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Tammy Branden  
tammy.branden@ndus.edu

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**Is there an Ideal Preoperative Glycated Hemoglobin for a Patient with Type 2 Diabetes Mellitus for Prevention of Postoperative Complications?**

Tammy Branden BSN

Family Nurse Practitioner Student

University of North Dakota

## PERMISSION

Title Is there an Ideal Pre-Operative Glycated Hemoglobin for a Patient with Type 2 Diabetes Mellitus for Prevention of Post-Operative Complications?  
Department Nursing  
Degree Master of Science

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Stanley R. Anderson

Date

March 13, 2020

### Abstract

Uncontrolled diabetes is a known risk factor for increasing the incidence of postoperative complications and one of the many challenges that providers often face when doing preoperative evaluations on patients with diabetes. We will look at a specific case study that describes a patient who presented for a preoperative evaluation for an elective right knee arthroplasty, who has type 2 diabetes mellitus, and compare the case study against the literature review analysis to determine if this patient should be cleared for surgery. A literature review was conducted using CINAHL complete and was found to have current literature regarding preoperative glycated hemoglobin for review. Upon analysis of the literature review studies, no definite consensus was appreciated regarding an ideal preoperative glycated hemoglobin value to reduce the risk of postoperative complications. Resources were lacking when taking additional factors into account, such as comorbidities and distinguishing between type 1 and type 2 diabetes variables. The question of an ideal preoperative glycated hemoglobin is a crucial one to address, for without a definitive answer the healthcare system is putting patients at risk of preventable postoperative complications and unnecessary hospital stays.

*Keywords: glycated hemoglobin, preoperative, postoperative complications*

Is there an ideal pre-operative glycated hemoglobin for a patient with type 2 diabetes mellitus for prevention of post-operative complications?

### **Background**

It is well known and widely agreed that people who have diabetes have a greater risk of post-operative surgical site infections, especially when they have elevated glycated hemoglobin (HbA1c) levels (Nicolini et al.,2018). An elevated glycated hemoglobin correlates with uncontrolled diabetes. However, there does not seem to be a consensus on what constitutes an elevated glycated hemoglobin in the literature reviewed.

The purpose of this paper is to use evidence-based research to evaluate what an ideal glycated hemoglobin should be preoperative to help decrease the risk of postoperative complications. While there may be a strong consensus that elevated blood sugars contribute to postoperative complications, there does not seem to be a consensus on an ideal preoperative glycated hemoglobin for a clinician who is performing a preoperative evaluation. Next, we will review a case study that will guide us in our literature review.

### **Case Report**

Name: T. Smith

Age; 46

Date of Visit: March

Examiner: Tammy Branden, FNP student at UND

Gender: Female

Race: Caucasian

Language: English

Historian: Patient, who is an excellent historian

**Chief Complaint:**

Preoperative evaluation for a right knee arthroplasty.

**History of Present Illness:**

A 46-year-old female presented to the clinic today for a preoperative evaluation for a right knee arthroplasty. She is scheduled to have surgery in 2 weeks with Dr. Knee. Patient reports that she suffered a meniscal tear in her right knee approximately 6 months ago when she fell on ice and her right knee slid under her. She is controlling her pain by taking Ibuprofen 600 mg TID and alternating with Tylenol 1000 mg TID. She is checking fasting blood sugars daily with stated results of "90-100." Denies any previous issues with anesthesia or any family members with malignant hyperthermia. Denies any recent URI symptoms. No known bleeding disorders. Does smoke one pack cigarettes per day.

**Current Medications:**

Lisinopril -10 mg daily

Metformin- 1000 mg BID

Rybelsus- 7 mg daily

Synthroid- 125 mcg daily

Aspirin – 81 mg daily

Tylenol – 1000 mg TID (pain related to right knee)

Ibuprofen – 600 mg TID (pain related to right knee)

**Allergies:**

Amoxicillin (hives)

Morphine (rash)

**Past Medical History:**

Hypertension

Obesity

Type 2 Diabetes (Diagnosed 3 years ago)

Hypothyroidism (Diagnosed one year ago)

Squamous Cell Skin Carcinoma (Right forearm)

**Past Surgical History:**

Hysterectomy (44 years old)

Skin biopsy (Right forearm, 2 years ago)

C Section x 2 (10/15 years ago)

**Family History:**

Father (Alive) CAD with stenting x3 @ age 55, prostate cancer, hypertension, hyperlipidemia

Mother (Alive) Breast cancer @ age 60, hypertension, obesity

Maternal Grandmother (Alive) Hypertension, breast cancer.

Maternal Grandfather (Alive) No known medical/mental health issues

Paternal Grandfather (Alive) hypertension, melanoma

Paternal Grandmother (Deceased) CVA @ age 80

Sister (Alive, 33y/o) No known medical/mental health issues

Brother (Alive, 28y/o) No known medical/mental health issues

**Social History:**

Married

2 children (10 & 15)

Tobacco: 1ppd x 20 years

Alcohol: Rare

Illicit drug use: None

Works full-time as an administrative assistant

**Review of Systems:**

**Constitutional:** Denies any fevers, chills, no weight loss, no activity change

**HEENT:** Denies any ear pain/drainage or sore throat, sinus pressure or drainage, denies any lymph soreness/enlargement

**Cardiovascular:** Denies any chest pain, SOB, can walk a block without SOB, denies leg swelling

**Pulmonary/Chest:** Denies any cough, wheezing

**Gastrointestinal:** Denies any nausea, vomiting, diarrhea, or constipation

**Genitourinary:** No dysuria, or frequency

**Musculoskeletal:** Right knee pain

**Hematologic:** Denies any bleeding issues regarding herself or her family

**Skin:** Denies any rashes, sores

**Physical Examination:**

**Vital signs:** BP: 136/88, Pulse: 78, R: 12 / Temp: 98.5F (oral) SPO2: 95% on RA

Height: 5'6", Weight: 211 lbs (95.9 kg) BMI: 34

**Constitutional:** She is orientated to person, place, and time. Appears well-developed and well-nourished. No acute distress.

**HEENT:**

**Right ear:** Tympanic membrane and external ear normal.

**Left ear:** Tympanic membrane and external ear normal.

**Nose:** No sinus tenderness. No sinus drainage.

**Moth/Throat:** Oropharynx is clear and moist. She does not have any dentures or missing teeth.

No oropharyngeal exudate.

**Neck:** Normal range of motion.

**Cardiovascular:** Regular rate and rhythm. Normal heart sounds, no murmurs heard.



**Pulmonary/Chest:** Effort normal and breath sounds normal. No respiratory distress, or wheezes.

**Abdominal:** Soft. Bowel sounds in all 4 quadrants. No distention or tenderness on palpation.

**Musculoskeletal:** No edema. **Right knee pain on palpation.**

**Lymphadenopathy:** No cervical adenopathy.

**Neurological:** Alert and orientated to person, place, and time.

**Skin:** Skin is warm. No sores or rashes noted.

**Psychiatric:** Normal mood and affect.

**Screening needed pre-operatively:**

CBC, CMP, HgbA1c, TSH, EKG

**Results:**

Hemoglobin, Platelets, Electrolytes are all WNL. TSH is WNL. HgbA1c is 6.2%. EKG is NSR.

Patient is fit to go ahead with surgery as of today's exam and lab work.

**Instructions:**

Please let Dr. Knee know if you develop any temperature ( $> 100.5$ ) or upper respiratory symptoms (cough, sinus issues, sore throat).

Stop taking your aspirin 7 days before your surgery.

Try and not smoke the day of your surgery.

Do not take any medications the day of your surgery. You may take all your medications (except your aspirin) as normal until the day of your surgery.

Risks of surgery and anesthesia including infection, bleeding, and death were reviewed with the patient. The patient was advised to notify her surgeon of any fevers or URI symptoms that come up between today and her surgery date.

## Literature Review

### Search Strategies

A literature search was performed using the Cumulative Index to Nursing and Allied Health Literature (CINAHL) complete database. Key words used in the search included a combination of terms including: (a) “diabetes”; (b) “surgery”; (c) “glycated hemoglobin”. The search was limited to the last 5 years, included only human subjects, peer-reviewed articles, and English text only. These limitations were intended to ensure the literature was current, pertained to the nursing discipline, and could be applicable to this paper’s analysis and evaluation. The search with (a) “surgery” and (b) “glycated hemoglobin” produced 142 articles. When the search was more detailed and included all three terms above “diabetes” AND “surgery” AND “glycated hemoglobin” it produced 73 articles with 12 being pertinent to the question presented.

No other searches were conducted beyond CINAHL complete, including reference sections or grey literature.

### Analysis of Literature

According to the Centers for Disease and Control Prevention (CDC), there are 34+ million Americans who currently live with diabetes and 88 million more who have pre-diabetes (CDC, 2020). This statistic is further broken down by the American Diabetes Association (ADA) which states the portion of these 34+ million Americans, who live with type 1 diabetes, is 1.6 million (ADA, 2020). These are staggering numbers. The gold standard for assessing these individuals with diabetes is a glycated hemoglobin laboratory test (ADA, 2020). This test shows how well the blood glucose has been controlled for the past two-three months and is performed every three-six months (ADA, 2020). The glycated hemoglobin can be tested by either a finger stick in the clinic office or by lab venipuncture. The laboratory results are provided in a

percentage and the percentage correlates with an average blood glucose (ADA, 2020). For example, a 7.0% result would correlate with an average blood glucose of 154 mg/dl over the past two-three months (ADA, 2020). The glycated hemoglobin value increases as the average blood glucoses increase (ADA, 2020). The goal glycated hemoglobin for most adults is <7.0% (ADA, 2020), but can be adjusted higher to accommodate for comorbidities, hypoglycemia unawareness, and safety.

While reviewing the preceding case, one can see that the patient has type 2 diabetes mellitus and is taking two different oral medications for it. She is undergoing an elective surgery, which raises the question of how her glycemic control preoperatively will affect her risk of postoperative complications.

Uncontrolled diabetes, “as measured by elevated HbA1c concentrations, has been associated with poor surgical outcomes for emergency and elective patients in many surgical specialties” (Dhatariya et al., 2016, p. 431). Breaking down the literature review articles by glycated hemoglobin results show that two studies cite a pre-operative HbA1c of  $\geq 6.5\%$  should be obtained (Goodenough et al., 2015; Shohat et al., 2018); one study cites that a HbA1c of 6-7% should be obtained (Biancari & Giordano, 2019); two studies recommend a HbA1c of 7.0 % (Pinxia Chen et al., 2018; Rollins et al., 2016) while yet another states  $\geq 7.0\%$  as a goal (Nicolini et al., 2018). Another study states a HbA1c of 7.5% as acceptable (Cancienne, Cooper, et al., 2017) while another gives  $\geq 8.0\%$  as acceptable (Hwang et al., 2015). Two studies state a preoperative HbA1c of 8.5% as reasonable (Dhatariya et al., 2016; Haines et al., 2018). One study did not give an actual glycated hemoglobin value and just stated that an elevated glycated hemoglobin contributes to surgical complications (Blankush et al., 2016) while another study

stated “increasing risk for superficial infection is found with increasing HbA1c levels”

(Cancienne, Werner, et al., 2017, p. 1646) but also did not give a glycated hemoglobin value.

More research is needed to determine what an ideal preoperative glycated hemoglobin value should be. A current consensus on an ideal preoperative glycated hemoglobin throughout these studies is lacking. This lack of consensus in the literature potentially puts patients with elevated glycated hemoglobin’s, undergoing elective procedures, at increased risks. The literature is lacking a specific guideline on when an elective surgery should be cancelled or postponed due to a glycated hemoglobin result. One must always look at their institution guidelines, however there should be a definitive consensus between the experts on this matter as well.

The studies support a significant linkage between a higher glycated hemoglobin and increased risk of complications postoperatively (Biancari & Giordano, 2019; Blankush et al., 2016; Cancienne, Cooper et al., 2017; Cancienne, Werner, et al., 2017; Dhatariya et al., 2016; Goodenough et al., 2015; Haines et al., 2018; Hwang et al., 2015; Nicolini et al., 2018; Rollins et al., 2016; Pinxia Chen et al., 2018; Shohat et al., 2018), although they do not agree on what constitutes an “elevated” glycated hemoglobin. Some of the postoperative complications that commonly occur with an elevated HgbA1c include surgical site infection, systemic infections, urinary tract infections, lower respiratory tract infections, acute kidney injury, acute coronary syndrome, pneumonia, intensive care admission, prolonged stay in hospital, and even death (Dhatariya et al., 2016).

One study that specifically looked at total knee arthroplasty in patients who have diabetes found:

Patient HbA1c levels were not reliable predictors of the risk of infection after total joint arthroplasty. Furthermore, the conventional cutoff HbA1c level of less than or equal to 7

was reported to have poor predictive value for the development of postoperative wound complications and prosthetic joint infection (Hwang et al., 2015, p. 1727).

This contrasted with another study focusing on total knee arthroplasty (TKA) and diabetes which found that a glycated hemoglobin level “greater than 8.0 mg/dL might serve as a threshold for an increased risk of deep postoperative infection after TKA (Cancienne, Werner et al., 2017, p.1727). Cancienne, Werner et al., (2017) also felt that the glycated hemoglobin was not adequate as an indicator of postoperative complications in and of itself.

Recent data that solely studied total knee arthroplasty recipients, who also had diabetes, found that there was a strong correlation between both joint and systemic complications in addition to an increase in the cost of care (Shohat et al., 2018). This same study stated that a patient should have a glycated hemoglobin of 6.5% pre-operatively and that they will cancel surgery if the pre-operative glycated hemoglobin is greater than 8.0% (Shohat et al., 2018). The American Diabetes Association takes the stand that surgery should not “be undertaken at all possible if the HbA1c exceeds 7%” (Rollins et al., 2016, p. 308).

Conversely, another study only analyzed the glycated hemoglobin without relation to a specific surgery, noted that there was a significant correlation between preoperative glycated hemoglobin and postoperative complications and stated that those who had a HgbA1c of 6.5% developed less complications than those who had a HgbA1c of 7.9% (Pinxia Chen et al., 2018). This is a difference between having an average blood sugar of 140 mg/dl versus 180 mg/dl respectively.

Blankush et al., (2016) found that in non-cardiac surgeries, if a preoperative glycated hemoglobin was less than 7%, chances of postoperative complications were greatly reduced.

Another broader study that did not identify a specific surgical population procedure, but studied only non-emergency surgeries in 2200 individuals, found a strong correlation between having sustained elevated blood sugars and an impaired immune system which could easily lead to postoperative complications (Blankush et al., 2016). The study also concluded that people with diabetes, no matter the preoperative level of glycated hemoglobin, generally did not do as well as those who did not have any diagnosis of diabetes (Blankush et al., 2016).

While the studies do concur that good glucose control prior to surgery is important, the studies also lack information in vital areas. There was no mention of comorbidities as something that could also put an individual with diabetes at an increased risk of postoperative complications or if a lower preoperative glycated hemoglobin would be indicated for such individuals versus someone with no comorbidities. Studies addressing this issue are becoming increasingly important as large numbers of people are living longer with diabetes, in congruence with other chronic health issues, and require preoperative clearance as well.

Another area where studies lack is in children and adults with type 1 diabetes. Most studies included participants who had type 2 diabetes. Although both type 1 and type 2 diabetes relate to blood sugar control, an individual with type 1 diabetes may have more volatile variations of blood glucose excursions and studies are needed to identify whether this would lead to an increased rate of postoperative complications in and of itself. In addition, someone with type 1 diabetes would most likely have had diabetes for numerous years when we compare type 1 and type 2 diabetes related to the usual younger onset of type 1 diabetes.

Comparing the above case report with the literature review analysis presented, one can easily become confused as to what an ideal preoperative glycated hemoglobin value should be.

We know that the patient has type 2 diabetes mellitus. She is on Metformin, and Rybelsus for her

diabetes control. Her glucose was reported as 98 mg/dl on her CMP panel and her HbA1c was reported as 6.2% which would indicate that she has controlled type 2 diabetes mellitus.

Theoretically, the patient in the case report would have a reduced risk of postoperative complications than someone who has a HbA1c of 10.0%. Therefore, it would be reasonable for this patient to go ahead with her scheduled right knee arthroplasty and one would anticipate a lower risk for postoperative complications.

However, if this patient presented for her preoperative clearance and everything was the same except her glycated hemoglobin came back at 12.0%, it is unclear where to go from there. From the literature review, one could conclude that this patient might be better off having the surgery cancelled and gaining better control of blood sugars prior to surgery to avoid postoperative complications. Although the studies agree that controlled glucose preoperative is desired, they do not give any direction as to how long someone should have controlled blood sugars preoperatively or a consensus on when to postpone surgery.

In a review of the literature it has been identified that more research is needed to help guide providers in selecting a specific preoperative glycated hemoglobin level to reduce patient risk. There is large variation between the studies themselves, much less any consensus on a specific glycated hemoglobin value. The one consensus supported throughout the studies reveal that the higher the preoperative glycated hemoglobin value the greater the risk of postoperative complications (Biancari et al., 2017; Blankush et al., 2016; Cancienne, Cooper et al., 2017; Cancienne, Werner et al., 2017; Dhatariya et al., 2016; Goodenough et al., 2015; Haines et al., 2018; Hwang et al., 2015; Nicolini et al., 2018; Pinxia Chen et al., 2018; Rollins et al., 2016; Shohat et al., 2018).

Until a specific guideline is created the determination for surgery will continue to be up to the surgeon.....potentially putting patients at greater risk for postoperative complications.

### **Learning Points**

- Literature supports that preoperative glucose control is a reliable indicator of postoperative complication risk.
- There is no consensus on a specific preoperative glycated hemoglobin number to be obtained prior to surgery. Know your institutions guidelines.
- Evidence is consistent in finding that a reduction in the preoperative glycated hemoglobin correlates directly with the reduction of postoperative complications.
- More studies are needed to come to a consensus on what constitutes adequate glucose control preoperatively as measured by the glycated hemoglobin.



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