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# Management of Type 1 Diabetes Perioperatively

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Department Nursing

Degree Master of Science

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**Abstract**

Diabetes Mellitus is a very common, costly and manageable chronic disease, posing a major public health concern in the United States. The Center for Disease Control (CDC), 2015, estimate that one million Americans are living with diabetes; with Type 1 diabetes accounting for about 5% of all cases diagnosed with diabetes. The American Diabetes Association (ADA), defines type 1 diabetes as “beta-cell destruction, usually leading to absolute destruction of beta cells of pancreas usually leading to absolute insulin deficiency.” Patients with DM especially type 1 diabetic patients, need thorough evaluations before, during and after surgery due to the high complexity and risk of perioperative infections, cardiovascular morbidity and mortality after surgery. This case report and literature review will highlight the management of the type 1 diabetic patient during the perioperative and postoperative phase of surgery. Proper perioperative management of the surgical adult with type 1 diabetes is aimed at decreasing adverse cardiovascular events, morbidity and mortality, reducing prolonged hospitalizations and overall cost.

### **Background**

With about one million type 1 diabetic patients in the United States today, the ADA, 2016, estimates that about 25%-50% of diabetic patients will need surgery at some point in their lives. Compared to nondiabetic persons, diabetic patients account for a greater majority of the surgical population annually, with increased mortality rates up to 5 times more than in nondiabetic patients (ADA, 2016). About 21% of adults 60 years of age and older have diabetes, with this number expected to double by 2025 (Vann, 2009). The ADA, 2016, estimated the total cost of diagnosed diabetes in the United States in 2012 at \$245 billion, with direct medical cost at \$176 billion resulting in \$69 billion of reduced productivity.

My case report presents a 67 year old Caucasian male with type 1 diabetes who is being evaluated for a right total knee replacement and has an insulin pump. Thorough assessment, planning and coordination with the patient's endocrinologist and diabetic team during the perioperative period is very important. This is because type 1 diabetic patients are insulin dependent requiring continuous basal supply of insulin which can be via subcutaneous insulin injections or via insulin pump as in the case of my patient. This patient population needs optimal perioperative glycemic management by experienced healthcare professionals (Patridge, Perkins, Mathieu, Nicholls, & Adeniji, 2016). This leads to decreased adverse outcomes such as hypoglycemia associated with intensive insulin therapy and diabetic keto acidosis commonly seen with type 1 diabetic patients (Chiang, Kirkman, Laffel, Peters, & Type 1 Diabetes Sourcebook Authors, 2014). These patients are also at risk for increased medical complications, higher readmission rates or to be readmitted within 30 days after joint replacements (Lovecchioer, Beal, Kwasny, & Manning, 2014).

Glycemic control during the perioperative period for patients with type 1 diabetes can be very challenging for clinicians leading to lengthened hospital stays, increased used of healthcare resources, increased risk for perioperative and post-operative infections and greater perioperative mortality compared to non-diabetic patients (Williams, 2007). Management challenges for type 1 diabetes mellitus during the perioperative period include lack of standardized diabetic care guidelines within institutions, associated hypoglycemia or hyperglycemia, co-morbidities, complexities with polypharmacy and insulin prescription errors and limited knowledge of diabetic management among staff providing care to this patient population (Barker et al., 2015). Adequate management of type 1 diabetic patients is therefore critical during the perioperative period to prevent adverse patient outcomes, reduce mortality and save on scarce healthcare resources.

Diabetic surgical patients usually fall into a higher risk category compared to non-diabetics, therefore optimizing perioperative management will require thorough evaluations to minimize renal, cardiovascular and neurologic complications (Khan, Ghali & Cagliero, 2016). It is therefore imperative for the health care team including surgeons, anesthesiologist and other specialists who perform surgical procedures to have an in-depth knowledge of type 1 diabetes and how it affects the overall care delivery process. Close glycemic monitoring perioperatively will reduce microvascular and macrovascular complications in the type 1 diabetic patient. The dilemma still remains as to what method is optimal in the perioperative management of adults with type 1 diabetes to prevent adverse surgical outcomes. This case report will examine the perioperative management of type 1 diabetics, some challenges clinicians encounter and how to optimize care for this patient population.

### Case Report

Mr. JX is a pleasant 67 year old adult Caucasian male with type 1 diabetes mellitus who presents to the clinic for a pre-operative evaluation for a right total knee arthroplasty/ replacement. Surgery has been scheduled to take place at the orthopedic hospital three weeks from this pre-operative visit. About two months ago Mr. J.X. had a left total knee arthroplasty/replacement and stated surgery was successful, but for issues with his blood sugars “bottoming out during surgery,” needing urgent glycemic control and intervention. Patient has a history of arthritis in both knees that has caused him significant discomfort, thus the need for total knee replacements bilaterally. Patient says his right knee gets weak, causing constant pain, aggravated with ambulation, and relieved by rest, using a cane for support or nonsteroidal anti-inflammatory drugs (NSAIDs) like ibuprofen. He had a fall 6 months ago, which was caused by his right knee gave out. Patient denied any bruising or bleeding after fall.

Other pertinent past medical history include; hypertension, sleep apnea, hyperlipidemia, diagnosed with type 1 diabetes in 1973 at age 6 years, carotid artery disease with about 60% blockage bilaterally, left knee injury in 1970 during a football game stating “left knee was clipped.” Patient denies any other heart diseases or respiratory problems. Patient denies any allergies. He denies having any problems with anesthesia or family complications from anesthesia. Significant surgeries include bilateral knee arthroscopes, left knee replacement/arthroplasty, two hernia repairs and an appendectomy. Patient does not use any home oxygen. Denies any recent acute or chronic infections. Patient denies bruising or bleeding easily. He has no family history of bleeding or clotting disorders. Patient is independent at home, has no trouble climbing stairs or a hill. He denies any shortness of breath or dizziness with ambulation and walks his dog for about 2 miles daily. He also denies any recent chest pain,

arrhythmias or congestive heart failure. Denies any history of Chronic Obstructive Pulmonary disease or asthma.

Patient's family/social history includes cardiovascular disease on father's side. His father died of a heart attack at age 69 years and his brother had a stroke. He also lost a brother to esophageal cancer. Patient states he smokes a pack of cigarettes a day and is trying to quit. Patient denies using any illicit drugs. Patient states he eats a balanced diet consisting of "meats, potatoes and lots of fruits and vegetables." For medications, patient is currently taking losartan 10mg, simvastatin 80mg, aspirin 81mg and multivitamins. He also has an insulin pump and checks his blood sugars four times a day with numbers averaging 140mg/dl. Patient's average blood pressure at home are in the 130's/80's range. Patient had a normal stress test done a year ago. Also says chest X-Ray was done in the past with no significant findings.

Patient's physical exam was negative for wheezes, crackles, jugular vein distention, carotid bruit or lower extremity edema. Significant findings during were a high blood pressure reading of 158/94. Pre-operative labs and tests ordered during this visit include a complete blood count with results of red blood cells slightly decreased at  $3.0 \times 10^6/\mu\text{L}$  and hematocrit at 34.5% probably due to some blood loss from previous left total knee replacement done two months ago. Patient's comprehensive metabolic panel came back normal. EKG indicated a normal sinus rhythm. With above elevated blood pressure readings, history of hypertension, and patient scheduled for surgery in three weeks, elevated blood pressures will have to be addressed before surgery.

The most significant plan for this patient included normalizing his blood pressure by adding a beta blocker, such as metoprolol 25 mg with recommendations to keeping blood pressure below 140/80 mmHg and monitor closely at home, reporting any abnormal readings



before surgery. Patient will continue to monitor blood sugars at home and keep a log to be reviewed before surgery. Lifestyle modifications such as quitting smoking especially before surgery was discussed including benefit to overall health and patient outcomes given other associated risk factors for stroke and coronary artery disease. He was encouraged to continue heart healthy diet and daily exercises. Patient also informed to stop aspirin a week before surgery to reduce risk of bleeding. Some expectations during the perioperative period such as hospital length of stay, glycemic control and discharge were discussed with patient. After reviewing, patient's history, medications, labs, imaging, physical exam and plan, patient was cleared for surgery.

### **Literature Review**

According to the American Diabetes Association (2016), type 1 diabetes represents 5% of all diagnosed diabetes cases, with diabetic patients accounting for a larger proportion of people needing surgery, and have a higher perioperative risk for complications and longer hospital stays compared to the nondiabetic population. About 21% of adults 60 years of age and older are diagnosed with diabetes and is projected to double by 2025. The complexity of type 1 diabetic patients during surgery can pose a challenge to clinicians needing careful assessment and planning (Khan et al., 2016). It is therefore important to conduct thorough evaluations and careful management during the perioperative period to prevent adverse outcomes post-operatively for type 1 diabetic patients.

A literature review was conducted to examine the perioperative, and post-operative management of adults with type 1 diabetes outlining some challenges faced by clinicians. An in depth search was conducted to review the most current literature 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 key word search using MeSH terms of *type 1 diabetes* AND *intraoperatively* within the last 5 years yielding 3 articles with two relevant articles for my case report. Using PubMed, other MeSH terms like *Perioperative* AND *management* AND *diabetes mellitus, type 1*, within the past 5 years yielded 17 articles with 6 articles being of relevance to my topic discussion. These 7 articles in their reference sections had about 6 to 8 other relevant articles used for my literature review. The ADA grading system used in the literature review range from A, B, C or E. A represents clear recommendations from well conducted, generalizable randomized controlled trials that are adequately powered. B grade means supportive evidence from well conducted cohort studies, C grade provides supportive evidence from poorly or uncontrolled studies and E grade is expert consensus or clinical experience (ADA, 2016).

### **The Importance of Managing Diabetes in the Surgical Setting**

The stress of surgery and anesthesia has been known to activate the neuroendocrine response, leading to a secretion of counter regulatory hormones such as cortisol and epinephrine, impacting the action of insulin and predisposing the patient to ketoacidosis and hyperglycemia (Rizvi, Chillag & Chillag, 2010). Hyperglycemia is also a risk factor for cerebral ischemia, impaired wound healing, increased hospital stay.

According to Sudhakaran & Surani, (2015), recent evidence has shown that careful glycemic control for diabetic patients undergoing major surgery including cardiac and orthopedic procedures may decrease adverse surgical complications and lead to better patient outcomes. Glycemic control in the perioperative setting especially for type 1 diabetics is done to recognize hypoglycemia which if missed can result in a number of neurologic complications including seizures, unconsciousness, somnolence, irreversible neurological insult and death. Sometimes

recognizing the adverse neurological effects of hypoglycemia can be difficult post operatively especially when the patient has been under anesthesia resulting in unrecognized hypoglycemia for a critical length of time before proper glycemc correction is ensured (Sudhakaran & Surani, 2015). In order to optimize glycemc control and prevent adverse surgical outcomes during the perioperative period, clinicians need to be vigilant and properly identify diabetes, glucose intolerance, insulin resistance and associated diabetic diseases and comorbidities.

### **Preoperative Evaluation**

Preoperative evaluation in the primary care setting for diabetes mellitus especially in type 1 diabetics is important in identifying risk factors, type of anesthesia to be used, improving efficiency intraoperatively, reduce unnecessary testing and consultations, improving patient education and satisfaction and decreasing perioperative complications.

During preoperative evaluations preoperative testing and laboratory evaluation should include at least an electrocardiogram, a basic metabolic panel to assess renal function, hemoglobin, electrolytes and hemoglobin A1c levels. Also knowing the type of diabetes and its treatment must be considered as type 1 diabetics require continuous insulin therapy to prevent diabetic ketoacidosis and hypoglycemia. Information of patient's hemoglobinA1c may be beneficial in not only classifying perioperative risk but to also determine care during the postoperative phase. Asymptomatic diabetic patients who have cardiac risk factors such as hypertension, tobacco use, or family history of cardiovascular disease should undergo cardiac image/stress testing to rule out coronary artery disease before general anesthesia as an EKG alone might not be sufficient in diagnosing silent coronary artery disease. The primary care provider also needs to be familiar with the patient's medications including mechanism of action and those that are contraindicated during the perioperative period (Meneghini, 2009).

The diabetic patient needing surgery should also be closely assessed preoperatively for signs and symptoms of cerebrovascular, coronary artery disease and peripheral vascular disease. Any comorbid health conditions must be identified and carefully managed perioperatively. Beta-blockers should be considered in diabetic patients with coronary artery disease to decrease risk of perioperative ischemia. Preoperative goals for the type 1 diabetic surgical patient will be to assess the patient's overall health status, uncover conditions that can pose a problem during and after surgery, determine the perioperative risk, optimize the patient's medical condition to decrease adverse surgical outcomes, formulate a concise perioperative plan of care and educating the patient about what to expect during the perioperative and postoperative and discharge period in order to reduce patient anxiety (Zambouri, 2007).

According to Koo, Hyder, Wanderer, Eikermann & Ramachandran (2015), the perioperative risk assessment is done using the American Society of Anesthesiologists' Classification of Physical Status. The ASA grading system which ranges from ASA class 1 to class 6 according to severity of the patient's disease state and E for emergency surgery, remains one of the few prospective descriptions of the patient's general health which correlates with the risk of anesthesia and surgery. Koo et al., conducted a meta-analysis combining 77 studies and 165,705 patients to predict the accuracy of postoperative mortality using the ASA physical status classification and found that even though it was a better predictor of postoperative mortality, it was more effective in settings with lower than higher death rates (Koo et al., 2015). My patient will be considered to be an ASA class II as patient underneath this category are those with mild systemic disease.

A study by Hollenberg and colleagues found that diabetes is one of the five independent risk factors for postoperative myocardial ischemia and insulin-independent diabetes is one of the

five clinical risk factors on the Revised Cardiac Risk Index and this index looks for major cardiac complications, including cardiac arrest, myocardial infarction, heart failure and heart block. The preoperative assessment of cardiac risk is done according to the American College of Cardiology/American Heart Association guidelines (Miller & Richman, 2016).

A retrospective observational study was conducted by Kallio et al. (2015) to test the hypothesis that anesthesia preoperative clinic referral for elevated glycosylated hemoglobin reduces complication rates after total joint arthroplasty. The total number of patients in this study was 203 with and without DM selected from 1,237 patients undergoing TJA from 2006 to 2012. Patients who were evaluated in the anesthesia preoperative clinic had surgery in 2006 to 2008 irrespective of HbA1c. Patients evaluated in two year intervals were referred to primary care for HbA1c greater than 10% and 8% respectively to improve glycemic control before surgery. Complications and mortality were quantified postoperatively at three, six and twelve months. Length of stay and prolonged stays (greater than 5 days) were recorded. The results of this study showed that patients undergoing TJA with uncontrolled HbA1c and those with HbA1c less than 10% but not those with HbA1c less than 8% had a higher incidence of coronary artery disease and hypercholesterolemia and increased complication rates than patients without DM. Also complication rates significantly decreased with tighter HbA1c control. The study saw an increase in prolonged hospital stay for DM patients with uncontrolled HbA1c greater than 10% versus those without DM. From this study we see the importance in referring DM patients to primary care providers for preoperative evaluations as it reduced complications rates and the incidence of prolonged hospitalizations during the first year after surgery in diabetics undergoing TJA.

### **Perioperative Glycemic Management**

There is an increased mortality for diabetics undergoing surgery, especially Type 1 diabetics who are particularly at risk for postoperative complications. The successful management of the type 1 diabetic patient during surgery therefore requires safe and simple protocols that can be understood by all staff to decrease surgical errors and optimize glycemic control.

There have been several management strategies proposed to maintain target range glucose perioperatively, but there is no consensus as to what strategy remains optimal. According to Khan et al. (2015), most protocols for insulin administration have been formulated by expert opinion and clinical experience. Decisions as to which strategy to use will depend on the hospital setting, individual patient, resources and clinician judgement. In a meta-analysis of 12 randomized trials, with 1,403 diabetic patients, intensive (<120 or <150mg/dL) versus conventional (variable) glycemic control during the perioperative period, intensive glycemic control perioperatively was not associated with any reduction in infectious complications, cardiovascular events or mortality but had an increased risk for hypoglycemia. In this study the mean difference for achieving blood glucose levels between the intensive and conventional group ranged from -13 to 91 mg/dL (0.72 to 5.0 mmol/L) (Khan.,Ghali.,Cagliero,2015).

Buchleitner et al., in a systemic review identified 12 trials randomizing 694 diabetic participants to the intensive control group and 709 diabetic participants to the conventional glycemic control group, with mean age at 64 years. Duration of intervention ranged from the duration of the surgical procedure up to 90 days. Despite achieving low blood glucose concentrations during the perioperative period, intensive glucose control did not significantly reduce the risk of important postoperative outcomes such as infections, cardiovascular

complications, renal failure or increased hospital stay. However intensive glycemic control was associated with increased hypoglycemia episodes in diabetic patients in the intensive glycemic group. The authors came to the conclusion that intensive glycemic control protocols with blood glucose near normal targets for patients with diabetes mellitus undergoing surgical procedures are currently not supported by an adequate scientific basis. For the future studies, these authors recommend that insulin protocols, patient and healthcare outcomes should be defined in a thorough and uniform way (Buchleitner et al., 2012).

Another study by Van den Berghe and colleagues on intensive insulin therapy in the surgical intensive care unit showed that patients demonstrated a major reduction in morbidity and mortality when glucose levels were controlled strictly, ranging from 80 to 110mg/dL, averaging 103 mg/dL, compared with conventional control of 180 to 200 mg/dL. The study also demonstrated benefits of intensive glycemic control which was seen to reduce outcomes such as sepsis, need for dialysis, need for blood transfusion and the development of polyneuropathy. Intensive insulin therapy also led to cost saving compared to conventional insulin therapy (Meneghini, 2009).

Finfer et al. (2009), designed a Normoglycemia in Intensive Care Evaluation-Survival Using Glucose Algorithm Regulation (NICE-SUGAR) trial to test the hypothesis that intensive glucose control reduced mortality at 90 days. A randomized controlled trial included adult medical and surgical patients admitted to the ICU of 42 hospitals were assigned to an intensive control target (81 to 108 mg/dL) and a conventional control target of 180 mg/dL or less. Blood glucose control was obtained with use of an intravenous infusion of insulin and saline. Blood glucose measurements were obtained by arterial blood gas analyzers, laboratory analyzers or by point-of-care. Use of capillary sample were discouraged. Results of this study showed that 206

out of 3,016 patients in the intensive control group experienced severe hypoglycemia (blood glucose <40mg/dL) compared to 15 of the 3,014 patients in the conventional control group. There was also no significant difference between the two treatment groups in regards to the average number of days in the ICU, hospital or renal-replacement therapy. This study therefore concludes that there is an increase in mortality among ICU adult patients with intensive glucose control of 81 to 108 mg/dL compared to lower mortality when blood glucose targets are 180mg/dL or less (Finfer et al., 2009).

However, the Society for Ambulatory Anesthesia states that even though hyperglycemia may be linked to increased morbidity and mortality in diabetic patients undergoing major surgery, several randomized controlled trials evaluating tight perioperative glycemic control (80 and 110mg/dL) have reported inconsistent results, with some studies reporting harm to patients. Tight control warrants frequent blood glucose monitoring making glycemic management more complex. Regardless of the above studies, major professional organizations such as the Centers for Medicare and Medicaid Services, recommend tight glycemic perioperative control as a national quality improvement initiative (Joshi et al., 2010).

Despite differences with above findings most of the author's main goal for the perioperative period is to avoid hypo or hyperglycemia and maintain adequate blood glucose control to decrease morbidity and mortality in the diabetic patient especially the adult type 1 diabetic patient.

Sudhakaran and Surani, (2015), in light of recent research have proposed perioperative management guidelines for the diabetic patient. Type 1 diabetic patient need to continue a basal insulin replacement preoperatively (0.2 to 0.3 U/kg/day) of a long acting insulin. For intraoperative glycemic management, even though there is no consensus for target range, current



literature suggest keeping blood glucose levels between 150 and 200 mg/dL during surgery. This is due to studies that have found increased morbidity and mortality with intraoperative hyperglycemia (glucose above 200mg/dL) as well as relative normoglycemia (glucose less than 140mg/dL) also found to be associated with significant mortality and morbidity.

Khan et al, 2015, suggest that for short procedures lasting less than 2 hours, type 1 diabetic patients who use insulin can continue subcutaneous insulin perioperatively rather than an insulin infusion. For morning procedures patients should also delay taking their morning insulin until after surgery and before they eat. 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, with catheter and pump remaining safely in place during surgery. Preoperative hypoglycemia can be avoided in patients with a known history of hypoglycemia as an outpatient by reducing their basal rate by 10 to 20%.

Khan et al., 2015 recommend that for long complex procedures, IV insulin is usually required. 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, attributed to different rates of insulin absorption when hypothermia, vasoconstriction or hypoperfusion occurs. Many studies have shown the safety of IV insulin infusions in highly monitored settings. Also insulin infusions can be more readily titrated due to its short half-life of IV insulin (5 to 10 minutes), enabling more precise glucose control. With IV insulin infusions, blood glucose should be monitored every hour and more frequently if blood glucose levels are <100mg/dL or it rates fall rapidly which can be an indication for hypoglycemia. Preferred method for intraoperative glucose testing is by laboratory or point of care testing, not finger stick glucose levels as they are less reliable. For sedated anesthetized

patients, with a blood glucose less than 70 mg/dL IV dextrose 25mg is administered and repeat glucose measurements in 5 to 10 minutes. In the awake patient that can swallow, symptomatic hypoglycemia is treated with at least 15 g of carbohydrate. (Khan et al. 2015)

The American Association of Clinical Endocrinologist and the ADA, 2009, recommend that IV infusion therapy be administered by means of validated protocols or computerized protocols enabling adjustments in insulin infusion rates based on glycemetic fluctuations and insulin dose. They emphasize on the fact that systems put in place to ease the appropriate use of scheduled insulin therapy, with institutional support for inpatient personnel who are knowledgeable in glycemetic management are important for achieving safe and reasonable levels of glycemetic control in hospitalized diabetic patients. A Portland Diabetic project, a 17 year prospective nonrandomized study of 4,864 patients with diabetes who underwent open-heart surgery, the implementation of a continuous IV insulin therapy to achieve predetermined target BG levels reduced the incidence of deep sternal wound infections by 66% resulting in a total net savings to the hospital of about 4,638 USD per patient (Furnary, Wu & Bookin, 2004; Moghissi et al., 2009).

Most recent recommendations from the American Diabetes Association (2016) about diabetes care in hospitals, recommend initiating insulin therapy for persistent hyperglycemia with blood sugars levels above 180mg/dL for critically ill patients and with target range of 140-180 mg/dL with a grade recommendation of grade A. Tighter glycemetic control may be needed for specific critically ill patients such as 110-140mg/dL as long as hypoglycemia can be prevented. Insulin infusion should be administered using validated or written or computerized protocols that allow for predefined adjustments of insulin (E grade). Hypoglycemia management protocols should be developed by each hospital with individualized plans to prevent

hypoglycemia for each patient (Grade E). The ADA, in their recent recommendations have also agreed that tight glycaemic control from research studies has led to increased mortality versus moderately controlled cohorts and have reflected these glycaemic changes mentioned above for diabetic hospitalized patients. Tight glycaemic control is therefore reserved for patients with a successful history in an outpatient setting who are stable clinically and can be maintained with glucose levels less than 140mg/dL (ADA, 2016)

Patridge et al. (2016), place clear emphasis the fact that hospitals and health care organizations have to come up with clear, concise and standardized national and international guidelines for inpatient management of type 1 diabetic patients with insulin pumps during surgery. As of yet most of recommendations are based on case reports with little evidence available to drive these recommendations as they are still non-standardized and based on local guidelines. With very limited research, on the use of insulin pump therapy during the perioperative period, the Joint British Diabetes Society (JBDS) have offered a set of guidelines and recommendations for the management of type 1 diabetes perioperatively.

The JBDS recommend that type 1 diabetic patients on insulin pumps undergoing surgery need to be reassured depending on the type of surgery that they will be receiving similar insulin therapy either through IV insulin or the form of multiple daily injections. Elective surgery for type 1 diabetic patients with adequate planning with the diabetic is recommended with HbA1c less than 8.5% using models like the Bournemouth diabetes surgical pre-assessment service to prevent micro and macrovascular complications. The JBDS also recommend that patients continue to use their insulin pumps and regimens for elective procedures while following instructions regarding fasting by the anesthetic team. Patridge et al, 2016 reviewed other recommendations from Australia recommending patients use 80% basal insulin rates upon

initiation of surgery used on a temporary basis and resumed to normal upon consciousness and when patient is able to manage their blood sugars. These conflict with recommendations from the United Kingdom for surgery as they recommend patients to continue their insulin at a 100% basal rate due to basal rate assessments done during the pre-operative assessment.

The JBDS also recommend the discontinuation of insulin pumps during major surgery replacing it with IV insulin which is started at least half an hour before discontinuing patient's insulin pump. They also strongly advise against using continuous glucose monitor devices attached to insulin pumps as a means of checking blood glucose during surgery due to discrepancies (Partridge et al., 2016).

Similar to other recommendations mentioned in the literature review it is strongly recommended that blood glucose be checked every hour preoperatively, perioperatively and postoperatively. As with other studies, Partridge et al, also assert that adequate glycemic targets during major and minor surgeries have been controversial as studies conducted by Van den Bergh proposing for tighter and conservative glycemic control (80-110 mg/dL), improving mortality compared with a more conservative approach have not been supported by the NICE-SUGAR study that opted for a more conservative blood sugar target, between 6mmol/l (108mg/dL) to 10mmol/l (180mg/dL).

Despite recommendations, studies, and epidemiologic studies, associating poor clinical outcomes to hypoglycemia, data show that insulin-induced hypoglycemia as causing direct harm to hospitalized patients is scarce. The strategies discussed above, even though effective have not been proven to optimally reduce outcomes of morbidity or mortality and the length of hospital stays. Many of the management strategies above require further investigation

### **Postoperative Glycemic Management**

Due to effects from anesthesia, and other postoperative complications, glycemic control during the postoperative phase for type 1 diabetic patients can pose a challenge to clinicians. To minimize postoperative complications diligent blood glucose management is very important.

During the postoperative phase, patients are usually transitioned to subcutaneous insulin when they begin eating or are transferred in to a lower-intensity of care after IV insulin infusions. Subcutaneous insulin must be administered 1-4 h before the discontinuation of IV insulin therapy to prevent hyperglycemia is the preferred methods of maintaining blood glucose control in the non-critical, non-ICU setting .With these recommendations, these authors note that “an effective transition regime has not been substantiated” (Moghissi et al.,2009). Recommendations by Khan et al, 2015, indicate continuation of insulin infusion postoperatively for patients who do not resume eating postoperatively and once food is tolerated they can be switched to subcutaneous insulin or insulin pump based on their outpatient regime to complement what is being eaten. It is important that basal insulin levels remain stable after intraoperative IV insulin discontinuation for type 1 diabetic patients to prevent diabetic ketoacidosis. Meanwhile there is no clear consensus on postoperative management other sources recommend the transition from IV to subcutaneous insulin 12 to 24 hours prior to stopping the insulin drip to reduce the change of diabetic ketoacidosis in type 1 diabetic patients (Sudhakaran & Surani,2015). The Society of Thoracic Surgeons as well as the AACE/ADA consensus recommend that postoperative glycemic ranges be between 140 to 180mg/dL. (Sudhakaran and Surani, 2015). The authors above from recent literature and recommendations all agree on adequate and safe glycemic control in the postoperative period while maintaining stable basal insulin levels for type 1 diabetics to prevent adverse outcomes such as diabetic ketoacidosis. All articles reviewed did not show a clear

consensus or any main optimal glycemic management during the postoperative period for type 1 diabetics.

Patridge et al. (2016), in regards to postoperative recommendations from the JBDS allow for hourly blood sugar checks until patients are fully conscious to make decisions regarding their insulin pumps. Also aware of post hyperglycemia for the conscious patient an hour or two hours after surgery the patient's insulin pump built in bolus calculator should be able to adjust the correct insulin dose needed to bring down the patient's blood glucose. Patients are also strongly encouraged to frequently monitor their blood sugars 1 to 2 days after surgery to re-establish their baseline status. These authors suggest that there have been studies showing benefits of lower fasting glucose on the first day postoperatively and more stable blood glucose in patients remaining on insulin pump therapy during elective surgery than those on non- insulin pump therapy even though trial designs and data in other studies remain ambiguous and inconclusive.

Transitioning the patient to the outpatient setting takes the responsibility from the hospital personnel to self-management by the type 1 diabetic patient. During the discharge process, successful transition requires a team approach by the endocrinologists, nurses, dieticians, diabetic educators, case managers, social workers and other involved clinicians. Before discharging patient to the home setting, certain areas such as understanding diabetes diagnosis, self- monitoring of BG at home, recognition, treatment and prevention of hyper or hypoglycemia, diet, how to administer BG lowering medications or ongoing management if on insulin pump will be very important to review with the patient (Moghissi et al,2009). This is done to identify areas of knowledge deficits in the type 1 diabetic patient so they can be better educated prior to discharge, leading to better self-management at home.

The ADA (2016) recommend follow up visit within one month post discharge for all diabetic patients who experienced hyperglycemia in the hospital with the patients primary care provider or endocrinologist. There should also be hospital guidelines to resume patient's medication regimen one to two days before discharge.

### **Learning Points**

- In the primary care setting, preoperative evaluations for the type 1 diabetic adult patient needing surgery are vital evaluations as they identify important risk factors before surgery that if missed can lead to adverse surgical outcomes. During this stage care coordination, medication reconciliation and management of presenting health problems are addressed which has led to a reduction perioperative and postoperative morbidity and mortality.
- Overtreatment or under treatment of hypoglycemia still remains a major safety concern during the perioperative and post-operative management of Type 1 diabetic patients and can be very challenging for clinicians. Proper identification of high risk patients is vital in the overall perioperative and postoperative management phase to prevent adverse surgical outcomes.
- Clear guidelines and protocols need to be developed by hospitals for the inpatient management of type 1 diabetic patients on insulin pumps with in service and education for all healthcare providers who are most likely to encounter these group of patients, in close collaboration with the diabetes team such as the endocrinologist and insulin pump nurse specialist.
- Intensive glycemic control programs for inpatient glycemic control for type 1 diabetic patients is backed by current evidence based research (even though studies reveal

conflicting data). Tight glycemic control appears to result in fewer in patient complications, reduced ICU and hospital stays, significant decreased morbidity and mortality and decreased cost.

- Proper discharge planning, thorough patient education and clear communication among the interdisciplinary team members and outpatient providers is critical in accomplishing a safe and successful transition to outpatient glycemic management.



## References

- Adams, A. L., Paxton, E. W., Wang, J. Q., Johnson, E. S., Bayliss, E. A., Ferrara, A., Nakasato, C., ... Namba, R. S. (January 01, 2013). Surgical Outcomes of Total Knee Replacement According to Diabetes Status and Glycemic Control, 2001 to 2009. *The Journal of Bone and Joint Surgery. American Volume*, 95(6), 481-7.
- American Diabetes Association (2016). Standards of Medical Care in Diabetes; Abridged for Primary Care Providers. (January 15, 2016). *Clinical Diabetes*, 34, 1, 3-21.
- American Diabetes Association (2016). All about Diabetes.
- Barker, P., Creasey, P. E., Dhatariya, K., Levy, N., Lipp, A., Nathanson, M. H., Penfold, N., Membership of the Working Party. (January 01, 2015). Peri-Operative Management of The Surgical Patient with Diabetes 2015: Association of Anaesthetists of Great Britain and Ireland. *Anaesthesia*, 70, 12, 1427-40.
- Buchleitner, A. M., Martínez-Alonso, M., Hernández, M., Solà, I., & Mauricio, D. (January 01, 2012). Perioperative Glycaemic Control for Diabetic Patients Undergoing Surgery. *The Cochrane Database of Systematic Reviews*, 9.
- Bolognesi, M. P., Marchant, M. H. J., Viens, N. A., Cook, C., Pietrobon, R., & Vail, T. P. (January 01, 2008). The Impact of Diabetes on Perioperative Patient Outcomes after Total Hip and Total Knee Arthroplasty in the United States. *The Journal of Arthroplasty*, 23, 6, 92-8.
- Center for Disease Control (2015). Basics about Diabetes.
- .

Chiang, J. L., Kirkman, M. S., Laffel, L. M., Peters, A. L., & Type 1 Diabetes Sourcebook

Authors. (January 01, 2014). Type 1 Diabetes through the Life Span: A Position

Statement of the American Diabetes Association. *Diabetes Care*, 37, 7, 2034-54.

Furnary, A. P., Wu, Y., & Bookin, S. O. (January 01, 2004). Effect of Hyperglycemia and

Continuous Intravenous Insulin Infusions on Outcomes of Cardiac Surgical Procedures:

The Portland Diabetic Project. *Endocrine Practice : Official Journal of the American*

*College of Endocrinology and the American Association of Clinical Endocrinologists*, 10.

Finfer, S., Chittock, D. R., Su, S. Y., Blair, D., Foster, D., Dhingra, V., Bellomo, R., NICE-

SUGAR Study Investigators. (January 01, 2009). Intensive versus Conventional Glucose

Control in Critically Ill Patients. *The New England Journal of Medicine*, 360, 13, 1283-

97.

Joshi, G. P., Chung, F., Vann, M. A., Ahmad, S., Gan, T. J., Goulson, D. T., Merrill, D. G.,

Society for Ambulatory Anesthesia. (January 01, 2010). Society for Ambulatory

Anesthesia Consensus Statement on Perioperative Blood Glucose Management in

Diabetic Patients Undergoing Ambulatory Surgery. *Anesthesia and Analgesia*, 111, 6,

1378-87.

Khan,A.N., Ghali,A,W., Cagliero.E.(2015). Perioperative Management of Blood Glucose in

Adults with Diabetes Mellitus. Retrieved from

<http://www.uptodate.com/contents/perioperative-management-of-blood-glucose-in-adults-with->

[diabetes](http://www.uptodate.com/contents/perioperative-management-of-blood-glucose-in-adults-with-diabetes)

[mellitus?source=search\\_result&search=perioperative+management+of+diabetes+mellitus](http://www.uptodate.com/contents/perioperative-management-of-blood-glucose-in-adults-with-diabetes)

[&selectedTitle=1~150](http://www.uptodate.com/contents/perioperative-management-of-blood-glucose-in-adults-with-diabetes)

- Kallio, P. J., Nolan, J., Olsen, A. C., Breakwell, S., Topp, R., & Pagel, P. S. (January 01, 2015). Anesthesia Preoperative Clinic Referral for Elevated HbA1c Reduces Complication Rate in Diabetic Patients Undergoing Total Joint Arthroplasty. *Anesthesiology and Pain Medicine*, 5, 3.)
- Koo, C. Y., Hyder, J. A., Wanderer, J. P., Eikermann, M., & Ramachandran, S. K. (January 01, 2015). A Meta-Analysis of the Predictive Accuracy of Postoperative Mortality Using the American Society of Anesthesiologists' Physical Status Classification System. *World Journal of Surgery*, 39, 1, 88-103.
- Lovecchio, F., Beal, M., Kwasny, M., & Manning, D. (2014). Do Patients with Insulin-Dependent and Noninsulin-dependent Diabetes Have Different Risks for Complications after Arthroplasty? *Clinical Orthopaedics and Related Research*, 472(11), 3570–3575. <http://doi.org.ezproxy.undmedlibrary.org/10.1007/s11999-014-3891-4>
- Meneghini, L. F. (January 01, 2009). Perioperative Management of Diabetes: Translating Evidence into Practice. *Cleveland Clinic Journal of Medicine*, 76, 53-9.
- Moghissi, E. S., Korytkowski, M. T., DiNardo, M., Einhorn, D., Hellman, R., Hirsch, I. B., Inzucchi, S. E., American Diabetes Association. (January 01, 2009). American Association of Clinical Endocrinologists and American Diabetes Association Consensus Statement on Inpatient Glycemic Control. *Diabetes Care*, 32, 6, 1119-31.
- Partridge, H., Perkins, B., Mathieu, S., Nicholls, A., & Adeniji, K. (January 01, 2016). Clinical Recommendations in the Management of the Patient with Type 1 Diabetes on Insulin Pump Therapy in the Perioperative Period: A Primer for the Anaesthetist. *British Journal of Anaesthesia*, 116, 1, 18-26.

- Rizvi, A. A., Chillag, S. A., & Chillag, K. J. (January 01, 2010). Perioperative Management of Diabetes and Hyperglycemia in Patients Undergoing Orthopaedic Surgery. *The Journal of the American Academy of Orthopaedic Surgeons*, 18, 7, 426-35.
- Sudhakaran, S., & Surani, S. R. (January 01, 2015). Guidelines for Perioperative Management of the Diabetic Patient. *Surgery Research and Practice*, 2015, 5, 1-8.
- Vann, M. A. (January 01, 2009). Perioperative Management of Ambulatory Surgical Patients with Diabetes Mellitus. *Current Opinion in Anaesthesiology*, 22, 6, 718-24.
- Williams, M. (2007). *Comprehensive hospital medicine: An evidence based approach*. Philadelphia: Saunders Elsevier.
- Wukich, D. K. (January 01, 2015). Diabetes and its Negative Impact on Outcomes in Orthopaedic Surgery. *World Journal of Orthopedics*, 6, 3, 331-9.
- Zambouri, A. (January 01, 2007). Preoperative Evaluation and Preparation for Anesthesia and Surgery. *Hippokratia*, 11, 1, 13-21.