4-16-2019

The Clinical Significance of Perioperative Glycemic Management in Type 2 Diabetes Patients

Anita Mambo Fru

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Anita Mambo Fru-FNP Student
Independent Study, NURS 997
Family Nurse Practitioner Program
University of North Dakota

PERMISSION

Title

Department Nursing

Degree Master of Science

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Abstract

Diabetes is the most common endocrine disease in the United States and throughout the world. The Center for Disease Control and Prevention (2017) estimated that 30.3 million Americans had diabetes in 2015, with type 2 diabetes accounting for 90% to 95% of all diabetes cases. The American Diabetes Association (2019) describes type 2 diabetes as a metabolic condition where the body does not use insulin properly, leading to insulin resistance and the destruction of pancreatic beta cells. Patients with type 2 diabetes, require thorough evaluations from their surgical team during the entire surgical process due to the risk of infections, anesthetic complications, and adverse recovery outcomes. This case report and literature review will highlight why perioperative glycemic management in type 2 diabetes patients undergoing surgical procedures is significant. Proper perioperative glycemic control in an adult with type 2 diabetes will aim at decreasing surgical infection risk, decreasing cardiovascular outcomes, preventing mortality, and promoting wound healing during recovery.

Background

The American Diabetes Association (2019) noted that about 25%-50% of diabetic patients would need surgery at some point in their lives compared to non-diabetic patients. Studies show that the number of diabetes patients will increase to about 48.3 million Americans by the year 2050 (Stryker, 2016). With such anticipation, clinicians must be well informed on how to care for these patients especially during surgery. The estimated total cost of diagnosed diabetes in the United States in 2017 was $327 billion, with the direct medical cost at $ 237 billion, resulting in $90 billion in reduced productivity (ADA, 2019). As cited above, diabetes has a profound impact on the patient's quality of life as well as on the economy.

This case report presents a 47-year-old Caucasian female with uncontrolled type 2 diabetes, who is diagnosed with cholelithiasis. She is being referred to general surgery for a cholecystectomy. Thorough assessment, referral, and coordination with diabetes patients, their primary care provider, endocrinologists, the patient's diabetic and surgical team during the perioperative period are critical in preventing complications (Kallio et al., 2015). The patient, like many people with diabetes, has established significant risk factors for complications during and after the surgical produce; thus, requiring cares from professionals who are knowledgeable on proper perioperative glycemic management. According to Stryker (2016), type 2 diabetes patients undergoing total joint arthroplasty had increased wound complications compared to non-diabetics. They had increased risk for perioperative and postoperative infections, deep vein thrombosis, increased hospital cost, prolonged length of stay, recurrent readmission, and greater perioperative mortality (Stryker, 2016).

Khan, Ghali & Cagliero (2018) noted that diabetic surgical patients, in general, fall into a higher risk category compared to non-diabetics. These patients when compared to nondiabetic

experience increase surgical complications associated with hypoglycemia and hyperglycemia. Therefore, perioperative glycemic management will require thorough evaluations to minimize renal, cardiovascular and neurologic complications (Khan et al., 2018). It is critical that clinicians have in-depth knowledge of the impact of glycemic management in type 2 diabetes patients and utilize a multimodality team approach in the overall care and delivery process. Stryker (2016) emphasized that effective communication of glycemic management goals and the active participation of all members involved in the patient's care is essential to the success of a perioperative management glycemic outcome. This case report will examine the clinical significance of perioperative glycemic control in type 2 diabetic patients, critical factors that need to be addressed and ways to optimize patient care.

Case Report

Mrs. K is a pleasant 47-year-old female who presents with complaints of right upper quadrant abdominal pain that started 12 hours ago. The patient states "It started pretty soon after dinner yesterday, and it has not gone away, since yesterday evening. I think it is getting worse." Patient reports that her pain is located in the middle, right upper quadrant of her abdomen and radiates to her center back and right shoulder. She describes her pain as an 8 out of 10 and dull in nature. She denies having previous episodes like this. However, she reports that she has had some stomach pain after meals a few months back, which went away after a couple of hours without intervention. Interventions attempted to include, application of warm water bottle with no relief. The patient states that sitting hunched over or lying on her side seems to help alleviate the pain (5/10) while moving and lying down on her back makes the pain worse. Patient reports having a stable appetite and a diet consisting of high levels of fat and complex carbohydrates. The patient denies any recent fever, chills, diarrhea or constipation. She denies bladder or bowel

irregularities, weight gain or loss. The patient also denies any headache, shortness of breath, chest pain, and musculoskeletal issues, other than right shoulder discomfort.

Pertinent past medical history includes diabetes type 2, hypertension, and obesity. Family history includes cardiovascular disease on the father's side (father died of a stroke when he was 65, and his mother has gallstones). The patient has no surgical history. Patient denies having any allergies. Current medications, the patient is currently prescribed Lisinopril 20mg and Metformin 1000mg daily. Patient notified the provider that she has not been compliant with taking her medications. She takes her pills several times a week, depending on how she feels rather than prescribed. Patient's social history includes married, lives at home with her husband, and has two children. She is a financial consultant. She reports drinking about 1–2 glasses of wine at dinner time most nights and even more when guests visit. However, the patient denies using any tobacco or illicit drugs. The patient does not exercise, stating she cannot find time for it.

Physical exam was negative except for discomfort from dull pain in the middle back, right shoulder, tenderness in the RUQ and epigastric region with guarding. Vital signs as follows, T: 99.5°F BP: 186/100 HR: 102 R: 20 Oxygen sat:98% on room air, and BMI: 30 kg/m2. Significant findings include a mildly elevated temperature and significantly elevated BP 186/100. Lab test and imaging ordered during this patients visit includes complete blood count (WBC-12.4 and BS-210), comprehensive metabolic panel (Calcium-10.1), liver function test (AST- 420u/l and ALT-590u/l), amylase (Negative) and lipase (32), HgbA1C (8.5), alkaline phosphatase (137), and total bilirubin (4.1 mg/dl). Imaging includes an upright and supine ultrasound of the abdomen that indicated a 3mm gallstone. Patient diagnosis is cholelithiasis.

Treatment plan includes pain management with ibuprofen 400 mg every four hours as needed, and a general surgery consults for cholecystectomy. Removal of the gallbladder is

generally indicated in patients who have experienced symptoms or complications of gallstones (Heuman, 2017). With a history of uncontrolled hypertension and uncontrolled diabetes, this patient is at moderate to high risk for surgical complications. Initial treatment plan includes normalizing her blood pressure. The patient was ordered to take her medication as scheduled daily, monitor BP daily for one week, document and return to the clinic for evaluation and further treatment. The patient was advised to take her metformin as prescribed as well, monitor her blood sugar AC & HS at home daily. She will document it and follow-up a week later for evaluation and further management. She was also educated on lifestyle modifications such as, decreasing the rate of her alcohol consumption, eating meals low in fat and cholesterol, but high in fiber. Patient instructed to exercise regularly, at least 150 minutes of moderate aerobic activity or 75 minutes of vigorous aerobic activity a week (Heuman, 2017). The patient was made aware of the surgical complications that are associated with uncontrolled diabetes and hypertension.

Literature Review

A literature review was conducted to examine the significance of perioperative glycemic management in type 2 diabetes patients. An in-depth search of current literature was performed using the University of North Dakota's Harley E. French Library of Health Sciences. PubMed was one of the online databases used to conduct a systematic search of literature with a keyword search using MeSH terms Perioperative AND glycemic management AND type 2 diabetes. Other MeSH terms using PubMed include Preoperative AND glycemic management AND diabetes, and Postoperative AND glycemic control AND diabetes AND outcome within the last five years. The search yielded more than 45 articles and I choose18 of the articles relevant to my topic of discussion.

According to the Center for Disease Control and Prevention (2017), an estimated 30.3 million or more Americans have diabetes. About 48.3 million Americans are projected to have diabetes by 2050 (Stryker, 2016). About 25% of patients with diabetes will undergo surgery at some point in their life (Jehan et al., 2018). These statistics are critical for clinicians as diabetic patients account for a significant proportion of primary care visits, and as indicated will need surgery at some point in their life. People with diabetes have a higher perioperative risk for surgical complications, metabolic alterations, and longer hospital stays, compared to the non-diabetic population (Boreland, Scott-Hudson, Hetherington, Frussinetty, and Slyer, 2015). Physiological changes during the surgical procedure and complications resulting from hypo/hyperglycemic episodes can pose challenges for clinicians caring for these patients. Therefore, it is essential to conduct thorough preoperative evaluations, utilize evidence base glycemic management strategies in the perioperative period, and appropriate postoperative glycemic interventions to prevent or minimize adverse outcomes.

Why Manage Glucose Levels in the Surgical Setting?

Diabetes affects multiple organs of the body leading to microvascular and macrovascular complications. These complications are a significant contributor to mortality and morbidity in diabetic patients, especially in a surgical situation. Diabetic patients as noted earlier will require a surgical procedure and are more likely to have adverse perioperative events compared with nondiabetic patients. Studies show that poor perioperative glycemic control is associated with poor surgical outcomes. Furthermore, the length of hospital stay for diabetes patients is 45% higher than those without diabetes, and mortality of surgical patients is twice as high as those without diabetes (Dhatariya, Levy, and Hall, 2016). Early identification of patients with poorly controlled diabetes in the preoperative period, will initiate communication between the clinical

teams and enable proactive treatment during the various stages of surgery. Glycemic management will minimize error, improve their glycemic control, and lower the risk of surgical complications.

Stress associated with surgery is also known to counter-regulate the bodies hormone levels leading to an increase in glucose concentrations and hyperglycemia. Jehan et al. (2018) noted that hyperglycemia places diabetic patients at an increased risk for cerebral ischemia, impaired wound healing, and prolonged hospital stays. In addition to these complications, the stress response from surgery may also cause other diabetic pathologies such as diabetic ketoacidosis or hyperglycemic hyperosmolar syndrome during surgery or postoperatively (Jehan et al., 2018).

Diabetic patients also experience hypoglycemia, which is a known independent risk factor that is associated with increased mortality. Thompson, Stearns, Apsey, Schlinkert, and Cook (2016) reported that during the perioperative period, recognizing the neurological manifestations of hypoglycemia when a patient has been under general anesthesia can be difficult thus, exposing the individual to a prolonged hypoglycemic state and increase adverse outcomes. Sreedharan and Abdelmalak (2018) agreed that providers should worry about perioperative glycemic states in a diabetic patient because hypoglycemia sometimes masked under general anesthesia resulting in irreversible neurologic damage and adverse perioperative outcomes.

In addition to recognizing the above complications, studies have shown that diabetic patients with well-control glucose levels undergoing major surgery such as cardiac and orthopedic, experienced decreased adverse surgical complications (Sreedharan and Abdelmalak, 2018). Therefore, clinicians need to be vigilant and accurately identify diabetic patients at risk to

prevent adverse outcomes and co-morbidities. It is critical that clinicians view the perioperative glycemic management in a type 2 diabetes patient as a continuum of care starting with admission through discharge.

Preoperative Glycemic Evaluation

The American Diabetes Association (2018) recommends that clinicians perform a preoperative risk assessment for diabetes patients at high risk for ischemic disease, autonomic neuropathy or renal failure (p. S148). The Society for Ambulatory Anesthesia has published guidelines for perioperative management of diabetic patients undergoing ambulatory surgery. They also recommend that providers perform a thorough evaluation of the patient's preoperative glycemic level, assess history and risk for hypoglycemia, the timing of operation and duration of fasting required before the initiation of preoperative insulin treatment (Demma, Carlson, Duggan, Morrow and Umpierrez, 2017).

With preoperative evaluations, clinicians will identify diabetic patient's risk factors and initiate early glycemic management. This phase will provide opportunities for early referrals and consultations, patient education, and medication reconciliation. Khan et al. (2018) emphasized that clinicians use the preoperative phase for "testing and laboratory evaluations that include basal glucose level, an electrocardiogram assessing cardiac risk, comprehensive chemistry panel to assess renal function, complete blood count, and hemoglobin A1c" (p.2). They emphasized that asymptomatic diabetic patients with cardiac risk factors including hypertension, tobacco use, and a family history of cardiovascular disease, should undergo cardiac image or stress testing to rule out coronary artery disease before general anesthesia use. This is because an EKG alone might not be sufficient to diagnose silent coronary artery disease known to cause complications with anesthesia use (Khan et al., 2018, p.2).

Miller & Richman (2016) noted that Hollenberg and colleagues in their study reported diabetes as one of the five independent risk factors for postoperative myocardial ischemia. They indicated that insulin-dependent diabetes is one of the five clinical risk factors on the Revised Cardiac Risk Index used for assessing major cardiac complications, such as cardiac arrest, myocardial infarction, heart failure, and heart block. This preoperative assessment of cardiac risk is done according to the American College of Cardiology/American Heart Association guidelines (Miller & Richman, 2016, p.157).

Clinicians must also evaluate and manage glycemic control in patients utilizing oral glycemic agents before surgery. The American Association of Clinical Endocrinologists and the American Diabetes Association recommended that surgical patients on oral diabetes should be identified and instructed to hold their metformin for 24 hours before surgery due to risk for renal impairment, hemodynamic instability, and the development of lactic acidosis (Miller & Richman, 2016, p.160). A randomized control study by Hulst et al. (2018) supported that finding. They found that a continuation of metformin during the perioperative period did not affect perioperative glycemic control other than a slight increase in the plasma lactate level. However, the rise in plasma lactate level was not significant to determine whether or not metformin should be continued or held during surgery (Hulst et al., 2018). Clinicians must be aware of these recommendations since not all diabetic patients utilize insulin therapy.

Preoperative evaluation of glycosylated hemoglobin (HbA1c) is crucial in preventing surgical complications. A retrospective observational study was conducted by Kallio et al. (2015) evaluating the impact of preoperative clinic referral by anesthesia for elevated HbA1c in patients undergoing total joint arthroplasty. The results of their study showed that patients undergoing JTA with uncontrolled HbA1c (great than10%) had a higher incidence of coronary artery

disease, hypercholesterolemia, and increased surgical complication rates compared to those with HbA1c of less than 8% or without DM (Kallio et al., 2015). The study also saw a 10% increase in prolonged hospital stays for DM patients with uncontrolled HbA1c, compared to those without DM (Kallio et al., 2015).

A meta-analysis study Yang, Sun, Li, and Liu (2017) assessing whether hemoglobin A1c and perioperative hyperglycemia was associated with increased risk of periprosthetic joint infection in diabetes patients undergoing a total knee and hip arthroplasty also showed that high HbA1c (greater than 7) and perioperative hyperglycemia are associated with a higher risk of periprosthetic joint infections. These studies highlight the importance of preoperative HbA1c evaluations and management before surgery. They emphasized that HbA1c is beneficial in classifying perioperative risk in diabetic patients. Therefore, clinicians should use the HbA1c levels to determine the glycemic management needs of surgical diabetes patients and initiate prompt treatment needed to prevent or reduce adverse surgical outcomes. An appropriate preoperative glycemic management plan will help clinicians avoid both hypoglycemia and hyperglycemia on the day of surgery, and postoperatively.

Glycemic Management During the Perioperative Period

With diabetes, patients are at increased risk of mortality and postoperative complications compared to non-diabetics. Thus, clinicians must adequately manage glucose levels during the perioperative period. To prevent surgical risk and reduce complications, Blaha et al. (2015) emphasized that clinicians have a clear understanding of glycemic strategies used in optimizing glycemic control. These strategies will guide providers and assure their patients' safety. However, the consensus regarding glycemic goal and management strategies proposed to

maintain optimal glucose levels perioperatively has been difficult to establish due to study data inconsistency (Blaha et al., 2015, p.3082).

Khan et al. (2018) also agreed that perioperative glucose targets and protocols vary with little supportive evidence. They noted that the decision on which strategies to use depends on the individual hospital or providers. A metanalysis of 12 randomized trials evaluating intensive (<120 or <150mg/dl) versus conventional glycemic control during the perioperative period reported that intensive glycemic control perioperatively was not associated with any reduction in infectious complications, cardiovascular events or mortality. However, it was associated with an increased risk for hypoglycemia (Khan et al., 2018). Palermo & Garg (2019), in their study, agreed that tight glycemic control during the intraoperative period failed to show a significant clinical outcome as well. They reported that variation in insulin infusion during the perioperative period was considered the safe and most effective means to achieve glycemic control and prevent adverse outcomes, and not implementation tight glycemic control. As cited in these studies, the use of tight glycemic control would result in a higher risk for hypoglycemia and surgical complications — an essential assessment for clinicians to consider during the perioperative phase of surgery.

Khan et al. (2018) also suggested that, for short procedures lasting less than two hours, diabetic patients utilizing insulin can continue subcutaneous insulin perioperatively, rather than an insulin infusion. They recommended that these patients should also delay taking their morning insulin until after surgery, and before they eat when scheduled for morning procedures. Khan et al. (2018) emphasized that diabetic patients who are on continuous insulin pumps may continue their basal insulin without any changes to their regular regiment, given that their basal insulin dose can be calculated correctly to meet the needs of surgery.

Khan et al. (2018) stressed that IV insulin is required long, complex procedures lasting greater than two hours to achieve appropriate glycemic control. They reported that studies have compared the use of subcutaneous insulin versus IV infusion and found a significant increase in the variability of the glucose concentration when using the subcutaneous route. Therefore, not only are insulin infusions in monitored settings are safe, it can be titrated to enabling more precise glucose control. Khan et al. (2018) recommended that blood glucose should be monitored every hour and more frequently in patients using IV insulin infusion. The preferred method for intraoperative glucose testing is by laboratory or point of care testing and not finger stick because they are less reliable. If hypoglycemia occurs or blood glucose levels drop to100mg/dl or less, insulin infusion should not be stopped but reduced to maintain appropriate glucose targets (Khan et al., 2018).

A systematic protocol with simple and clear directions must also be in place to achieve safe and reasonable levels of glycemic controls in hospitalized diabetic patients. These protocols will facilitate a successful glycemic transition throughout every stage of surgery, produce positive outcomes, and reduce cost. For instance, the 17-year prospective Portland Diabetes Project, a non-randomized study of diabetes patients who underwent open-heart surgery with implementation of an IV insulin infusion, resulted in a 66% reduction of postoperative deep sternal wound infections and a total net savings to the hospital of $4,638 per patient (Miller & Richman, 2016). This study emphasizes the importance of having a glycemic protocol when caring for diabetic patients undergoing surgery and its impact on the economy.

The concept of tight glycemic control in diabetes patient has been called into question whether or not it impacts the patient's surgical outcomes. The American Diabetes Association (2018) report on diabetes care in hospitals, recommends that clinicians initiate insulin therapy for

persistent hyperglycemia with blood sugars levels above 180mg/dl with a target range of 140-180 mg/dl for critically ill and non-critically ill diabetic patients. The ADA (2018) also suggested that strict glycemic target of 110-140mg/dl may be utilized for some critically ill patients as long as clinicians can prevent hypoglycemia.

The ADA (2018) also emphasized that hospitals adopt and implement a hypoglycemic management protocol with an individualized plan to prevent hypoglycemia. Their recommendations include maintaining perioperative target glucose of 80-180mg/dl vs. tighter glucose control known to result in hypoglycemia and adverse surgical outcomes. An observational study on the effect of basal insulin dosage on blood glucose concentration in ambulatory surgery patients with type 2 diabetes by Demma et al. (2017) observed that, patients who reduced their evening basal insulin dose by 25 % the evening prior to surgery, achieved target glucose control on the day of operation compared to patients who took their full insulin dose. With IV insulin infusion proven to be the best method for achieving glycemic targets in the perioperative period, a well- written protocol based on evidence will allow for predefined adjustments in patients infusion rates, proper management of glycemic fluctuations, and reduce complications. It is imperative that future studies work on consensus guidelines or standardize protocols for optimal perioperative glycemic control of patients with diabetes undergoing surgery.

Postoperative Glycemic Management and Outcome

Postoperative glycemic management is critical as patients transition from inpatient to outpatient care. Postoperative glycemic control will maintain a safe glucose target range and prevent complications that could either delay patients discharge or impair healing and recovery. Hypoglycemia or hyperglycemia before, during and after surgery is known to complicate the

recovery process. Hyperglycemia during surgery has been associated with a 30% increase in adverse surgical outcomes such as increase in surgical site infections, pulmonary and renal complications (Thompson et al., 2016). Diligent blood glucose management during the perioperative period will minimize the risk of postoperative complications and enhance the recovery process.

To avoid postoperative adverse outcomes in diabetic patients, Khan et al. (2018) recommended that diabetes treatment regimen before surgery be reinstated once the patients start eating. They emphasized that diabetes patient should receive their first dose of subcutaneous insulin before discontinuation of the IV insulin infusion due to its short half-life, and the risk for hypoglycemia in the postoperative phase (Khan et al., 2018). As noted earlier, clinicians must avoid hypoglycemia during anesthesia use because hypoglycemic symptoms may mimic post-anesthesia symptoms in the postoperative stage. To optimize glucose control, a sedated and anesthetized patient with a blood glucose of <70 mg/dl should be given IV dextrose (25 g) immediately, and blood glucose measurements repeated every 10 minutes until the stability of the glucose level is achieved (Khan et al., 2018).

The study by Jehan et al. (2018) evaluating the impact of HbA1c levels on outcomes after general emergency surgery found that patients with hypertension, history of coronary artery disease, body mass index of 30 kg/m or higher, and a HbA1c of 6.0% or greater experienced significant surgical complications. These patients stayed in the hospital an average of four days longer than their counterparts, had a 16% increase in complication rates, and a 30-day readmission rate of 8% compared to 3.2% in those with less than 6% HbA1c (Jehan et al., 2018). As indicated in the literature, a HbA1c must be assessed in all diabetes patients before surgery, and interventions initiated to prevent complications and promote recovery.

A successful perioperative glycemic management requires the active participation of all interdisciplinary members involved in the inpatient's care as well as the patient (Stryker,2016). Therefore, clinicians must educate and encourage patients to take charge of managing their blood glucose levels and maintain an appropriate HbA1c level to prevent co-morbidities and surgical complications.

According to the ADA (2018), structured discharge plans tailored to the individual patients has also shown to reduce surgical complications and increase patient satisfaction. The ADA (2018) recommends that diabetic patients who experienced glycemic instability in the hospital should follow-up with their primary care provider or endocrinology team within a one month for evaluation and further treatment. For patients whose glucose level are not well-controlled at the time of discharge, they should follow-up in one to two weeks to avoid hyperglycemic or hypoglycemic complications (ADA, 2018). These visits will provide opportunities for clinicians to assess the patient's progress, establish treatment goals, provide needed treatments, and assurance of continuity of care.

Learning Points

1. It is estimated that 25%-50% of diabetic patients will need surgery at some point in their lives compared to non-diabetics. Not only does diabetes impact the patient's quality of life, but it is also a financial burden costing the US economy billions of dollars yearly.
2. Preoperative evaluations are essential in diabetic patients needing surgery. Providers will use this stage to identify risk factors that if missed, can lead to adverse surgical outcomes, reconcile the patient's medications, and manage to present health problems.

3. A secure glycemic management protocol, not tight glycemic control during the perioperative period have resulted in fewer surgical complications, reduced length of hospital stays, decrease cost and reduce mortality.
4. Communication between the interdisciplinary surgical team, diabetic management, and outpatient providers is critical in accomplishing a proper surgical glycemic control. Efficient communication will ease the transition from inpatient to outpatient and prevent adverse surgical outcomes in diabetic patients.
5. Individualized discharge planning is a critical part of the postoperative glycemic management process because patients' recoveries vary, and poor glycemic control may complicate their recovery process. To prevent post-surgical complications, these patients must be an active participant in their discharge planning and follow-up as scheduled to assure continuity of care.

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