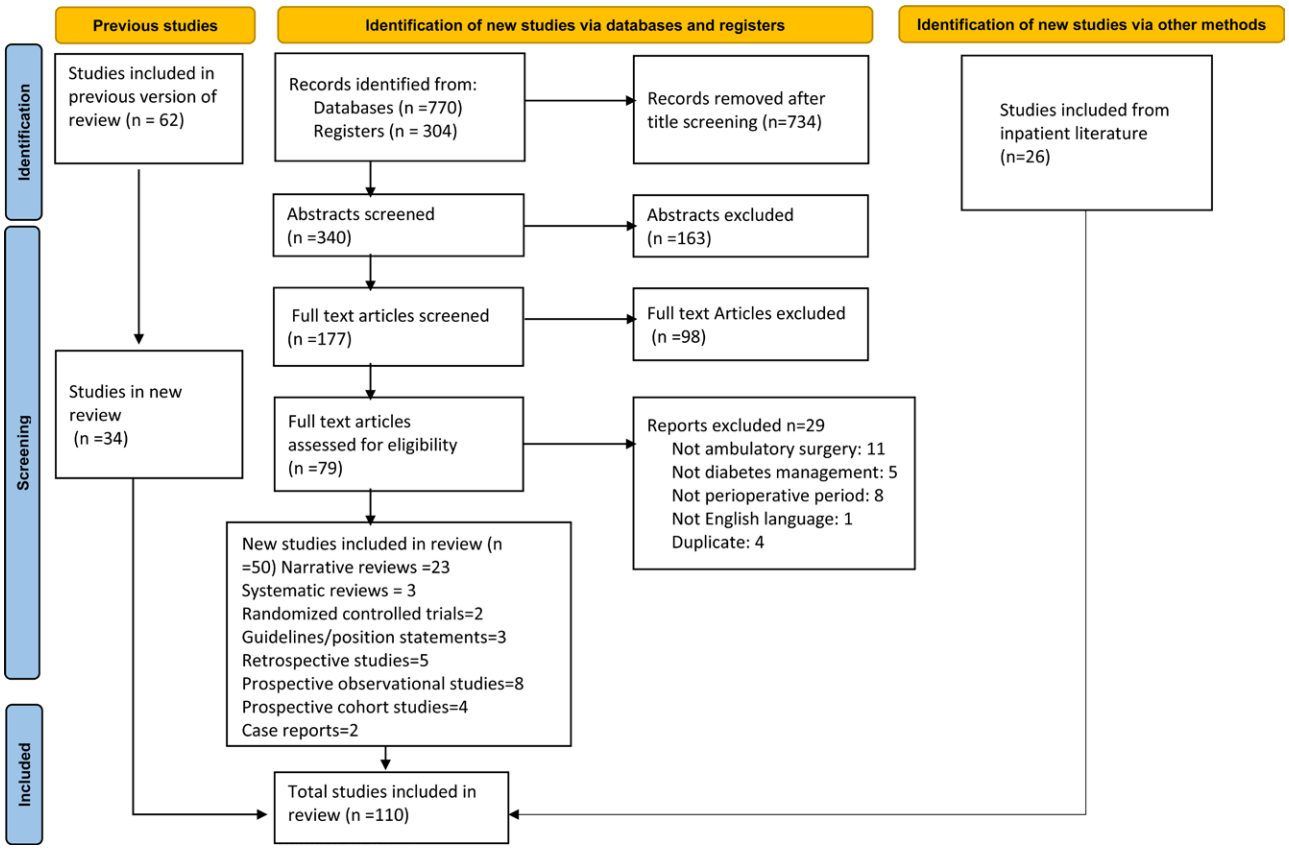

Figure. Flowchart of the literature search and study selection.

shifts and thus, are less likely to cause major metabolic derangements. Therefore, the surgical stress response that often influences glucose physiology, including increase in insulin resistance and perioperative morbidity in hospitalized patients,[15] may not be applicable in the ambulatory setting. The impact of surgical stress on glucose physiology has not been well studied after ambulatory procedures; however, a 2015 prospective multicenter cohort study, assessing hyperglycemia during ambulatory surgery and associated outcomes, found that minor ambulatory surgery resulted in a minimal glucose change in patients with or without DM, indicating the need to uniquely evaluate diabetic patients undergoing outpatient surgery.[16]

Patients presenting for ambulatory surgery are also less likely to have severe preoperative metabolic derangements preoperatively or they would be unsuitable for elective surgery. Importantly, there is rapid recovery and return to activities of daily living including resumption of oral intake with minimal anticipated disruption in BG management regimen. The above-mentioned considerations influence the approach to preoperative medication management, intraoperative BG management, and BG monitoring. Other factors that need to be considered are that the majority of ambulatory procedures are less than 2 hours in duration with short (<60 minutes) anticipated recovery time and discharge time. Also, perioperative care needs to consider the demands placed on an Ambulatory Surgery Center to manage high surgical volumes and facilitate rapid turnover.

Notably, similar to the 2010 consensus statement, these recommendations are intended to provide a broad framework for periprocedure/perioperative glycemic control of a patient with DM; they are not intended to be prescriptive for specific procedure and/or patient characteristics within the ambulatory setting. The task force is mindful of the significant variability within the ambulatory setting (eg, management of patients undergoing cataract surgery under topical anesthesia would be different from a patient undergoing major total joint surgery). Therefore, these recommendations are not intended to supersede clinical judgment or individual patient choices or values. Ultimately, clinical decision-making must always be customized to the individual situation. The supervising physician should make appropriate modifications based on their expertise on a patient-to-patient basis.

Table 1. Summary Recommendations for Perioperative Blood Glucose Management in Adult Patients Undergoing Ambulatory Surgery

Recommendation	Strength	Grade of evidence	Change from 2010
We recommend procedure postponement in patients with hyperglycemia associated with symptoms suggestive of complications such as diabetic ketoacidosis or hyperglycemic hyperosmolar nonketotic syndrome	Strong	Moderate	Unchanged
We do not recommend postponing ambulatory procedure based on A1C levels	Strong	Moderate	New
We recommend proceeding with the planned procedure in patients presenting with hyperglycemia (BG >180 mg/dL, 10 mmol/L) in the absence of DKA or HHNS	Strong	Moderate	Unchanged
We recommend target blood glucose concentrations of 180–250 mg/dL, based on patient and procedure characteristics	Strong	Moderate	New
We recommend preprocedure hydration with water in lieu of carbohydrate loading in diabetes patients	Strong	Moderate	New
We recommend the use of subcutaneous insulin administration for treatment of hyperglycemia	Strong	Moderate	Unchanged
We recommend the use of point-of-care glucose meters to confirm accuracy of continuous glucose monitors and automated insulin dosing systems in periprocedure blood glucose management	Strong	Moderate	New
We suggest continuing a patient's continuous subcutaneous insulin infusion for procedures under 2 h if the device can be placed outside of the surgical field and can be easily visualized and accessed	Conditional	Low	New
We suggest that significant periprocedure hyperglycemia (blood glucose concentrations >250 mg/dL) in insulin naïve patients may be treated with insulin based on patient and procedure characteristics	Conditional	Low	New
We recommend the use of low-dose (4 mg) dexamethasone in patients with diabetes	Strong	Moderate	Unchanged
We recommend each facility develop and implement a blood glucose management protocol	Strong	Moderate	New

Abbreviations: BG, blood glucose; DKA, diabetic ketoacidosis; eGFR, estimated glomerular filtration rate; HHNS, hyperglycemic hyperosmolar nonketotic syndrome; QHS, at bedtime.

PREOPERATIVE MANAGEMENT

What Preoperative Information Specifically Related to Glycemic Control Should Be Obtained About Patients With DM?

With regard to information specifically related to glycemic control, the task force reiterates the recommendations from the 2010 Consensus Statement.[4] The preoperative information should include the type and duration of DM, DM complications, and coexisting diseases, which include obesity, sleep-disordered breathing, coronary artery disease, peripheral neuropathy, autonomic neuropathy, peripheral arterial disease, and renal insufficiency.[17] The type of DM treatment (ie, diet controlled, oral agent only, combination therapy including oral agents, insulin and/or injectables, or continuous insulin infusion) needs to be documented. Insulin use should be differentiated as physiologic insulin (basal infusion plus bolus regimen which mimics natural pancreatic function) or supplemental insulin (insulin used with oral medications or noninsulin injectables).[18,19]

The occurrence and frequency of hypoglycemia, the manifestations of hypoglycemia, blood glucose level at which hypoglycemic symptoms occur, and hospital admissions due to glycemic control issues should also be documented. Patients should be asked specifically about the occurrence of nighttime or morning hypoglycemia, the occurrence of hypoglycemia if meals are missed and if they experience hypoglycemia unawareness.[18,19]

Preoperative hemoglobin A1C (A1C) levels and BG concentrations, if available, provide information regarding long-term BG control. For patients using a continuous subcutaneous insulin infusion (CSII) and/or CGM, the site should be ascertained. For patients using pumps of automated insulin dosing systems, the type of insulin used, the pump settings, and typical BG target should be documented. The patient should be advised to place the device away from the surgical site before surgery and to bring pump supplies to replace the pump (Omnipod) or reservoir and tubing should the pump become dislodged in the perioperative setting (Minimed or Tandem pumps). The ability of the patient to reliably test BG as well as to understand and manage DM should also be noted because this information can guide BG management planning including perioperative treatment goals.[20,21] All patients with DM should have a point-of-care (POC) BG measurement on the day of surgery when they arrive at the preoperative area. This guides further management as outlined below.

How Are Preoperative Oral Antidiabetic and Noninsulin Injectable Therapy Managed?

The optimal perioperative use of oral hypoglycemic medications and noninsulin injectables is not well

established in the ambulatory setting. However, the task force reiterates the recommendations from the 2010 Consensus Statement,[4] and new data are presented where available.

Oral Antidiabetic Medications. Currently, there are 10 classes of orally available pharmacological agents to treat type 2 DM with 8 being used commercially (Table 2).[22,23] Metformin is currently the most commonly used oral medication for type 2 DM in the United States. Current data suggests that metformin does not cause hypoglycemia during fasting, and thus can be continued preoperatively in patients with normal renal function who are not receiving nephrotoxic agents.[4,24–26] Sulfonylureas carry the risk of asymptomatic hypoglycemia,[27] and thus should be held the day of surgery to reduce the risk of hypoglycemia. Meglitinides also stimulate the release of insulin from beta-pancreatic cells. These agents demonstrate an increased risk of hypoglycemia,[28] albeit to a lesser degree than sulfonylureas, and thus should be held the day of surgery.

Thiazolidinediones carry a low risk of hypoglycemia,[29] and may be continued preoperatively. Dipeptidyl peptidase-4 (DPP-4) inhibitors, also known as "gliptins," have a low risk of hypoglycemia in the perioperative period particularly when used as monotherapy.[30–33] They have been shown to be safe and efficacious in obtaining glycemic control in hospitalized patients and may be continued preoperatively.

Sodium-glucose cotransporter 2 (SGLT2) inhibitors work by blocking the sodium-glucose cotransporter-2 in the kidneys and promote glucosuria by inhibiting renal glucose reabsorption. Perioperative use of SGLT-2 inhibitors has been associated with euglycemic ketoacidosis with effects lasting beyond 5 elimination half-lives.[34] The US Food and Drug Administration (FDA) recently approved a label change recommending before elective surgery, a 3-day cessation of canagliflozin, dapagliflozin, and empagliflozin and a 4-day cessation of ertugliflozin.[35,36] Therefore, these drugs should be stopped 3 to 4 days before surgery.

Alpha-glucosidase inhibitors may be continued for cases later in the day if the patient is allowed to eat on the morning of surgery.[32] However, if the patient is fasting, these medications need to be held on the day of surgery and resumed when oral intake resumes.

Noninsulin Injectables. Currently available noninsulin injectables include glucagon-like peptide 1 (GLP-1) receptor agonists, dual GLP-1 receptor and glucose-dependent insulinotropic polypeptide (GIP) receptor agonists, and amylin mimetics (Table 3). Structurally, there are 2 broad categories of these agents: the GLP-1 backbone agents and the exendin-4 backbone agents (exenatide). The associated risk of hypoglycemia when using these agents is low.[37] The most common side effect limiting their use is gastrointestinal symptoms including nausea, vomiting, and diarrhea. Recent reports of delayed gastric emptying in patients taking semaglutide, which is administered weekly, suggest the need to extend fasting duration or confirm gastric emptying by ultrasound, or treat the patient as having a "full stomach."[38]

The recent American Society of Anesthesiologists Consensus-Based Guidance on Preoperative Management of Patients (Adults and Children) on Glucagon-Like Peptide-1 (GLP-1) Receptor Agonists recommend holding GLP-1 agonists on the day of the procedure/surgery for patients on daily dosing, and for patients on weekly dosing, holding GLP-1 agonists the week before the procedure/surgery. The Guidance Statement recommends following the current ASA fasting guidelines for patients on GLP-1 agonists.[39]

The other type of injectable drug is an amylin mimetic, also an incretin. Mimicking amylin, a hormone produced by the pancreas, inhibits the release of glucose and helps to lower postmeal glucose levels. Amylin is taken with meals and has a higher risk of causing hypoglycemia (particularly when given with insulin) than the GLP-1 agonists. Amylin should be held on the morning of surgery and resumed once the patient is eating normally.[40]

How Are Preoperative Insulin Therapy and Insulin Pumps Managed?

There is a paucity of definitive evidence guiding the administration of insulin before ambulatory surgery; as such, perioperative dosing needs to consider the goals of patient safety and perioperative glycemic control as emphasized in the 2010 SAMBA consensus statement.[4] Preoperative insulin dosing should be based on several factors including the patient's usual insulin regimen, concomitant use of additional hypoglycemic medications (oral and injectable), the type and delivery method of insulin, the patient's comfort with and ability to check BG levels, the level of usual glucose control, and the patient's risk for hypoglycemia (based on history, usual fasting BG, and length of expected fasting) (Table 4).

Patients With Type I Diabetes Mellitus. Patients with type 1 DM are insulin deficient and require basal insulin dosing to mimic physiologic insulin release required to maintain glucose levels overnight and while fasting. These patients are usually receiving a combined regimen that includes long-acting insulin

Table 2. Oral Antidiabetic Drugs: Pharmacology and Instructions to Patients

Drug class	Mechanism of action	Typical doses	Day of surgery recommendation	Additional considerations
Biguanides	Decreases hepatic glucose production and intestinal insulin absorption; increases insulin sensitivity	Metformin: 500–100 mg po BID Metformin ER: 1000–2000 mg po QHS	Take unless eGFR <45 mL/min and/or procedure includes nephrotoxic agents (eg, contrast dye)	• Initiation therapy may cause nausea and diarrhea • Contraindicated with eGFR <30 mL/min
Sulfonylureas	Stimulates pancreatic beta islet cell insulin release	Glimepride: 1–4 mg po QD Glipizide: 2.5–20 mg po QD (or split BID) Glyburide: 1.25–20 mg po QD (or split BID)	Hold	• Increased likeliness of hypoglycemia in the fasting period compared to other classes of oral agents • Often administered in combination with other oral agents
Meglitinides	Stimulates pancreatic beta islet cell insulin release	Nateglinide: 60–120 mg po TID 15–30 min before meals Repaglinide: 0.5–4 mg po TID 15–30 min before meals	Hold	• Decreased risk of nocturnal hypoglycemia or in setting of meal omission compared to sulfonylureas
Thiazolidinediones	Decreases hepatic gluconeogenesis, increases insulin-dependent glucose uptake in muscle and fat; increases insulin sensitivity	Pioglitazone: 15–45 mg po QD	Take	• FDA black box warning: can cause or exacerbate heart failure; should not be used in NYHA Class III–IV CHF • Caution in patients at risk of, or experiencing, increased fluid retention
DPP-4 inhibitors	Inhibits DPP-4, slowing incretin metabolism, increasing insulin synthesis and release; decreases glucagon levels	Sitagliptin: 100 mg po QD[a] Linagliptin: 5 mg po QD Alogliptin: 25 mg po QD[a] Saxagliptin: 5 mg po QD[a]	Take	• Minimal risk of hypoglycemia • Associated with risk of nausea and vomiting, most commonly with therapy initiation, abates with continued use
SGLT-2 inhibitors	Inhibits SGLT-2 receptors, reducing glucose/sodium reabsorption, increasing urinary glucose excretion	Dapagliflozin: 5–10 mg po qam Canagliflozin: 100–300 mg po Empagliflozin: 10–25 mg po qam Ertugliflozin: 5–15 mg po qam	Hold 3 d before surgery except ertugliflozin hold 4 d prior	• FDA warning for increased risk of developing Fournier gangrene, urinary tract infections and euglycemic ketoacidosis • Avoid in patients with reduced renal function
GLP-1 receptor agonist	Activates GLP-1 receptor increasing insulin secretion, decreasing glucagon secretion; delays gastric emptying	Semaglutide: 7–14 mg po	Hold	• FDA black box warning: contraindicated in patients with medullary thyroid cancer or multiple endocrine neoplasia syndrome type 2 • Associated with nausea, vomiting and diarrhea
Alpha glucosidase inhibitors	Delays glucose absorption	Acarbose: 50–100 mg po TID with meals Miglitol: 50–100 mg po TID with meals	Hold for morning surgery (may take if patient eats morning meal)	• Flatus common due to resulting colonic starch formation • Avoid in patients with serum creatinine > 2 mg/dL

Abbreviations: FDA, Food and Drug Administration; CHF, congestive heart failure; DPP, dipeptidyl peptidase; eGFR, estimated glomerular filtration rate; GLP, glucagon-like peptide; Metformin ER, Metformin extended-release; NYHA, New York Heart Association; po, by mouth; qam, every morning; QD, once daily; QHS, at bedtime; SGLT, sodium glucose co-transporter; TID, three times a day.

[a]Adjust dose with reduced kidney function.

to cover background insulin needs (basal dosing), and rapid-acting insulin analogs (RAIA) to cover meals and correction of hyperglycemia (bolus dosing).[4,18,41] Existing guidelines and literature advocate for minimal disruption in the patient's usual insulin regimen to maintain optimal BG control and minimize glycemic variability during the perioperative period.[19,32,42]

Patients with type 1 DM who do not experience nocturnal, nor morning hypoglycemia when required to skip breakfast, may administer their full dose of nighttime peakless basal insulin, the night before surgery. Those who report morning hypoglycemia or hypoglycemia with missed meals need to reduce their nighttime dose to 80% the night before surgery.[20] Patients administering twice daily peakless insulin (eg, detemir) should take their usual morning dose of basal insulin if they do not experience frequent hypoglycemia.

Table 3. Noninsulin Injectables: Pharmacology and Instructions to Patients

Agent class	Mechanism of action	Typical doses	Day of surgery instructions	Additional considerations
GLP-1 receptor agonist GLP-1 backbone structure	Activates GLP-1 receptor increasing insulin secretion, decreasing glucagon secretion; delays gastric emptying (incretin mimetic)	Dulaglutide: 0.75–4.5 mg SC weekly Liraglutide: 1.2–1.8 mg SC daily Semaglutide: 2–5 mg SC weekly	Hold	• FDA black box warning: contraindicated in patients with medullary thyroid cancer or multiple endocrine neoplasia syndrome type 2 • Associated with nausea, vomiting and diarrhea
GLP-1 receptor agonist exendin-4 backbone structure	Activates GLP-1 receptor increasing insulin secretion, decreasing glucagon secretion; delays gastric emptying (incretin mimetic)	Exenatide: 2 mg SC weekly	Hold	• Avoid in patients with eGFR <45 mL/min • FDA black box warning: contraindicated in patients with medullary thyroid cancer or multiple endocrine neoplasia syndrome type 2 • Associated with risk of nausea, vomiting and diarrhea
Dual GLP-1 receptor agonist and GIP receptor agonists	Activates GIP and GLP-1 receptors increasing insulin secretion, decreasing glucagon secretion; delays gastric emptying (incretin mimetic)	Tirzepatide: 5–15 mg SC weekly	Take (may hold if patient experiences nausea/vomiting commonly after administration or if at a high risk for PONV)	• FDA black box warning: contraindicated in patients with medullary thyroid cancer or multiple endocrine neoplasia syndrome type 2 • Associated with nausea, vomiting and diarrhea
Amylin agonists	Suppresses plasma glucagon secretion, slows gastric emptying, promotes satiety; decreases postprandial glucose rise	Pramlintide: Type 1 DM: 30–60 µg SC qac Type 2 DM: 120 µg SC qac	Hold	• Avoid with eGFR <15 mL/min • FDA black box warning: use with insulin increases risk of severe hypoglycemia

Abbreviations: DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; FDA, US Food and Drug Administration; GIP, glucose-dependent insulinotropic polypeptide; GLP, glucagon-like peptide; PONV, postoperative nausea and vomiting; SC, subcutaneous.

Insulin pumps administer a continuous basal dose of rapid-acting insulin, and patients self-administer bolus doses via the pump for meals and to correct hyperglycemia. In patients with type 1 DM with more stringent targets (BG <110 mg/dL), the basal rate may be adjusted to 80% to minimize the risk of hypoglycemia in the perioperative setting.[43] Patients with type 1 DM may give themselves the usual correction dose of RAIA for hyperglycemia that occurs overnight or on awakening, or may wait to do so until they arrive at the facility and consult with the anesthesiologist.[18,44]

If possible, the patient should confer with the treating endocrinologist regarding surgery to determine safe infusion rate based on timing of surgery and expected fasting period.[45] Alternatively, the patient can be instructed to maintain the CSII basal rate on the morning of surgery.[46] Patients should be advised to check their BG on the morning of surgery, and to make pump adjustments to manage hyperglycemia.[47] If hypoglycemia occurs, the rate should be reduced in accordance with their sick day plan or the endocrinologist's recommendation. If on the morning of surgery, the patient's BG is <100 mg/dL (5.6 mmol/L), the pump should be suspended, and BG monitored every 30 minutes until > 100mg/dL. If the blood glucose falls below 70mg/dL, treatment according to hypoglycemic protocol should be initiated. (See Question 10).

Patients With Type 2 Diabetes Mellitus. Most commonly, patients with type 2 DM receiving insulin administer a peakless long-acting insulin once or twice daily. Some patients may additionally administer mealtime or correctional insulin. Patients using supplemental insulins will need a different preoperative dosing schedule than patients with type 1 DM.[32] Two studies, 1 observational and 1 randomized trial, published since the 2010 SAMBA consensus statement, specifically looked at basal insulin nighttime dosing with glargine before ambulatory surgery.[41,48] The observational study enrolled only patients with type 2 DM , while the randomized study included 18% patients with type 1 DM. Despite some limitations, the results of these studies suggest that it is prudent to reduce glargine dosing by 20% to 25% in patients with type 2 DM the evening before surgery.

Preoperative dosing of intermediate and combination insulins should be guided by the incidence of nighttime or morning hypoglycemia. Since it is not possible to separate out the rapid- and

Table 4. Insulin: Pharmacology and Instructions to Patients

Insulin regimen	Dose administration and frequency	Onset, peak, and duration	Day before surgery	Day of surgery
Ultra-long-acting insulin	Insulin glargine 300 U/mL (Toujeo): subcutaneous once daily (or twice daily) Insulin degludec (Tresiba): subcutaneous once daily (or twice daily)	Onset: 6 h Peak: none Duration: 36 h (glargine), 42 h (degludec)	Type 1 DM: administer full dose[a] Type 2 DM: administer 75%–80% of daily dose	If twice daily dosing, take 75%–80% of usual morning dose
Long-acting insulin	Insulin glargine 100 U/mL (Lantus, Semglee, Basaglar): subcutaneous daily or twice daily Insulin detemir (Levemir): subcutaneous daily or twice daily	Onset: 1–2 h Peak: none Duration: 12–24 h (detemir), 24 h (glargine)	Type 1 DM: administer full dose[b] Type 2 DM: administer 75%–80% of daily dose	If twice daily dosing, take 75%–80% of usual morning dose
Intermediate-acting insulin	Insulin NPH (Novolin N, Humulin N): SC daily or subdivided doses twice daily	Onset: 1–2 h Peak: 4–14 h Duration: 10–24 h	Administer 75%–80% of evening dose	Take 50% if BG >160 mg/dL Hold for BG <160 mg/dL
Short-acting insulin	Human regular (Novolin R, Humulin R): subcutaneous two to four times daily before meals or to correct hyperglycemia	Onset: 30 min Peak: 2–3 h Duration: 4–6 h	Administer usual daily dose	Hold
Rapid-acting insulin	Insulin lispro (lispro, Admelog, Humalog 100, Humalog 200) Insulin aspart (Fiasp, Novolog) Insulin glulisine (Apidra): subcutaneous two to four times daily before meals	Onset: 15 min Peak: 1–2 h Duration: <6 h Fiasp onset time = 2.5 min	Administer usual daily dose	Type 1 DM: can administer for hyperglycemia Type 2 DM: hold

Abbreviations: BG, blood glucose; DM, diabetes mellitus; SC, subcutaneous.
[a]Reduce dose to 80% of usual daily dose if patient experiences nocturnal or morning hypoglycemia.
[b]Reduce dose to 80% of usual evening dose if patient experiences nocturnal or morning hypoglycemia.

intermediate-acting components of combination insulin, the task force recommends the same dosing approach for intermediate and combination insulins.[18,44] Evening doses should be reduced to 75% of the usual dose and morning dose reduced to 50% of the usual dose, or held if BG levels are <160 mg/dL (8.9 mmol/L).

There is scarce evidence guiding the perioperative dosing of concentrated peakless insulins (Glargine U300 instead of the usual U100). These insulins are typically administered every 24–36 hours and have a lower risk of hypoglycemia compared to their less concentrated counterparts.[49,50] However, with longer fasting times and/or in patients with concomitant use of oral or injectable hypoglycemic agents, caution is advised.[20] The task force recommends holding these insulins on the day of surgery and closely monitoring BG while fasting.

Is There a Preoperative HbA1C Level Above Which One Should Postpone Elective Surgery?

Several studies report an association between elevated A1C levels and poor postoperative outcomes. However, most of these studies are retrospective and do not adequately account for the contribution of perioperative BG excursion or variability, or day of surgery treatment.[51,52] Data indicates that in the setting of elevated A1C, postoperative BG concentrations and variability are higher, both of which are also associated with adverse surgical outcomes.[53,54] Preoperative medication adjustment and education in patients with A1C >8%, has been shown to improve BG concentrations on the day of surgery; however, it is unclear if this positively impacts surgical outcomes.[55] Obtaining significant change in A1C levels has been reported to take several months and may be unachievable for some diabetics. In a study examining patients with DM (n=404) presenting for total joint arthroplasty whose surgery was delayed to achieve A1C ≤7%, 60% required a median of 141 days to achieve control, while the remainder were unable to achieve the A1c goal of 7% (range, 7 to 1043 days) limiting their access to joint surgery.[56] A study in patients with A1C ≤8%, found that 10.4% had BG ≥180 mg/dL immediately before surgery, indicating that a small but significant portion of patients with "good" glycemic control can arrive on the day of surgery with hyperglycemia.[57]

The 2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing elective noncardiac surgery, recommend postponing surgery for preoperative HbA1C > 8.5%. The SAMBA Task Force did not find sufficient evidence to support this position for patients undergoing ambulatory surgery.[58] In the absence of definitive evidence indicating that postponing surgery to achieve a certain A1C would improve outcomes, the task force does not

recommend postponing elective surgery based on A1C levels. Nevertheless, A1C levels indicate glycemic management and control, providing an opportunity for referral if the patient is not under the care of a physician or endocrinologist. Also, if significantly elevated (>9%), it provides the opportunity to notify the surgeon particularly in cases where risk of hyperglycemia portends worse outcomes (eg, total joint arthroplasty, vascular surgery, and spine surgery with instrumentation) such that a plan can be made for continued monitoring and treatment, or referral for medication adjustment or initiation.

Is There a Preoperative Blood Glucose Concentration Above Which One Should Postpone Ambulatory Procedures?

Patients presenting for ambulatory procedures with hyperglycemia and symptoms suggestive of, diabetic ketoacidosis (DKA) or hyperglycemic hyperosmolar nonketotic syndrome (HHNS), should be transferred to an emergency department or hospital for further management and the procedure should be postponed.

If the patient presents with uncomplicated hyperglycemia (BG >180 mg/dL, 10 mmol/L), there is limited evidence suggesting that canceling a procedure to optimize BG control improves surgical outcomes. There are a variety of reasons for hyperglycemia on arrival at the ambulatory surgery facility: stress and anxiety, medication discontinuation, poor baseline control, overcorrection of a hypoglycemic episode, or response to a preoperative carbohydrate drink.[4,20,59] Thus, the task force recommends that in the absence of DKA or HHNS, patients with hyperglycemia should proceed to surgery. However, patients who arrive for ambulatory surgery with severe hyperglycemia (BG >300 mg/dL, 16.7mmol/L), due to lack of routine DM care, inability to obtain or administer home medications, or chronically elevated BG may benefit from postponement of elective surgery, unless it is a minor procedure (gastrointestinal endoscopy or cataract surgery), and referral to their physician or a diabetologist.[26,60] If an infection is suspected as the cause of hyperglycemia, discussion with the surgeon is advisable to determine optimal surgical timing.

How Should Preoperative Hyperglycemia Be Managed?

There is no evidence to suggest that short-term BG control improves outcomes in ambulatory surgery patients. Although there is evidence indicating that BG < 180 mg/dL (10 mmol/L) may improve surgical outcomes in inpatient populations,[43,61,62] the task force does not recommend aggressive treatment for chronic hyperglycemia in ambulatory surgery patients due to the risk of acute glycemic variability. The decision to allow patients to use their own short-acting correctional insulin depends on the policies of the individual ambulatory facility. Detailed discussion on insulin administration and hyperglycemia treatment is described in Question 8.

Are Preoperative Carbohydrate Drinks Appropriate for Patients With Diabetes Mellitus?

In patients without DM, the Enhanced Recovery after Surgery Society, the European Society for Clinical Nutrition and Metabolism, and the American Society for Enhanced Recovery and Perioperative Quality Initiative recommend nutrition strategies such as preoperative complex carbohydrate administration ("carbohydrate loading") to reduce perioperative insulin resistance.[63–65] However, clinical evidence of improved postoperative outcomes remains controversial.[66,67] A review of the literature did not observe conclusive evidence in favor of this practice and recommended an individualized approach based on patient needs and characteristics.[68] Recent meta-analyses and Cochrane reviews also demonstrate that in patients without DM, hydration with water offers similar benefit as preoperative carbohydrate loading.[69,70]

Carbohydrate loading in patients with type 2 DM has not been well studied, as the vast majority of studies have excluded patients with DM or those with elevated fasting BG concentrations.[71,72] Potential concerns include regurgitation and pulmonary aspiration in patients with DM with delayed gastric emptying, increased glucose variability, and perioperative hyperglycemia.[20,70] The Endocrine Society Guidelines recommend against carbohydrate-containing oral fluids in patients with DM undergoing surgical procedures.[73] The American Society of Anesthesiologists (ASA) Guidelines and a related modular update state that clear liquids up to 400 mL, may be consumed up to 2 hours before planned procedures in patients without factors that increase the risk for aspiration.[74]

Overall, due to the paucity of evidence examining carbohydrate loading in patients with DM, the potential risk of hyperglycemia, and the data supporting the benefits of preoperative water consumption (vs carbohydrate loading), the task force recommends that water be used in lieu of carbohydrate loading in the preoperative period in patients with DM.

INTRAOPERATIVE MANAGEMENT

What Is the Optimal Intraoperative Blood Glucose Concentration?

Current recommendations for optimal intraoperative BG are based on published guidelines representing a variety of national and international societies.[5–8]

These organizations recommend maintaining BG <180 mg/dl (<10 mmol/L). This target is based primarily on hospitalized patients; there is limited evidence directly assessing these targets in ambulatory surgery patients. A prospective multicenter cohort study, assessing hyperglycemia during ambulatory surgery and associated outcomes, found that minor ambulatory surgery did not result in a clinically relevant glucose change in patients with or without DM[3] albeit the population of patients with DM included was small (<5%) and an even smaller percentage of these patients were type 2 DM patients on oral antidiabetic agents or insulin.

Ambulatory patients are, however, in an environment that does not mimic the inpatient setting. Ambulatory patients often undergo short procedures (eg colonoscopy, cataracts surgery, etc.) and have a limited time frame to achieve a target BG of 180 mg/dL (10 mmol/L). They also return home quickly, and can rapidly resume antidiabetic therapy, limiting the need for more intensive insulin regimens. Therefore, a pragmatic approach combining clinical judgment with an ongoing assessment of the patient's status including anticipated changes in BG level based on procedure invasiveness and length, patient comorbidity, baseline BG control, access to preoperative DM care, adherence to home medication regimen, and concomitant medications that can affect BG levels (eg, glucocorticoids), should be incorporated into the decision.[20,75] Also, for patients presenting with poorly controlled chronic hyperglycemia, a higher target BG level may be acceptable.[76] The task force recommends insulin with more liberal treatment targets of 180–250 mg/dL permitted based on patient and procedure characteristics.

How Should the Optimal Blood Glucose Concentrations Be Maintained?

There is insufficient data to determine the best strategy or regimen to attain target BG concentrations in ambulatory patients with DM. Insulin therapy should be initiated for the treatment of hyperglycemia to achieve BG target range based on the patient's baseline BG control, the invasiveness and length of surgery, anticipated perioperative risk, and the pharmacodynamic and pharmacokinetic considerations of insulin used (type and route of administration).[20,75] It is recommended that each facility create and follow a BG management protocol because patients managed using standardized glycemic management order sets demonstrate improved BG control.[62]

Type of Insulin: Regular Versus Rapid Acting. There are no randomized controlled trials comparing outcomes and adverse events between using regular insulin or rapid-acting insulin to treat hyperglycemia in ambulatory patients. Pharmacological differences between insulin types demonstrate that rapid-acting insulin offers an advantage in the surgical patient population. These insulins are absorbed quickly (10–15 minutes) resulting in an earlier onset of therapeutic effect, and peak in 30–60 minutes, allowing providers to recheck BG levels to ensure appropriate response and monitor for hypoglycemia. This offers an improved safety profile, particularly for patients undergoing shorter surgeries, and allows for expeditious discharge. Regular insulin has an onset of therapeutic effect within 30–60 minutes after subcutaneous (SQ) administration with peak effect occurring in 2–4 hours, indicating that several patients treated with regular insulin may be discharged from the surgical facility before the medication effect can be safely evaluated.[77]

Route of Insulin Administration. Studies demonstrate that subcutaneous rapid-acting insulins quickly and safely correct elevated BG concentrations in patients at risk for complications from significant hyperglycemia, indicating a comparable effect to intravenous regular insulin infusion.[78,79] However, a single intravenous bolus dose of regular insulin has a short duration of action, which requires repeated dosing and close monitoring. Therefore, the task force recommends the use of subcutaneous insulin to correct hyperglycemia in the ambulatory setting with the following exception: intravenous insulin boluses may be appropriate when severe hyperglycemia (>300 mg/dL) is detected in the absence of DKA or HHNS and the patient is undergoing a short procedure.

Insulin Correction Factor. The insulin correction factor (also called an "insulin sensitivity factor") is frequently used to calculate the amount of insulin required to bring the BG into the target range. The original formula calculating the correction factor was based on the use of regular SQ insulin and is commonly referred to as the "1500 Rule." The formula was later revised to use 1800 as the numerator to account for shorter-acting insulins being increasingly prescribed for patients with DM.[80] Current insulin-dosing guidelines provided by the AACE/ACE Consensus Statement recommend the following formulas: correction factor is equal to 1800 divided by the total daily dose of insulin, whereby correction factor represents the expected decrease in BG per 1 unit of insulin administered.[81] The total daily dose is equivalent to the patient's daily amount of basal, prandial, and correctional insulin. Type 1 DM patients have a higher insulin sensitivity factor than type 2 DM patients, the former requiring less insulin to decrease BG levels. For type 1 DM patients,

correctional dosing with a rapid-acting insulin can be calculated with the following formula: measured glucose minus 100 divided by the insulin sensitivity factor. Insulin sensitivity factor is equal to 1800 divided by the patient's total daily dose of insulin. If the total daily dose is not available or if a patient is using only oral medications at home, a sensitivity factor (denominator) of 40 provides a safe calculation for a correctional insulin dose.[43]

What Is the Optimal Perioperative Blood Glucose Monitoring, and How Should Continuous Glucose Monitors Be Managed?

The frequency of BG monitoring depends on several factors. Patients with DM undergoing short outpatient procedures (<2 hours) only require BG check using the facility's POC glucometer on admission and before discharge home. Patients requiring insulin treatment and/or those undergoing longer (>2 hours) outpatient procedures require more frequent monitoring.[43,82,83] Patients administered SQ rapid-acting insulin need a repeat BG check within 90–120 minutes. Patients who develop hypoglycemia, require close BG monitoring (every 15–30 minutes) until adequate correction to safe BG concentrations.[43]

Glucometer Standards. POC glucometers are commonly used to monitor BG levels and to facilitate rapid treatment decisions due to their ease of use and bedside availability. Currently, there are 2 standards guiding accuracy for glucometers: the International Organization for Standardization (ISO) standards for Europe and the FDA standards for the United States. Glucometers are only required to meet standards at the time they were manufactured, which may not reflect current accuracy standards.[84] Therefore, it is critical that these devices undergo regular analysis for performance via ongoing quality assessment.

The Diabetes Technology Society Blood Glucose Monitoring System Surveillance Program provides information on the performance of devices used for BG monitoring. The BG measurements from POC devices differ from the laboratory blood or capillary glucose measurements.[8,21,44] The FDA allows for a 15% error in BG levels below 100 mg/dL and 20% for readings above 100 mg/dL. Current FDA guidelines mandate that 95% of all glucometer values be within 12% of the reference value for BG >75 mg/dL (4.2 mmol/L) and within 12 mg/dL for BG measurements <75 mg/dL.[84] Of note, the FDA only allows POC glucometers labeled as "approved for hospital use," to measure BG in hospital and health care environments. Factors such as hypoglycemia, oxygen administration, hypotension, vasopressor use, anemia, pH changes, active warming or cooling, or vitamin C excess, may cause inaccurate readings. Nevertheless, POC glucose meter readings are considered accurate during times of homeostasis, typical in patients undergoing ambulatory procedures.

Continuous Glucose Monitors. Real-time CGM provides frequent measurements of BG, as well as the direction and magnitude of BG change. These monitors sample BG intravascularly or within interstitial fluid. The frequency of measurement occurs every 1–15 minutes, most commonly every 5 minutes. CGMs have several theoretical advantages over POC testing: decreased number of finger sticks, increased frequency of BG measurements, and increased detection and prevention of hypoglycemia.[85] During the coronavirus disease-2019 (COVID-19) pandemic, the FDA issued guidance stating that they "did not object" to the use of CGM devices in the inpatient setting with the objective of conserving personal protective equipment and mitigating staff exposure.[86] Literature suggests that CGM devices may be safely incorporated in the inpatient setting.[87–90] Intraoperative electromagnetic interference has been demonstrated in patients using CGMs.[91]

A CGM system may be used alone, or in conjunction with a wireless connection in a feedback loop system with CSII systems. The 2 components, CGM and CSII, may also be fully integrated into a single unit, an automated insulin dosing system. Elective surgery preplanning and admission preparation allows for the appropriate use of CGMs and automated insulin dosing systems in the perioperative setting.[85] However, CGMs are not reliable in determining BG or guiding treatment decisions in patients with skin infections near sensor site, significant edema or significant fluid shifts[85] or severe hypoglycemia (<40 mg/dL, 2.2 mmol/L), or hyperglycemia (>500 mg/dL, 27.8 mmoL/L).[92]

Given the lack of evidence in the ambulatory setting, the task force recommends the use of POC glucose meters to confirm the accuracy of CGMs and automated insulin dosing systems for periprocedure BG management especially before initiating therapeutic measures for BG management.

How Should Perioperative Hypoglycemia Be Identified and Managed?

Increased vigilance is required in the perioperative period because patients undergoing general anesthesia and sedation will not manifest or express symptoms of hypoglycemia. To prevent adverse sequalae, hypoglycemia requires early detection and immediate correction.[93] Hypoglycemia is classified as level 1 hypoglycemia when BG <70 mg/dL (3.9 mmoL/L) and is identified as an alert value to adjust insulin dosing and provide rapid carbohydrate or glucose treatment.[94,95] Level 2 is defined by BG <55 mg/dl (3.1

mmol/L) without hypoglycemic symptoms. Level 3 hypoglycemia is indicated by altered mental or physical functioning that requires assistance from another person for recovery, independent of measured BG levels.[95]

Hypoglycemia is more common among older patients, those with multiple or advanced comorbid diseases, cognitive impairment, frailty, long DM duration, and use of multiple glucose-lowering medications.[96] Iatrogenic factors that increase the risk of developing hypoglycemia include aggressive glycemic targets, poor provider communication, administration of insulin without adjustment for fasting, and failure to monitor BG levels.[97,98]

Every facility should implement a hypoglycemia management protocol that entails a plan for both the prevention and treatment of hypoglycemia as well as optimal frequency of BG monitoring.[99] Episodes of hypoglycemia in the facility should be documented in the medical record and tracked for quality improvement/quality assessment.

Prevention. All patients with DM undergoing outpatient surgery should be educated about the signs and symptoms of hypoglycemia. It is recommended that patients check their BG the morning of surgery and if levels are low, initiate treatment and notify the ambulatory surgery facility. Additionally, ambulatory surgery patients should travel with appropriate hypoglycemic treatment. For patients who are fasting, treatment may include 4 to 8 oz of clear juice or 15 to 20 g of glucose in gel form. If the patient has arrived at the ambulatory facility, intravenous dextrose can be initiated as an alternative treatment. Treatment should be repeated until BG levels increase and hypoglycemic symptoms resolve.[4]

How Should Insulin Pumps Be Managed in the Ambulatory Setting?

The prevalence of patients with DM managed with CSII, with or without integrated CGM, continues to increase, compelling ambulatory surgery facilities to develop periprocedure device management protocols. Despite the increasing prevalence of CSII, there is minimal data to outline safe and optimal use of CSII in the ambulatory setting. A study to establish safety and efficacy of CSII in patients with DM undergoing same-day surgery, found that patients undergoing surgery <2 hours had lower postoperative BG levels (<200 mg/dl) as compared to those undergoing longer procedures despite similar admission BG.[100] Of note, there were no episodes of hypoglycemia in any patient treated with CSII.[100]

Insulin pump failures can lead to adverse events related to either hyperglycemia or hypoglycemia and are most frequently due to mechanical failures, blockages within the infusion set, infusion site complications, instability of the insulin stored within the pump, and user error. Safeguards should be in place to maintain patient safety and prevent hyperglycemia and hypoglycemia, including securing the infusion site and tubing away from the surgical field, insertion site inspection, isolating the pump from accidental contact, and BG monitoring. Because CSII pumps may fail after exposure to ionizing radiation or electromagnetic fields or malfunction when exposed to electrocautery, it is necessary to protect them from exposure or remove them if it is not possible to avoid exposure.[101]

For patients using CSII, the basal rate can be continued or reduced by 20% for patients who maintain more stringent home BG targets. Of note, the BG levels need to be checked hourly.[43,47,102] If BG levels are <100 mg/dL, the infusion is suspended, and BG checked every 30 minutes until the BG level increases. If hyperglycemia develops, correctional insulin should be provided to maintain BG levels in the target range.[47]

The task force suggests continuing CSII for procedures under 2 hours if the device can be placed outside of the surgical field and can be easily visualized and accessed. The decision to use CSII during longer procedures depends on acuity of the procedure, anticipated volume shifts, and/or vasopressor use. If the pump is not used during surgery in a type 1 diabetic patient, frequent BG monitoring and insulin administration is necessary to prevent DKA. If CSII and tubing are removed, the equipment should be safely stored because replacement costs may limit postoperative use and subsequent safe DM management.[102] The pump should be replaced before discharge, to ensure the device is connected and functioning appropriately.

Should an Insulin-Naïve Patient Receive Insulin to Optimize Blood Glucose Concentrations?

Current evidence does not demonstrate a greater hypoglycemic response to perioperative insulin administration in hospitalized patients with DM without prior insulin therapy compared to those on insulin.[103,104] However, as described above, inpatient literature may not always be applicable to the ambulatory setting. Therefore, before administering insulin to insulin naïve ambulatory patients, it is necessary to consider specific patient and procedure characteristics as well as the facility setting. The task force suggests that significant periprocedure hyperglycemia (BG >250 mg/dL) in insulin naïve patients may be treated with insulin based on patient and procedure characteristics. When possible, determining the patient's insulin sensitivity before treatment is recommended to minimize the risk of hypoglycemia.[43]

Should Patients Receive Long-Acting Insulins in Ambulatory Surgery Facilities?

There is no evidence addressing this question in the current literature. Administration of long-acting insulins in the ambulatory setting may not be possible, since it is unlikely that ambulatory facilities stock long-acting insulin because they are infrequently administered and expensive. Also, patients' home medications are not typically used at facilities because home medications may not meet the facility standards for storage and maintenance and due to the need to implement safeguards including staff training.

Is Intravenous Dexamethasone Appropriate in Patients With Diabetes Mellitus?

Dexamethasone is routinely administered in the perioperative period for the prevention of postoperative nausea and vomiting (PONV),[105] and as a component of multimodal pain therapy.[106] Several studies have reported increased postoperative BG levels in patients with and without DM receiving dexamethasone.[107–109] Predictors of postoperative hyperglycemia include preoperative BG levels, duration of surgery, and dose of insulin administered in the periprocedure period.[110] Additionally, increase in BG levels was observed with dexamethasone 8 mg as compared to the 4 mg dose.[110] Dexamethasone 8 mg IV given to diabetic and nondiabetic patients undergoing elective noncardiac surgery was not inferior to placebo with respect to surgical-site infection.[111] However, patients with poorly controlled DM (A1C >9%) were excluded.[111] The task force recommends the use of low-dose (4 mg) dexamethasone in patients with DM. The use of dexamethasone in patients with type 1 DM and patients with poorly controlled type 2 DM (A1C >9%) should be individualized.

POSTOPERATIVE MANAGEMENT

What Are the Discharge Considerations for Surgical Outpatients With Diabetes Mellitus?

Before discharge from the ambulatory facility, a patient with DM must meet standard discharge criteria. Transfer of care reports from the operating room to the PACU should include information about the patient's type and duration of DM, report of preoperative and intraoperative BG levels, as well as any treatment provided for hyper- or hypoglycemia. BG should be checked on arrival to the PACU. Treatment should be immediately provided for hypoglycemia. Insulin dosing needs to account for previous dose and timing of intraoperative insulin (if given) to prevent insulin stacking which increases the risk of hypoglycemia and adverse outcome. Patients who have received perioperative insulin and are unable to resume oral intake should be observed until the risk of hypoglycemia can be ruled out (usually 1.5 hours for rapid-acting insulin and 3–4 hours for regular-acting insulin).

The United Kingdom's National Health Service (NHS) guidelines recommend the development of discharge protocols with the plan for the patient to resume routine DM care as soon as possible.[19] A joint French diabetology and anesthesiology position statement recommends a referral to a diabetologist for patients with inappropriate preoperative DM control (A1C <5% or >8%), newly diagnosed DM on preoperative anesthesia consultation, or BG levels >300 mg/dL during ambulatory surgery.[26] The recent ADA "Standards of Medical Care in Diabetes" recommends a structured discharge plan tailored to the individual patient, with potential to reduce readmission rates and increase patient satisfaction.[5]

What Is Some Advice for Patients With Diabetes Mellitus for Glucose Control and Medication Management After Being Discharged?

Discharge planning should begin at time of surgical scheduling such that a plan is in place for the patient's oral medications, insulin and noninsulin injectables for those whose surgical procedure mandates reduced oral intake.[5] At discharge, patients need to be provided specific instructions regarding DM management including oral medications and insulin resumption, considerations for diet disruption, encouragement of home BG testing, and a physician contact for concerns pertaining to postoperative BG management. Additionally, education should be provided to patients regarding the recognition, treatment, and prevention of hyperglycemia and hypoglycemia.[20]

Oral medications and injectables should be resumed with food intake. Caution should be exercised when restarting antidiabetic medications if the patient experienced severe PONV. If the surgical procedure precludes normal postoperative diet (eg, oral surgery), antidiabetic medications need to be adjusted accordingly. When transitioning back to the home regimen, the discharging physician must ensure that the peak effect of any perioperatively administered insulin has been communicated to the patient to minimize overlap with oral hypoglycemic agents.[82] Long-acting evening insulin should be administered when the patient returns home and tolerates a normal meal. Patients with insulin pumps should return to typical pump dosing when adequate oral intake is tolerated. Before that time, the "sick day" protocol may be used or infusion rate decreased as recommended by the patient's endocrinologist.[47,83,112]

MISCELLANEOUS

What Are Other Considerations Specific to Glycemic Control in Outpatients?

It has been recommended that patients with DM be scheduled earlier in the day to reduce the duration of fasting and perturbations in medication management.[4] Decreased fasting times limit the risk of hypoglycemia, may improve BG control, facilitate recovery, and discharge home.

Protocols to aid in the perioperative care of patients with DM frequently describe a multidisciplinary approach involving diabetologists, surgeons, anesthesiologists, and nurses. The Joint British Diabetes Society proposed utilizing a comprehensive care pathway for the management of the surgical patients with DM, similar to an enhanced recovery after surgery multidisciplinary pathway including the involvement of the general practitioner.[113] Regardless of the specifics, studies demonstrate that such protocols improve BG management including monitoring and BG control, particularly in patients with CSII.[62,100,114] The task force recommends each facility develop and implement a blood glucose management protocol.

What Are the Areas for Future Research on Perioperative Blood Glucose Management in Adult Patients With Diabetes Mellitus Undergoing Ambulatory Surgery?

Large, prospective, adequately powered, well-designed trials are necessary to examine the following questions specific to the ambulatory setting.

1. What are the risks of hyperglycemia/hypoglycemia in patients undergoing ambulatory procedures?
2. What predictors (eg, BG and A1c levels, and other comorbidities) suggest delaying ambulatory surgery?
3. Does administration of oral and injectable antidiabetic medications on the day of surgery improve perioperative glycemic control, decrease glucose variability and improve perioperative outcomes?
4. What is the optimal timing for preoperative administration of oral and injectable antidiabetic medications?
5. Does preoperative carbohydrate loading improve perioperative outcomes or increase risks in patients with DM? Are there differences between patients with type 1 and patients with type 2 DM?
6. What is the optimal target BG for ambulatory procedures. Are there differences in optimal target BG for high-risk versus low-risk patients and procedures?
7. Are there differences in optimal BG management (eg short- and long-term control, day of surgery BG targets, insulin type/dosing) in type 1 versus type 2 DM in the ambulatory setting?
8. Compared to POC BG monitoring, when and how can CGM be used to guide insulin therapy during and after ambulatory surgery?
9. Do automated insulin delivery systems offer improved BG control in ambulatory setting as compared to current POC BG monitoring and provider-administered insulin?
10. Are there differences in patient outcomes between the various routes of administration of insulin?
11. What is the optimal dexamethasone dosing in diabetic outpatients?
12. Does the scheduled time of the surgery (ie, early versus late) have a significant influence on perioperative outcomes, and if so, is there a patient subpopulation particularly impacted?
13. What is the impact of anesthetic technique (local/regional anesthesia, sedation/analgesia technique, general anesthesia) on BG control in outpatient procedures?

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