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Interprofessional Strategies for Optimizing Perioperative Glycemic Control: Evidence-Based Approaches for Pharmacists, Anesthesiologists, and Nursing Professionals in the Management of Patients with Diabetes

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Abstract

Background: The increasing prevalence of diabetes mellitus has intensified the need for effective perioperative glycemic control to reduce surgical complications. Hyperglycemia during surgery is linked to poor outcomes, including infections, delayed healing, and increased mortality.

Aim: This article aims to present evidence-based, interprofessional strategies for managing perioperative glycemic control in diabetic patients, emphasizing the roles of pharmacists, anesthesiologists, and nurses.

Methods: A comprehensive review of current guidelines and clinical trials was conducted, focusing on perioperative glucose targets, insulin regimens, and medication adjustments. The article synthesizes recommendations from major professional societies and integrates findings from randomized controlled trials such as NICE-SUGAR and SITA-HOSPITAL.

Results: Optimal glycemic control (140–180 mg/dL) across perioperative phases significantly improves outcomes. Preoperative planning includes medication adjustments and HbA1c assessment. Intraoperative management favors intravenous insulin for complex surgeries, while postoperative care requires individualized insulin regimens based on nutritional intake and clinical status. Pharmacists ensure safe medication transitions, nurses provide continuous monitoring and education, and anesthesiologists manage intraoperative glucose fluctuations.

Conclusion: Effective perioperative diabetes management demands coordinated, multidisciplinary care. Structured protocols, individualized insulin therapy, and continuous glucose monitoring are essential to minimize complications and enhance recovery. Interprofessional collaboration is critical for safe transitions across surgical phases and discharge planning.

Keywords: Perioperative glycemic control, diabetes management, insulin therapy, hyperglycemia, hypoglycemia, pharmacists, anesthesiologists, nurses, interprofessional care, surgical outcomes.

1. Introduction

The rising prevalence of diabetes mellitus has led to a corresponding increase in the number of surgical procedures performed on individuals with this condition, making effective perioperative diabetes management a critical component of surgical care. Maintaining optimal glycemic control before, during, and after surgery is essential to reduce the risk of perioperative complications. Hyperglycemia, defined as blood glucose levels exceeding 140 mg/dL, is a frequent occurrence in surgical patients and serves as an independent predictor of adverse outcomes in both diabetic and non-diabetic populations. Studies indicate that the prevalence of perioperative hyperglycemia

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ranges from 20% to 40% in general surgical patients and can reach as high as 80% to 90% in those undergoing cardiac surgery [2][4][5][6]. Elevated glucose levels in the perioperative period have been consistently associated with increased morbidity and mortality, delayed wound healing, higher rates of surgical site infections, extended hospital stays, greater ICU admissions, and increased postoperative mortality [1][2][3][4]. The pathophysiology underlying perioperative hyperglycemia is closely linked to the physiological stress induced by surgery, anesthesia, and acute illness. Surgical stress triggers a surge in counterregulatory hormones, including cortisol, glucagon, growth hormone, and catecholamines [7]. These hormonal changes lead to reduced insulin secretion, increased insulin resistance, and augmented gluconeogenesis and glycogenolysis, resulting in elevated blood glucose levels. Simultaneously, heightened lipolysis and proteolysis contribute to metabolic disturbances, further exacerbating hyperglycemia. This stress-induced hyperglycemia is particularly pronounced in patients with preexisting diabetes, whose baseline glycemic control may already be compromised. Uncontrolled perioperative hyperglycemia has multiple detrimental effects on physiological homeostasis. Osmotic diuresis may occur, leading to fluid depletion and electrolyte imbalances, while ketogenesis can predispose patients to metabolic acidosis. Hyperglycemia also promotes the production of proinflammatory cytokines, which contribute to endothelial dysfunction, mitochondrial injury, and impaired immune response [8][9]. These mechanisms collectively increase the risk of infectious complications, poor wound healing, and systemic organ dysfunction. Given these risks, stringent perioperative glucose management is essential to mitigate adverse outcomes and enhance recovery.

Perioperative diabetes management requires coordinated strategies across multiple healthcare disciplines, including anesthesiology, nursing, and pharmacy. Preoperative optimization involves assessing baseline glycemic control, adjusting oral hypoglycemic agents and insulin regimens, and identifying comorbid conditions that may influence perioperative glucose metabolism. Intraoperative and postoperative care focuses on continuous monitoring of glucose levels, timely administration of insulin or other glycemic agents, and adjustment of fluid and nutritional support to maintain euglycemia. Evidence indicates that perioperative glucose control significantly improves patient outcomes, reduces complications, and shortens hospital length of stay [4][5]. Overall, the management of diabetes in the perioperative period is complex and requires an integrated, evidence-based approach. Maintaining optimal glucose levels before, during, and after surgery is associated with improved surgical outcomes, reduced postoperative complications, and enhanced patient safety. Understanding the pathophysiological mechanisms of stress-induced hyperglycemia and implementing structured interprofessional management protocols are critical for optimizing perioperative care in patients with diabetes [1][2][3][4][5][6][7][8][9].

Issues of Concern

Perioperative management of diabetes presents several challenges, primarily due to the dynamic changes in glucose metabolism caused by surgical stress, anesthesia, and underlying comorbidities. Multiple professional societies have established guidelines for optimal glucose control in the perioperative period, emphasizing both the prevention of hyperglycemia and the avoidance of hypoglycemia, which can independently increase morbidity and mortality [10]. The American Diabetes Association (ADA) recommends maintaining a target blood glucose range of 80 to 180 mg/dL in the perioperative period, with a narrower goal of 140 to 180 mg/dL for critically ill patients. These targets are designed to balance the risks of hyperglycemia-induced complications, such as surgical site infections and delayed wound healing, against the hazards of overly aggressive glucose lowering, which may result in hypoglycemic events that are equally detrimental [10]. The Society for Ambulatory Anesthesia advises maintaining intraoperative blood glucose levels below 180 mg/dL in patients undergoing ambulatory procedures. This recommendation acknowledges that even short-duration surgeries can provoke significant stress hyperglycemia and that uncontrolled glucose fluctuations increase the likelihood of postoperative complications, including infection and delayed recovery. Similarly, the Society of Critical Care Medicine recommends initiating insulin therapy for critically ill patients when blood glucose exceeds 150 mg/dL, reflecting the heightened vulnerability of these patients to metabolic derangements and systemic complications in the perioperative setting [10].

The American College of Physicians cautions against intensive insulin therapy and recommends maintaining blood glucose levels between 140 and 200 mg/dL. This approach reflects evidence that aggressive glucose lowering does not consistently improve outcomes and increases the risk of hypoglycemia, which can precipitate cardiovascular events, neurological deficits, or mortality. In contrast, the Society of Thoracic Surgeons emphasizes maintaining intraoperative glucose levels below 180 mg/dL, with pre-meal or fasting glucose levels kept below 110 mg/dL, highlighting the importance of tighter control in high-risk cardiac surgical populations where hyperglycemia is strongly associated with adverse outcomes [10]. The Endocrine Society provides guidance for non-critically ill hospitalized patients, recommending pre-meal glucose targets below 140 mg/dL and random glucose levels below 180 mg/dL. For patients with limited life expectancy, terminal illness, or high risk of hypoglycemia, a more lenient target of under 200 mg/dL is considered acceptable to minimize harm from intensive glucose management [10]. In the United Kingdom, the Joint British Diabetes Societies advocate for blood glucose levels between 108 and 180 mg/dL for most patients, allowing an acceptable range from 72 to 216 mg/dL. This flexible approach accommodates variability in individual patient factors, such as age, comorbidities, and surgical complexity, while prioritizing safety [10].

Table-1: Preoperative Insulin Adjustments.

Preoperative Insulin Adjustments		
Insulin Type	**Evening Before Surgery**	**Morning of Surgery**
Long-acting insulin*	75% to 80% of usual dose	75% to 80% of usual dose
Intermediate-acting insulin	Usual dose	50% of usual dose
Premixed insulin	Usual dose	50% of usual dose**
Nutritional insulin	Usual dose	HOLD

*Reduce long-acting insulin by 50% to 75% in patients who administer significant doses of basal insulin (>60% of TDD), administer a total daily dose of insulin >80 units, or are prone to hypoglycemia (eg, older adults, patients with advanced renal or hepatic disease, or individuals who are malnourished).
** When feasible, long-acting insulin, which is one-half of the total daily premixed insulin, is preferred over the patient's premixed formulation on the morning of surgery.

Correctional Insulin Scale				
Blood Glucose (mg/dL)	**Insulin Sensitive Scale** (TDD <40 units, insulin naïve, older than 70 years, renal or hepatic disease)	**Insulin Standard Scale**	**Insulin Resistant Scale** (TDD >80 units, BMI >35 kg/m^2, or on high-dose steroids	**Nighttime Dosing Scale** (at bedtime and 3 AM)
150-199	1	2	3	0
200-249	2	4	6	2
250-299	3	6	9	3
300-349	4	8	12	4
350-399	5	10	15	5
≥ 400	**Call provider for blood glucose ≥ 400**			

Despite these recommendations, the optimal perioperative glucose target remains a subject of debate, with no universally accepted standard. However, evidence supports maintaining blood glucose between 140 and 180 mg/dL as a reasonable goal for most perioperative patients to minimize both hyperglycemia and hypoglycemia. Effective perioperative glucose management requires structured planning across three phases: preoperative, intraoperative, and postoperative. Preoperative management involves assessment of baseline glycemic control, adjustment of antidiabetic medications, and preparation for insulin therapy if indicated. Intraoperative management focuses on continuous glucose monitoring and timely intervention to prevent excursions outside target ranges. Postoperative management emphasizes ongoing monitoring, adjustment of therapy based on nutrition and activity, and patient education to reduce the risk of delayed complications [11]. In conclusion, perioperative glycemic control is a multifaceted concern requiring individualized strategies tailored to patient-specific risk factors, surgical complexity, and underlying comorbidities. Coordination among anesthesiologists, surgeons, nurses, pharmacists, and endocrinology specialists is essential to ensure safe glucose targets, timely interventions, and improved postoperative outcomes. While target ranges vary slightly among professional societies, maintaining blood glucose between 140 and 180 mg/dL across the perioperative phases represents a practical and evidence-based approach that balances efficacy and safety [10][11].

Preoperative Phase

The preoperative phase of diabetic perioperative management is crucial for minimizing the risks associated with hyperglycemia and hypoglycemia during surgery and optimizing postoperative outcomes. A comprehensive medical history is the foundation of this phase, with particular attention to the type and duration of diabetes, current glycemic control, ongoing treatment regimens, and the presence of diabetes-related complications. These complications may include nephropathy, neuropathy, retinopathy, and cardiovascular diseases, all of which can influence perioperative risk and necessitate adjustments in management strategies [12]. A thorough understanding of the patient’s susceptibility to hypoglycemia, including prior episodes of hypoglycemia and hypoglycemia unawareness, is essential to prevent intraoperative and postoperative adverse events. For patients using antidiabetic medications, it is imperative to assess the type of therapy, dosage, timing, and adherence to ensure safe perioperative glycemic control [12]. Surgical history is equally important. Clinicians must gather information about prior surgical procedures, whether elective or emergent, ambulatory or inpatient, and the duration and complexity of these procedures. Understanding the anticipated duration of surgery and the associated fasting requirements allows for appropriate adjustment of antidiabetic therapy and minimizes perioperative metabolic instability. For patients undergoing complex or prolonged procedures, more intensive perioperative glucose monitoring and insulin management may be warranted.

Glycated hemoglobin (HbA1c) measurement provides a reliable index of long-term glycemic control and is recommended preoperatively if not assessed within the prior three months. While the association between elevated HbA1c and poor postoperative outcomes remains debated, studies suggest that higher preoperative HbA1c levels may reflect suboptimal glucose control and predict perioperative complications, including infections, delayed wound healing, and cardiovascular events [13][14][15][16][17]. Furthermore, preoperative HbA1c testing can identify undiagnosed diabetes, allowing clinicians to optimize metabolic control prior to surgery [18]. Management of oral antihyperglycemic and non-insulin injectable medications requires careful consideration due to potential perioperative risks. Metformin carries a risk of lactic acidosis in patients with renal impairment. Sulfonylureas and other insulin secretagogues increase the likelihood of hypoglycemia, particularly when combined with intravenous contrast or prolonged fasting. Sodium-glucose cotransporter-2 (SGLT-2) inhibitors are associated with euglycemic ketoacidosis during fasting or acute illness. Glucagon-like peptide-1 (GLP-1) receptor agonists may exacerbate nausea and vomiting by delaying gastric emptying. Consequently, guidelines recommend withholding these medications on the day of surgery, with SGLT-2 inhibitors requiring discontinuation 24 to 72 hours prior to surgery [19][20][21][22][23]. Recent randomized controlled trials, including the SITA-HOSPITAL trial, indicate that dipeptidyl peptidase-4 (DPP-4) inhibitors are safe and effective in medical and surgical patients with mild-to-moderate hyperglycemia, though current ADA guidelines do not support routine inpatient use [24][25][26]. GLP-1 agonists remain under investigation in large trials to evaluate their safety and efficacy in perioperative settings [27].

Insulin therapy requires individualized titration during the preoperative phase. For patients using home insulin, basal insulin doses (glargine or detemir) should generally be reduced by 20% to 25% the evening before surgery. For twice-daily basal insulin, similar reductions are applied to both the evening and morning doses. High-dose basal insulin recipients, those with total daily insulin exceeding 80 units, or patients at elevated hypoglycemia risk should consider reductions of 50% to 75% to mitigate hypoglycemia [28]. Intermediate-acting insulin such as neutral protamine Hagedorn (NPH) is typically given at the usual evening dose with a 50% reduction on the morning of surgery. Patients on premixed insulin formulations may be transitioned to long-acting insulin the evening prior, or the morning dose may be reduced by 50% with concurrent initiation of dextrose-containing intravenous solutions [29]. During fasting periods, prandial insulin is withheld, and subcutaneous correctional insulin is administered based on regular blood glucose monitoring every 4 to 6 hours. Many institutions implement standardized correctional insulin scales to ensure safety and consistency in insulin administration. For critically ill patients or those with hemodynamic instability, continuous intravenous insulin infusion is preferred due to predictable pharmacokinetics and rapid titratability. Short-acting intravenous insulin has a half-life of 10 to 15 minutes, allowing for rapid adjustments and minimizing the need for multiple subcutaneous injections [30]. Institutional protocols for continuous infusion should include standardized preparation, initiation, titration, and monitoring procedures to ensure safety and efficacy.

Scheduling and preoperative monitoring are essential components of preoperative management. Early-day surgical scheduling reduces prolonged fasting and the risk of metabolic instability. Preoperative blood glucose assessment allows for timely intervention if hypoglycemia or hyperglycemia is detected. Hypoglycemia can be treated with oral glucose, gels, or intravenous dextrose solutions, whereas severe hyperglycemia exceeding 250 mg/dL or evidence of metabolic decompensation, including diabetic ketoacidosis or hyperosmolar hyperglycemic state, warrants postponement of elective surgery until glycemic control is achieved. Such measures are critical for optimizing surgical outcomes, minimizing complications, and ensuring patient safety throughout the perioperative period. In summary, the preoperative phase of diabetic perioperative management requires meticulous assessment of medical and surgical history, glycemic control, and current pharmacotherapy. Adjustments to oral and injectable antidiabetic medications, individualized insulin titration, and strategic preoperative scheduling are essential to prevent perioperative hyperglycemia and hypoglycemia. Coordinated care among endocrinologists, anesthesiologists, surgeons, and nursing staff ensures that patients are metabolically optimized, risks are minimized, and surgical outcomes are improved. Early detection of metabolic derangements and proactive intervention remain fundamental to achieving optimal perioperative management in patients with diabetes.

Intraoperative and Postoperative Phase

The intraoperative and postoperative phases of perioperative diabetes management require meticulous planning, individualized therapeutic strategies, and close monitoring to prevent both hyperglycemia and hypoglycemia. Surgical stress induces a significant neuroendocrine response characterized by elevated secretion of counterregulatory hormones, including cortisol, glucagon, catecholamines, and growth hormone, which collectively increase insulin resistance, reduce peripheral glucose utilization, and enhance gluconeogenesis and glycogenolysis. These physiological adaptations predispose patients to stress hyperglycemia, which is independently associated with adverse surgical outcomes, including delayed wound healing, higher infection rates, prolonged hospital stay, and increased postoperative mortality [1][2][3][4]. Consequently, effective intraoperative glucose control is essential for optimizing both short- and long-term outcomes in patients with diabetes undergoing surgical procedures. For surgical procedures of shorter duration, typically less than four hours, and in patients with anticipated hemodynamic stability and minimal fluid shifts, subcutaneous correctional insulin is often sufficient to manage perioperative hyperglycemia. Rapid-acting insulin formulations are preferred due to their predictable onset of action and shorter duration, allowing timely correction of elevated glucose levels. Blood glucose monitoring should be performed at regular intervals, generally every two hours, to ensure that glucose concentrations remain within the target range of 140 to 180 mg/dL, consistent with recommendations from multiple professional societies [10][11]. This approach is appropriate when significant physiological perturbations are not expected, and the pharmacokinetics of subcutaneous insulin are reliable. In contrast, for surgeries exceeding four hours in duration, or those associated with substantial fluid shifts, hemodynamic instability, or anticipated blood loss, intravenous insulin infusion is the preferred modality. Blood glucose should be assessed every 1 to 2 hours, and insulin titration should be guided by validated institutional protocols to maintain glucose below 180 mg/dL while avoiding hypoglycemia. The use of intravenous insulin provides rapid, predictable titratability and immediate reversibility in the event of unanticipated changes in hemodynamic status, fluid balance, or metabolic demand [31].

Following the conclusion of surgery, patients are transferred to the post-anesthesia care unit (PACU), where continuity of glucose management remains critical. Intraoperative interventions should be reviewed, and blood glucose should be closely monitored using either intravenous or subcutaneous insulin, depending on the patient's clinical stability and previous glycemic control. Ambulatory surgery patients who are hemodynamically stable, able to tolerate oral intake, and demonstrate adequate glycemic control may be discharged while continuing their preoperative antihyperglycemic regimen. In such cases, patient education regarding home monitoring, recognition of hyperglycemia or hypoglycemia, and adherence to prescribed therapy is essential to minimize postoperative complications. Non-critically ill patients requiring hospitalization are transferred from the PACU to medical or surgical wards and initiated on subcutaneous insulin regimens tailored to their nutritional status. For patients with poor or no oral intake, basal plus correctional insulin therapy is recommended. Basal insulin provides continuous glucose control during periods of fasting or between meals and is usually administered as long-acting insulin, such as glargine or detemir, once or twice daily. Nutritional insulin, also referred to as prandial insulin, addresses postprandial glucose excursions and can be administered as rapid-acting insulin analogues, including lispro, aspart, or glulisine, or as short-acting regular insulin. Correctional insulin is used to manage hyperglycemia exceeding targeted levels and may be co-administered with nutritional insulin when indicated [31].

Individualization of insulin dosing is essential and can be based on patient weight, pre-hospitalization insulin regimen, or clinical judgment. For the average patient, the total daily dose (TDD) of insulin typically ranges from 0.4 to 0.5 U/kg/day. Insulin-sensitive patients, including those with type 1 diabetes, insulin-naïve individuals, older adults, and those with renal or hepatic insufficiency, require a lower starting dose of 0.2 to 0.3 U/kg/day. Conversely, insulin-resistant patients, such as individuals with obesity or those receiving high-dose corticosteroids, may require TDD of 0.6 to 0.7 U/kg/day. Patients exhibiting features of both insulin sensitivity and resistance should be dosed conservatively using insulin-sensitive parameters to reduce the risk of hypoglycemia [32]. Once the TDD is established, approximately 50% is administered as basal insulin, and one-sixth is administered as prandial insulin with each meal. Blood glucose monitoring is performed four times daily in patients consuming oral nutrition, with correctional insulin administered as indicated. For patients who are nil per os, glucose measurements are performed every 4 to 6 hours depending on the type of insulin and correctional scale used [33][34]. Critically ill patients are managed in intensive care units using continuous intravenous insulin (CII), bypassing standard PACU protocols. Regular insulin is preferred due to its predictable pharmacokinetics and short duration of action. Blood glucose should be monitored every 1 to 2 hours, and insulin titration should follow validated institutional protocols. Transitioning from CII to subcutaneous long- or intermediate-acting insulin requires hemodynamic stability, minimal glycemic variability, and maintenance of steady intravenous infusion rates for six to eight hours. Overlap between intravenous and subcutaneous insulin is essential for two to three hours to prevent gaps in basal insulin delivery, which may precipitate rebound hyperglycemia or metabolic decompensation, particularly in patients with type 1 diabetes [35][36].

Basal insulin dosing during transition can be determined using the rate of infusion method, weight-based calculations, or prior home insulin dosing. In the rate-of-infusion approach, the average insulin infusion rate over the preceding six to eight hours is extrapolated to a 24-hour total, with 70% to 80% of this dose administered as basal insulin. In patients receiving minimal or no caloric intake, 100% of the calculated TDD may be administered as basal, whereas in patients receiving adequate nutrition, 50% is allocated to basal and 50% to nutritional insulin. Weight-based dosing parallels the strategies employed for non-critically ill patients, with basal insulin comprising half the TDD and prandial insulin the remainder. For patients with well-controlled home insulin regimens, 70% to 80% of the home basal insulin dose may be administered, with correctional insulin provided to address hyperglycemia. Correctional insulin should be administered every 4 to 6 hours in fasting patients or before meals and at bedtime in patients consuming oral nutrition [35][36]. Exclusive reliance on correctional insulin is discouraged due to unpredictable glycemic fluctuations and the risk of inadequate basal coverage [37][38]. Premixed insulin formulations are generally avoided in the perioperative setting due to heightened hypoglycemia risk. Current evidence does not support the use of oral or non-insulin antihyperglycemic agents in the inpatient perioperative setting, and their use remains investigational [10].

Ongoing adjustments to insulin therapy are necessary for nearly all patients, guided by trends in blood glucose levels, nutritional intake, and changes in clinical status. Continuous assessment of glucose patterns is more informative than isolated readings, enabling clinicians to optimize insulin therapy, prevent complications, and ensure a safe and effective perioperative course. The integration of structured insulin protocols, vigilant monitoring, and interdisciplinary collaboration ensures that perioperative glycemic management minimizes the risk of hyperglycemia-induced complications and enhances surgical outcomes. In summary, the intraoperative and postoperative phases of diabetic perioperative management require careful selection of insulin regimens based on surgical complexity, hemodynamic stability, and nutritional intake. Subcutaneous correctional insulin is appropriate for shorter, uncomplicated procedures, whereas intravenous insulin infusion is essential for longer or more physiologically challenging surgeries. Postoperatively, basal, prandial, and correctional insulin components should be tailored to the patient's oral intake and glycemic trends. Critically ill patients necessitate continuous intravenous insulin with careful transition to subcutaneous formulations to maintain basal coverage and avoid metabolic instability. Insulin dosing must be individualized according to patient sensitivity and resistance, body weight, caloric intake, and home regimens. Avoiding reliance solely on correctional insulin, avoiding premixed formulations, and withholding oral antihyperglycemic agents are critical strategies. Continuous reassessment of glycemic trends, proactive titration, and interdisciplinary collaboration remain the cornerstone of safe and effective perioperative glucose management, ultimately improving short- and long-term patient outcomes [31][32][33][34][35][36][37][38][39].

Clinical Significance

The management of hyperglycemia in critically ill patients has been extensively studied, with significant implications for clinical outcomes in perioperative and intensive care settings. The NICE-SUGAR trial (Normoglycemia in Intensive Care Evaluation–Survival Using Glucose Algorithm Regulation) remains a landmark randomized controlled trial evaluating the effects of intensive versus conventional glucose control in critically ill patients. In this study, intensive glucose control aimed for a blood glucose range of 81 to 108 mg/dL, whereas conventional therapy targeted levels below 180 mg/dL [5][40][41]. The findings revealed a higher incidence of severe hypoglycemia among patients receiving intensive therapy, accompanied by a paradoxical increase in mortality. These outcomes challenged earlier assumptions that tighter glycemic control would universally improve survival and reduce complications in critically ill populations [42][43]. Severe hypoglycemia poses considerable risks, including neurological impairment, cardiac arrhythmias, and hemodynamic instability. The NICE-

SUGAR results underscored the delicate balance between achieving euglycemia and avoiding iatrogenic hypoglycemia. While hyperglycemia is independently associated with adverse outcomes such as increased infection rates, impaired wound healing, and organ dysfunction, aggressive glucose lowering carries its own risks. Consequently, current guidelines favor a more moderate glucose target of 140 to 180 mg/dL in critically ill patients, emphasizing patient safety while still mitigating the detrimental effects of hyperglycemia [5].

In non-critically ill patients, there is a notable paucity of randomized controlled trials addressing optimal perioperative glucose management. Clinicians are therefore compelled to extrapolate data from critically ill cohorts, while recognizing that these populations differ significantly in terms of physiologic stress, comorbidities, and risk profiles. Non-critically ill patients may tolerate slightly higher glucose levels without the same degree of morbidity, yet hyperglycemia in this population remains clinically significant due to its association with postoperative infections, delayed wound healing, and prolonged hospital stays [5]. From a practical standpoint, these findings highlight the importance of individualized glucose management strategies. Clinicians must consider the patient's baseline glycemic control, comorbidities, nutritional status, and the type and complexity of the surgical procedure when determining perioperative targets. Protocolized insulin therapy, including basal, nutritional, and correctional components, allows for flexible adjustments in response to dynamic glucose trends, reducing the likelihood of severe hyperglycemia or hypoglycemia. Continuous monitoring and timely intervention are essential, particularly during periods of physiological stress, such as major surgery or critical illness [5][40].

The clinical significance of these data extends beyond inpatient management. Avoiding both hyperglycemia and hypoglycemia has implications for short-term outcomes, such as postoperative infection rates and length of hospital stay, as well as long-term consequences, including cardiovascular risk and overall survival. It reinforces the need for interprofessional collaboration, including input from endocrinologists, anesthesiologists, surgeons, and nursing staff, to ensure that glycemic targets are appropriate for the individual patient and adjusted dynamically in response to evolving clinical conditions [41][42][43]. In summary, the NICE-SUGAR trial and subsequent analyses provide critical evidence guiding perioperative and intensive care glucose management. While intensive glucose control may be harmful in critically ill patients due to the risk of severe hypoglycemia and increased mortality, moderate glucose targets offer a safer, evidence-based approach. In non-critically ill populations, clinical judgment informed by extrapolation from critically ill cohorts remains necessary. Optimal perioperative glycemic control requires careful monitoring, individualized insulin regimens, and coordinated interdisciplinary care to improve both short- and long-term patient outcomes [5][40][41][42][43].

Other Issues

Management of patients with type 1 diabetes in the perioperative period presents unique challenges due to the absolute dependence on exogenous insulin. Unlike patients with type 2 diabetes, those with type 1 diabetes possess minimal to no endogenous pancreatic beta-cell function, rendering them unable to produce sufficient insulin to maintain euglycemia. Consequently, these individuals require a continuous basal supply of insulin at all times, whether administered subcutaneously or intravenously, regardless of fasting status. Failure to provide this basal insulin can precipitate rapid metabolic decompensation, culminating in diabetic ketoacidosis (DKA), which carries significant morbidity and mortality if not promptly recognized and treated [44]. The increasing prevalence of insulin pump therapy has introduced additional considerations for perioperative diabetes management. Insulin pumps provide a continuous subcutaneous infusion of rapid-acting insulin, delivering basal coverage while also permitting bolus doses for nutritional intake or correctional purposes. Their use in type 1 diabetes has grown substantially, with evidence demonstrating improved glycemic control, reflected by increased time-in-range glucose levels, without a concomitant rise in hypoglycemia or ketosis [48]. However, perioperative use of insulin pumps must be carefully coordinated with hospital protocols and the anesthesiology team. Institutional policies typically restrict intraoperative pump use to procedures of less than two hours and require the patient to have the capacity to self-manage the device [45][46][47].

When continued pump use is impractical, patients should transition to a basal-bolus insulin regimen. To prevent interruption in basal insulin delivery and avoid rebound hyperglycemia, it is recommended to administer long-acting basal insulin at least two hours before discontinuing the pump. The basal insulin dose should be equivalent to the patient's 24-hour basal requirement delivered by the pump, although adjustments may be made based on weight and individual insulin sensitivity [49][50]. Nutritional and correctional insulin, previously managed through the pump, is then administered subcutaneously using rapid-acting insulin to maintain appropriate glucose control. Enteral nutrition introduces additional complexity for diabetic patients in the perioperative or inpatient setting. Formulas containing low carbohydrate content and higher levels of monounsaturated fatty acids are preferred to minimize postprandial hyperglycemia. Subcutaneous insulin therapy for patients receiving enteral nutrition should include basal, nutritional, and correctional components to address both continuous glucose exposure and episodic carbohydrate loads. Basal insulin typically accounts for 30% to 50% of the total daily dose (TDD), administered once or twice daily. The remaining 50% to 70% of TDD is allocated to nutritional insulin, which may be administered as bolus doses coinciding with enteral feeding or as divided doses throughout a continuous feed [10][51][52].

One method to calculate the nutritional insulin dose involves administering 1 unit of rapid-acting or regular insulin for every 10 to 15 grams of carbohydrates provided either in a bolus feed or over a 24-hour continuous feed. Correctional insulin is administered in parallel, either at regular intervals—every four hours with rapid-acting insulin or every six hours with regular insulin—or immediately before bolus feeds to counteract hyperglycemic excursions. Careful glucose monitoring remains essential, particularly in patients receiving continuous enteral feeds, as delayed insulin adjustments can result in sustained hyperglycemia or hypoglycemia. Coordination among nursing, pharmacy, and endocrinology teams ensures timely adjustments and optimizes both safety and glycemic control. The integration of insulin pumps, subcutaneous basal-bolus regimens, and enteral nutrition strategies underscores the importance of individualized, dynamic management for patients with type 1 diabetes. Attention to the continuity of basal insulin, precise calculation of nutritional doses, and frequent glucose monitoring is critical to prevent metabolic decompensation and achieve favorable perioperative outcomes. Institutional protocols must provide clear guidance for transitions between insulin delivery methods, the timing of basal insulin administration, and glucose monitoring schedules. Interprofessional collaboration among anesthesiologists, endocrinologists, nurses, and pharmacists is paramount to maintain patient safety, prevent diabetic ketoacidosis, and reduce perioperative complications. In conclusion, type 1 diabetes necessitates meticulous planning and individualized strategies in the perioperative and inpatient settings. Insulin pump therapy offers enhanced glycemic stability when managed appropriately, but transitions to basal-bolus regimens must be executed carefully to avoid interruptions in insulin delivery. Enteral nutrition requires precise insulin dosing aligned with carbohydrate intake, coupled with frequent monitoring to maintain glucose within target ranges. By adhering to evidence-based strategies and ensuring close interdisciplinary coordination, healthcare teams can minimize metabolic risk and optimize outcomes for patients with type 1 diabetes [44][45][46][47][48][49][50][51][52].

Total Parenteral Nutrition

Total parenteral nutrition (TPN) is a critical therapeutic modality for patients who cannot tolerate enteral feeding, and managing glycemia in these patients requires meticulous planning. Hyperglycemia is a frequent complication of TPN due to the high dextrose content, stress response, and concomitant illness, necessitating the use of insulin to maintain glucose within target ranges. Insulin can be administered in two principal ways: either as a separate intravenous infusion or incorporated directly into the TPN solution. When insulin is added to the TPN, a common initial approach is to provide 1 unit of regular insulin per 10 grams of dextrose. This dosing is then titrated every one to two days based on observed glycemic trends, taking into account both preexisting diabetes and any additional stress hyperglycemia. This method allows continuous insulin coverage aligned with dextrose delivery, reducing fluctuations in blood glucose levels [10][53]. Alternatively, a separate intravenous insulin infusion may be initiated independently of the TPN solution. This method is often preferred in patients with marked hyperglycemia or high variability in glucose levels, as it allows precise titration and rapid response to blood glucose changes. Once glycemia is stabilized and the patient demonstrates predictable glucose control, the total insulin delivered intravenously can be transitioned into the TPN solution, typically incorporating 80% to 100% of the previously administered dose. Regardless of the chosen method, close monitoring remains critical. Blood glucose measurements should be performed frequently, with subcutaneous correctional insulin administered every four to six hours to address any hyperglycemia that exceeds target thresholds. This proactive strategy helps maintain glucose within recommended limits, minimizing the risk of metabolic complications [10][53].

Hypoglycemia

Hypoglycemia represents one of the most serious complications of antihyperglycemic therapy, particularly in the perioperative and inpatient setting. The International Hypoglycemia Study Group classifies hypoglycemia into three levels: level 1 is defined as a blood glucose concentration below 70 mg/dL, serving as an alert threshold; level 2, a blood glucose concentration below 54 mg/dL, indicates clinically significant hypoglycemia; and level 3 is characterized by severe hypoglycemia with cognitive impairment, regardless of glucose level [54]. Iatrogenic hypoglycemia remains the most dangerous adverse effect of insulin therapy and other antihyperglycemic agents and constitutes a major barrier to achieving optimal glycemic control. It is strongly associated with increased morbidity and mortality in hospitalized patients, particularly those undergoing surgery or receiving TPN [42][55]. Multiple factors contribute to perioperative hypoglycemia. Inaccurate insulin dosing, aggressive glycemic targets, and failure to synchronize insulin administration with nutrient intake are common causes. Additional risks include insulin stacking, unanticipated changes in caloric intake, ineffective communication among healthcare providers, and a lack of recognition of glycemic trends [56]. Each of these factors underscores the importance of robust institutional protocols for hypoglycemia prevention and management. Such protocols should outline clear steps for identifying, treating, and preventing hypoglycemia, ensuring that all members of the care team are aware of their roles. According to ADA guidelines, any blood glucose measurement below 70 mg/dL should prompt immediate review and adjustment of the patient's antihyperglycemic regimen, as this often precedes more severe hypoglycemia [57].

Treatment strategies for hypoglycemia must be rapid, effective, and tailored to the patient's clinical status. Mild hypoglycemia can be corrected with oral glucose, such as tablets or gels, while moderate to severe hypoglycemia may require intravenous dextrose solutions or glucagon administration. In the context of TPN, hypoglycemia may necessitate temporary suspension or adjustment of the dextrose infusion, along with corresponding modifications to insulin dosing. Continuous monitoring and prompt intervention are essential to prevent progression to level 2 or level 3 hypoglycemia, which carries increased risk for neurological compromise and hemodynamic instability. Implementing a structured protocol for both insulin administration in TPN and hypoglycemia management improves patient safety and clinical outcomes. By ensuring frequent glucose monitoring, appropriate insulin titration, and rapid correction of hypoglycemia, healthcare teams can maintain effective glycemic control while minimizing the risk of iatrogenic complications. Integration of these practices into institutional policies also supports interprofessional communication and coordination, which are vital in complex inpatient settings. Maintaining optimal glucose control during TPN administration and preventing hypoglycemia are intertwined objectives. Effective management requires a combination of careful insulin dosing, vigilant monitoring, and adherence to established protocols. Together, these measures reduce metabolic variability, prevent adverse outcomes, and support overall clinical stability in patients dependent on TPN and intensive glycemic management [10][53][54][55][56][57].

Enhancing Healthcare Team Outcomes

Effective perioperative management of diabetes relies heavily on coordinated efforts among the interprofessional healthcare team. Pharmacists, nurses, and anesthesiologists play pivotal roles in ensuring patient safety, optimizing glycemic control, and preventing perioperative complications. Their contributions extend across preoperative, intraoperative, and postoperative phases, with each discipline providing unique expertise that complements the others. Pharmacists are central to medication management in patients with diabetes undergoing surgery. They conduct thorough medication reconciliation, ensuring that all antihyperglycemic agents, including insulin, oral medications, and non-insulin injectables, are appropriately adjusted for the perioperative period. Pharmacists assess drug interactions, contraindications, and the risk of adverse effects, particularly hypoglycemia or hyperglycemia, which are common during fasting or stress conditions. They provide recommendations regarding the timing of medication discontinuation, for example, metformin, sulfonylureas, and SGLT-2 inhibitors, and guide transitions from oral or subcutaneous therapies to intravenous insulin when necessary [19][21][22]. Pharmacists also develop individualized dosing protocols and correctional insulin scales, supporting evidence-based practice while reducing the risk of dosing errors. Their involvement extends to patient education, counseling patients about medication adherence, potential side effects, and the importance of monitoring blood glucose levels at home or after discharge. By identifying medication-related issues, pharmacists facilitate prompt communication with the broader care team, ensuring that any concerns are addressed prior to surgery and upon discharge [10][58].

Nurses have a critical role in the direct clinical management of patients with diabetes in the perioperative period. They monitor blood glucose levels, administer insulin or oral antihyperglycemic medications, and assess patients for signs of hypo- or hyperglycemia. Nurses serve as the first point of contact for patients, educating them on fasting requirements, perioperative glucose monitoring, and self-care practices. In the preoperative phase, nurses ensure that patients understand adjustments to their medication regimen and reinforce instructions on when to take or withhold doses. Intraoperatively, they collaborate with anesthesiologists to monitor glycemic trends and administer correctional insulin as required. Postoperatively, nurses maintain close monitoring of glucose levels, coordinate with the pharmacy for insulin titration, and ensure timely administration of nutrition, whether enteral, parenteral, or oral, in alignment with glycemic targets [31][35]. Diabetes nurse educators play an essential role in discharge planning, providing detailed instructions to patients and families regarding medication schedules, blood glucose monitoring, and recognition of symptoms of hypo- or hyperglycemia. This educational support is critical to preventing readmissions and ensuring continuity of care [58]. Anesthesiologists provide specialized expertise in the intraoperative and perioperative management of patients with diabetes. They are responsible for maintaining hemodynamic stability, anticipating stress-induced hyperglycemia, and collaborating with pharmacists and nurses to implement insulin infusion protocols or subcutaneous correctional insulin strategies. Anesthesiologists monitor blood glucose levels continuously or at frequent intervals, adjusting anesthetic and pharmacologic interventions to minimize perioperative metabolic fluctuations. Their role is especially critical during complex or prolonged surgeries, where stress responses can exacerbate hyperglycemia, increase insulin resistance, and elevate the risk of complications such as infection or delayed wound healing. Anesthesiologists coordinate with surgeons to schedule procedures early in the day when possible, reducing fasting duration and mitigating the risk of hypoglycemia. They also participate in postoperative handoff, ensuring that glucose management strategies are communicated clearly to nursing staff and other team members [7][10][58].

Interprofessional communication and care coordination among pharmacists, nurses, and anesthesiologists are essential to achieving optimal outcomes. Pharmacists' medication expertise, nurses' patient-centered monitoring, and anesthesiologists' perioperative management form a collaborative framework that minimizes errors, ensures adherence to evidence-based protocols, and reduces complications. Structured protocols and computerized insulin algorithms further support this collaboration by standardizing care and providing clear guidance for dose adjustments and monitoring [58]. Effective communication extends to patient and family education, where each discipline reinforces instructions regarding medication changes, dietary adjustments, and self-monitoring techniques. The discharge process highlights the importance of coordinated interprofessional care. Pharmacists ensure accurate medication reconciliation and identify potential drug-related issues, while nurses and diabetes educators verify patient understanding of insulin regimens and monitoring strategies. Anesthesiologists may provide perioperative notes regarding intraoperative glucose trends and interventions, assisting outpatient providers in adjusting therapy post-discharge. A timely follow-up visit with a primary care provider or endocrinologist, ideally within one month or sooner if glycemic control was suboptimal, is crucial. Prescriptions, medical supplies, and educational resources should be provided before discharge to bridge inpatient and outpatient care effectively [10][58]. In conclusion, the combined efforts of pharmacists, nurses, and anesthesiologists form the cornerstone of safe and effective perioperative diabetes management. Pharmacists ensure precise medication management and risk mitigation, nurses deliver continuous monitoring, patient education, and postoperative care, while anesthesiologists provide specialized intraoperative expertise. Through structured protocols, clear communication, and collaborative care, this interprofessional team optimizes glycemic control, reduces perioperative complications, and enhances overall patient outcomes in individuals with diabetes undergoing surgical procedures.

Conclusion:

Effective perioperative glycemic control in patients with diabetes is a complex, multidisciplinary challenge that demands coordinated efforts among pharmacists, anesthesiologists, and nursing professionals. Hyperglycemia and hypoglycemia during the surgical period are associated with increased risks of infection, delayed healing, cardiovascular events, and mortality. Evidence supports maintaining blood glucose levels between 140–180 mg/dL to balance safety and efficacy across preoperative, intraoperative, and postoperative phases. Pharmacists play a vital role in medication reconciliation, insulin titration, and risk mitigation, while nurses ensure continuous monitoring, patient education, and timely intervention. Anesthesiologists manage intraoperative glucose fluctuations and collaborate on insulin infusion protocols. Structured protocols, individualized insulin regimens, and frequent glucose monitoring are essential to minimize complications and optimize recovery. The integration of evidence-based guidelines, such as those from the ADA, NICE-SUGAR, and other professional societies, reinforces the importance of moderate glucose targets and proactive management strategies. Ultimately, interprofessional collaboration enhances patient safety, reduces perioperative complications, and improves surgical outcomes. As the prevalence of diabetes continues to rise, healthcare systems must prioritize team-based approaches and standardized protocols to ensure high-quality perioperative care for diabetic patients.

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