A Preoperative Intervention to Improve Glycemic Control in Surgical Patients with Diabetes

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Pilot Project: A Preoperative Intervention to Improve Glycemic Control in Surgical Patients with Diabetes

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Abstract

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Kelsey Leanne Boyd

Perioperative hyperglycemia is reported in 20-40% of patients undergoing general surgery and is an independent risk factor for negative surgical outcomes. Patients with diabetes presenting to a local community hospital are at risk for negative surgical outcomes due to the lack of strategies to prevent perioperative hyperglycemia. This project aimed to implement and evaluate the usefulness of succinct diabetes education for preoperative total joint surgical patients with diabetes. The intervention was a nurse-led, face-to-face diabetes education session provided to total joint surgical patients with diabetes during a preoperative evaluation appointment, compared to usual care (no preoperative diabetes education). This project utilized a retrospective review consisting of an 8-week baseline period (usual care), followed by an 8-week active period (intervention received). Participants included all total joint surgical patients with and without diabetes during the described time periods selected by convenience. Outcome measures including glycemic control, length of stay (LOS), surgical site infections, and number of patients who received diabetes education were measured. Results were analyzed using descriptive statistics to evaluate the effectiveness and usefulness of the intervention. Participants in the active period showed a significant increase in the number of patients who received diabetes education (p <0.05). Of those participants, 48% reported never receiving formal diabetes education. Providing preoperative diabetes education was not associated with improved glycemic control, decreased LOS, or decrease in surgical associated infections (p > 0.05). Studies have shown providing diabetes education leads to improved glycemic control and reduces diabetes associated complications. This project shows the importance of identifying perioperative hyperglycemia and the clinical significance it has on surgical populations.
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Pilot Project: A Preoperative Intervention to Improve Glycemic Control in Surgical Patients with Diabetes

Perioperative hyperglycemia is reported in 20-40% of patients undergoing general surgery (Duggan et al., 2017). Perioperative hyperglycemia is an independent risk factor for negative surgical outcomes and can result in impaired healing, surgical site infections, increased length of stay (LOS), increased intensive care admission, and mortality (Rutan & Sommers, 2012). Preoperative optimization of glycemic control can improve surgical outcomes (Duggan et al., 2017). Patients with diabetes presenting to a local community hospital are at risk for negative surgical outcomes due to the lack of strategies to prevent perioperative hyperglycemia. Management of patients with diabetes undergoing surgery has been ineffective in targeting preoperative glycemic control and no educational strategies are in place to optimize glycemic control preoperatively. The aim of this project was to identify if a preoperative intervention for surgical patients with diabetes improved preoperative glycemic control and prevented negative surgical outcomes associated with perioperative hyperglycemia.

Problem Description

Diabetes mellitus is a nationwide epidemic. It is estimated that 34 million American’s have diabetes; and more than 88 million have prediabetes (American Diabetes Association [ADA], 2020). Of those affected, more than 7 million have diabetes that is undiagnosed, until faced with associated complications (ADA, 2020). Diabetes mellitus occurs when the body cannot make or effectively use its own insulin. Insulin, a hormone produced by the pancreas, binds to insulin receptors on the outside of the cell and produces a conformational change. This change leads to signal transduction and phosphorylation that opens glucose channels and allows glucose from ingested food to enter cells and be used for energy (Diabetes Research Institute
Without insulin, glucose channels remain closed, and cells are unable to utilize glucose for energy. Type 1 diabetes occurs when the body cannot produce its own insulin. Type 2 diabetes, the most common form of diabetes, occurs when the body cannot utilize insulin effectively, leading to insulin resistance (ADA, 2020). The insulin issues with both Type 1 and Type 2 diabetes result in high levels of glucose in the blood (hyperglycemia) because the insulin deficit keeps the glucose from being able to enter cells (ADA, 2020).

The ADA estimates that 25% of hospitalized patients have diabetes, and the prevalence of patients with diabetes undergoing surgery is increasing (Loh-Trivedi, 2011). Surgery and general anesthesia trigger a stress response that causes counterregulatory hormone secretion of hormones such as glucagon, epinephrine, and cortisol, which raise glucose levels (Khan et al., 2018). As a result, increased amounts of glucose are released into the blood stream and insulin production is reduced, leading to hyperglycemia. Patients without diabetes can compensate for this counterregulatory hormone response and maintain glycemic control. Patients with diabetes that experience hyperglycemia are often unable to produce a significant amount of insulin to counter this response, and thus will be unable to utilize glucose for energy processes needed in the surgical and anesthesia setting. This uncompensated hyperglycemia may result in impaired healing, increasing the risk for infections and diabetes associated complications.

In 2017, the estimated cost of diabetes in the United States was 327 billion dollars annually with the largest components being hospital inpatient care and diabetes related complications (ADA, 2020). Patients with diabetes have medical costs that are 2.3 times higher than patients without diabetes (ADA, 2020) and have a five times higher mortality rate (Loh-Trivedi, 2011). Diabetes education has been shown to improve glycemic control, prevent diabetes associated complications, decrease LOS, lower readmission rates, and reduce medical
expenditures. Healthcare providers play a key role in providing patient education (Ellis et al., 2003; Healy et al., 2013; Umpierrez et al., 2012).

Outpatient diabetes education programs that target lifestyle modifications required for optimal diabetes self-management are endorsed by current clinical practice guidelines (American Association of Diabetes Educators [AADE]. (2020); ADA, 2020; Umpierrez et al., 2012). Diabetes survival skills education is a brief and targeted approach that provides information on basic meal planning, medication administration, glucose monitoring, hypo/hyperglycemia detection, treatment, and prevention for any patients with diabetes. This education enables safe care at home and during transition to community resources for continued and expanded self-management education (Hardee et al., 2015). The hospital environment is often associated with stress to the patient and is not conducive to learning. Therefore, diabetes education provided to patients in this setting should be targeted, brief, and help patients access comprehensive diabetes education resources in their communities (Hardee et al., 2015).

At the community hospital of interest, there is not a standardized preoperative education plan for patients with diabetes. Additionally, there is not a diabetes educator available for inpatients with diabetes. This represented a concern for surgical patients with diabetes. Thus, a change in practice was proposed to address hyperglycemia in the surgical population.

Available Knowledge

A literature search was performed utilizing the approach of asking answerable questions by defining the population of interest, main intervention, comparison intervention, and clinical outcome of interest. This approach is known as asking a PICO question (Larrabee, 2009). The PICO question that guided this review was, “In adult surgical patients with diabetes, does preoperative diabetes education improve surgical outcomes compared to usual care?” Relevant
studies identified from the search were critically appraised and compiled into a findings table for synthesis. Information from the literature contributed to this pilot project’s design.

The search strategy aimed to find published studies and practice guidelines. An initial search of the databases CINHAL, PubMed, and Cochrane Library was commenced using key words: “preoperative, perioperative, diabetes, hyperglycemia, intervention, education and management”. Search limitations were placed for publications in the English language. Titles and abstracts were reviewed for inclusion of key words and relation to the PICO question.

The initial search strategy yielded 329 articles from three databases (CINHAL, PubMed, and Cochrane Library). Studies that did not include key words in the title or abstract and that did not directly relate to the PICO question were excluded. The remaining articles were reviewed for detailed evaluation. Six studies that met inclusion criteria were included in this proposal. Of the included studies, 4 were retrospective studies, 1 was a cluster randomized trial, and 1 was a meta-analysis.

**Literature Review Synthesis**

The studies’ interventions and outcome measures varied within the literature review. Two studies included early intervention of hyperglycemia to assess the effects on glycemic control and patient outcomes (Garg et al., 2018; Kyi et al., 2019). Two studies measured the effects diabetes education had on glycemic control and patient outcomes (Ellis et al., 2003; Healy et al., 2013). Two studies identified presurgical glycemic control for comparison to patient outcomes (Frisch et al., 2010; Underwood et al., 2014).

Several studies found the presence of perioperative hyperglycemia was associated with a longer LOS and increased incidence of complications (Frisch et al., 2010; Garg et al., 2018; Healy et al., 2013; Underwood et al., 2014). Although these studies used different design
methods, they support the notion that perioperative hyperglycemia negatively affects surgical outcomes. Within these studies it was identified that patients with diabetes had higher preoperative blood glucose levels than patients without diabetes (Frisch et al., 2010; Garg et al., 2018). Two studies found that early identification and management of hyperglycemia improved glycemic control and reduced the number of associated complications (Garg et al., 2018; Kyi et al., 2019). Three studies found that diabetes education improved glycemic control (Ellis et al., 2003; Garg et al., 2018; Healy et al., 2013). Education methods varied between the studies but identified that preoperative delivery of diabetes education improved surgical outcomes and decreased the rate of readmission which contributed to a cost savings. Interestingly, one study found that a face-to-face delivery of the diabetes education resulted in a greater degree of glycemic control (Ellis et al., 2003).

All included studies had limitations. The most common limitation identified was a retrospective study design that relied on historical data and accurate recordkeeping (Frisch et al., 2010; Garg et al., 2018; Healy et al., 2013; Underwood et al., 2014). Three studies identified a small sample size as a limitation, which increase the chance of bias and possibility of error (Ellis et al., 2003; Kyi et al., 2019; Underwood et al., 2014). Concern for the generalizability of the study findings based on demographics of the study population was also identified (Healy et al., 2013, Kyi et al., 2019, Underwood et al., 2014).

An overall weakness of the included studies is the difference in baseline and outcome measures assessed. This is a weakness because there is not a standardized value being assessed perioperatively and significant variation in practices exist.

Maintenance of internal validity of the studies was done by controlling for variability of patient demographics and characteristics. This was done by including comparison groups based
on different characteristics into the design (patients with diabetes vs. patients without diabetes) and matching patient characteristics between control and intervention group. External validity was marginally compromised by studies performed at a single center being less generalizable and a possible Hawthorne effect (Kyi et al., 2019).

Although there is substantial evidence within available literature linking hyperglycemia to adverse patient outcomes, all the included studies identified a need for conduction of randomized or prospective controlled trials to build upon the data base of interventions aiming to improve outcomes in patients experiencing perioperative hyperglycemia. Future research should identify what specific interventions reduce adverse patient outcomes associated with perioperative hyperglycemia, feasibility of preoperative interventions, and best timing for delivery of interventions.

**Rationale**

This project was guided by the Plan-Do-Check-Act change model (PDCA). PDCA is a four-step model for carrying out change that is utilized for quality improvement processes (American Society for Quality, 2020). This model was chosen because it allows the user to plan a change, implement an intervention, review results, and apply modifications to improve the original plan. Providing the opportunity to restart the PDCA model after completion of the cycle allows for continuous improvement.

We recognized the need for change to occur and utilized this model to “plan” our intervention. With the prevalence of diabetes on the rise, there is an imperative need for perioperative planning and management to prevent hyperglycemia. At a local community hospital, a lack of strategies to prevent perioperative hyperglycemia placed surgical patients with diabetes at risk for negative surgical outcomes. A synthesis of available literature identified
improving glycemic control through early identification and management of hyperglycemia and face-to-face delivery of preoperative diabetes education was associated with a reduction in associated complications and improved surgical outcomes (Ellis et al., 2003; Garg et al., 2018; Healy et al., 2013; Kyi et al., 2019). The community hospital lacked standardized preoperative education and perioperative management for surgical patients with diabetes resulting in inconsistent assessment and management of surgical patients with diabetes creating a gap in the standard of care. The Healthy People 2020 guidelines recommend increasing the proportion of adults diagnosed with diabetes who receive formal diabetes education (Healthy People, 2020). A combination of the identified problem, synthesis of literature, and application of available guidelines were used in developing the project design. The intervention, providing preoperative diabetes survival skills education, was expected to identify surgical patients with diabetes, optimize glycemic control preoperatively, and improve surgical outcomes. Implementation of the intervention occurred during the “do” phase of this model. During this phase, the project leader conducted an education session for preoperative evaluation staff in preparation for providing preoperative diabetes education to identified patients who would benefit. The preoperative evaluation staff then provided the education during an 8-week trial period. A retrospective chart review by the project leader to gather data represented the “check” phase of the model. Data collected during this review was evaluated for significance using statistical analysis and descriptive statistics. The fourth phase of this model is the “act” phase. During this phase, results were translated into recommendations for altering the original intervention and recycling through the PDCA model to work towards continuous improvement.
Specific Aims

The purpose of this project was to evaluate the usefulness of preoperative diabetes survival skills education on total joint surgical patients’ glycemic control and postoperative outcomes. Aims and objectives for this project include:

1) Implement a succinct diabetes education intervention for preoperative orthopedic surgical patients with diabetes.
   a. Educate preoperative evaluation clinic staff about succinct preoperative diabetes education and patients who could benefit.
   b. Identify preoperative orthopedic surgical patients who could potentially benefit from preoperative diabetes education.
   c. Evaluate staff perception and feasibility of the intervention.

2) Evaluate the usefulness of succinct diabetes education for preoperative orthopedic surgical patients with diabetes.
   a. Assess the number of patients with diabetes who receive diabetes education prior to their orthopedic surgery.
   b. Compare preoperative clinic and immediate preoperative blood glucose levels in patients with diabetes before and after the intervention.
   c. Compare surgical outcomes, i.e., length of stay and rate of surgical site infections, in patients with diabetes before and after the intervention.

Methods

Context

Adult surgical patients with diabetes who underwent surgical procedures at a community hospital in West Virginia (WV) were the population of interest. Surgical populations for the
delivery of the project were considered, and those coming in for a face-to-face preoperative evaluation were deemed best candidates as a meta-analysis by Ellis et al. (2003) showed that face-to-face delivery of diabetes education resulted in a greater degree of glycemic control. The surgical populations presenting for a face-to-face preoperative evaluation consisted of patients being evaluated for total joint, cardiac, and vascular procedures. Cardiac and vascular procedures are not always elective, and often will occur despite uncontrolled diabetes. Total joint surgical procedures are projected to be the most common elective surgical procedure in the next decade (Kremers et al., 2015), and were determined to be the ideal surgical population for this pilot project.

**Intervention**

Preoperative orthopedic surgical patients present to the orthopedic surgeon’s office in an office separate from the community hospital. If the surgeon and patient agree that a total joint surgical procedure is recommended, a preoperative evaluation is ordered and is performed by a preoperative RN at the nearby community hospital. The surgeon orders labs and any diagnostic tests on a patient-by-patient basis. All orthopedic surgical patients with diabetes receive a basic metabolic panel (BMP) and a hemoglobin A1C if not performed within the previous 3 months. Lab results are reviewed by the community hospital’s preoperative nurses. If a surgical patient is found to have poorly controlled diabetes, current practice is to report the finding to the orthopedic surgeon’s office who then refers the patient to their primary care provider (PCP) for glucose control prior to undergoing surgical intervention.

This project directed total joint surgical patients with diabetes to a nurse-led, face-to-face diabetes survival skills education session during the community hospitals preoperative evaluation appointment described above. This education session served to provide education preemptively
and did not replace referral to the patient’s PCP if deemed necessary by the orthopedic surgeon. Preoperative Evaluation Clinic nurses educated the patients utilizing an education packet containing a preoperative information card, *Stay on TOP of Your Blood Glucose*, a DM survival skills booklet, *How to Thrive: A Guide for Your Journey with Diabetes*, and a flyer, *Diabetes Learning Center*. The preoperative RN documented the patient education in the electronic health record (EHR), which was a data point to collect and evaluate whether providing preoperative diabetes education improved preoperative glycemic control. In addition, the preoperative RN collected data regarding previous diabetes self-management education via survey, to serve as a comparison during evaluation.

The education packet was provided to each surgical patient with diabetes as take-home material to reinforce instruction. *Stay on TOP of Your Blood Glucose* emphasized the target blood glucose endorsed by the community hospital for preoperative surgical patients (Appendix G). American Diabetes Association booklet, *How to Thrive: A Guide for Your Journey with Diabetes*, highlights diabetes survival skills including basic meal planning, medication administration, glucose monitoring, hypo/hyperglycemia detection, treatment, and prevention. The Diabetes Learning Center Flyer describes the local outpatient resources to learn how to modify lifestyle, improve nutrition, and manage overall health as a patient with diabetes.

Preoperative nurses were prepared for this new responsibility through an educational session led by the project leader. A face-to-face educational session was conducted during regular working hours. The project leader reviewed background information, importance of providing diabetes education, clinical practice guidelines, explained the practice change, and provided the education packet for distribution to surgical patients with diabetes. Contact
information for a diabetes educator affiliated with the organization was provided to serve as a content expert resource for preoperative nurses.

**Gaps in Evidence**

A research gap in preoperative interventions to reduce hyperglycemia and improve surgical outcomes was identified from available literature. This pilot project implemented a nurse led preoperative intervention through face-to-face DM education. Providing face-to-face education in the preoperative period may be more successful in improving preoperative glycemic control and improving patient outcomes.

**Benchmarks**

Evidence has shown that early intervention and diabetes education has been successful in improving glycemic control and reducing negative patient outcomes. The Healthy People 2020 guidelines recommend increasing the proportion of adults diagnosed with diabetes who receive formal diabetes education (Healthy People, 2020). The pilot project’s intervention to provide preoperative diabetes education will help to meet this benchmark.

**Feasibility Analysis**

**Needs Assessment.** The community hospital for implementation of this project lacks standardized preoperative education and perioperative management for surgical patients with diabetes. The resulting inconsistent assessment and management of surgical patients with diabetes undergoing surgical procedures creates a gap in the standard of care and highlights the need for practice change to occur. An estimated 25% of patients with diabetes will require surgery (Loh-Trivedi, M. (2011). In addition, 16% of the adult population in WV has diabetes—the highest rate in the United States (CDC, 2018). Patients with diabetes have an increased risk of associated complications and experience mortality rates 5 times higher than patients without
diabetes. With the aging baby boomer population, total joint procedures are projected to become the most common elective surgical procedure in the next decade (Kremers et al., 2015). This unprecedented demand in combination with surgical risk factors for patients with diabetes demonstrates an imperative need to be addressed through perioperative planning and management.

**Budget.** Organizational cost for project implementation was projected to be low. The space needed to deliver diabetes education was already established and in use by preoperative RNs for face-to-face evaluations and will not contribute to overall costs. Employees participating in this project did not perform tasks outside of their current roles or defined full time equivalent within the organization. Educational sessions for preoperative RNs and employee execution of the intervention were performed in congruence with established workflow; associated cost were covered by hourly wage contribution by the organization. Education packets containing *Stay on TOP of your Blood glucose, How to Thrive: A Guide for Your Journey with Diabetes*, and the Diabetes Learning Center flyer will be covered by personal contribution from the student. A full breakdown of employee time contribution and associated “in kind” cost is provided in a budget plan form in Appendix A. Project leader contribution to this project was anticipated to exceed 350 hours.

**Personnel.** Project stakeholders included the project leader (student), orthopedic surgeon, unit manager, unit nurses, diabetes educator, and patients with diabetes undergoing total joint surgical procedures. The project leader was responsible for educating staff, monitoring the implementation of the intervention, assessing needs from involved personnel, and evaluating outcomes. The orthopedic surgeon who oversees quality improvement efforts of the orthopedic surgery population gave verbal support of the project. The unit manager served as a resource for
staff and helped drive project implementation. Preoperative evaluation clinic nurses provided the education to the selected patient population. Registered nurses caring for the patients the day of surgery were provided a brief overview of the project design and received reminders to be diligent in obtaining preoperative blood glucose values on the identified population. The diabetes educator served as the content expert for this project and was a resource to the preoperative evaluation nurses providing diabetes education.

**Technology.** All technology needs identified were available and in use by the unit staff including the EHR and glucometers. No patient identifiers were collected. To protect the integrity of this project, all project materials were stored using an encrypted thumb drive. Preoperative surveys completed by the RN were stored in a locked cabinet at the community hospital. The student collected and entered data into an Excel spread sheet on a weekly basis. Once inserted, the original forms were confidentially shredded, never leaving the community hospital. During project evaluation, outcome data was pulled from the EHR through retrospective chart review and immediately entered into a spreadsheet for statistical analysis. This data was also protected using an encrypted thumb drive and contained no patient identifiers.

**Congruence with the Organizations Strategic Plan.** The community hospital for this project has a mission to enhance the health of communities they serve, one person at a time (Mission Statement, 2020). The health system’s vision and values focus on “providing an extraordinary patient experience, compassionate care, and clinical excellence” (Mission Statement, 2020). The community hospital’s strategic plan emphasizes the need to reinvent delivery of care to make healthcare more affordable and accessible to ultimately enhance the health of the communities they serve. This pilot project’s overarching goal was to improve the
health of patients with diabetes which aligns with the mission, vision, and values of the organization.

**Evidence of key site support.** The unit manager who oversees all perioperative staff provided written support for this project. In addition, verbal support and commitment was obtained from the orthopedic surgeon overseeing quality improvement within the designated population. The diabetes educator serving as a content expert was willing and motivated to be involved in a change process to improve the care for surgical patients with diabetes. Registered Nurses within the preoperative unit were supportive of the change process and looked forward to contributing to their patients’ outcomes beyond the preoperative period.

**Evaluation Plan**

This project utilized the logic model to guide evaluation and can be found in Appendix B (Hickey & Brosnan, 2017). Outcomes for this project include implementing and evaluating the usefulness of a succinct diabetes education intervention for preoperative orthopedic surgical patients with diabetes. Outcomes were measured by gathering data through a retrospective chart review and comparing the data of the non-intervention group to the intervention group. The non-intervention group included all total joint surgical patients with and without diabetes from June 1st, 2020, to July 31st, 2020. The intervention group included all total joint surgical patients with and without diabetes from March 1st, 2021, to April 30th, 2021. The data intake tool utilized is available in Appendix D. Inputs include the volunteered time from the project leader, time contributed by staff and participants, and the readiness of staff to participate in providing diabetes education. Inputs were assessed by post intervention survey of preoperative evaluation staff. Activities include training preoperative evaluation staff on providing preoperative diabetes education and the staff providing the education to identified surgical patients who would benefit.
Activities were assessed by retrospective chart review. Outputs include blood glucose values, LOS, incidence of surgical associated infections, and incidence of diabetes education. The evaluation plan is outlined in Appendix C.

**Measurable Aims**

**Primary Aim.** Implement a succinct diabetes education intervention for preoperative orthopedic surgical patients with diabetes.

**First Objective.** The project leader created an educational session that included background information, importance of providing preoperative diabetes education, clinical practice guidelines, and highlighted the new preoperative diabetes education session to be performed. Preoperative evaluation clinic staff who performed preoperative evaluation assessments were identified and attended the project leader’s educational session. After the session, preoperative evaluation clinic staff performed a mock preoperative diabetes educational session utilizing a teach back method using the project leader as the identified orthopedic surgical patient with diabetes. The objective was successfully met upon completion of the mock preoperative diabetes education by the preoperative evaluation clinic staff.

**Second Objective.** Preoperative evaluation staff were educated on the target population for preoperative diabetes education during the educational session. Upon implementation of the intervention, staff were responsible for identifying total joint surgical patients with diabetes at the preoperative evaluation appointment and providing diabetes survival skill education to patients with a documented history of diabetes. Completion of the education session was documented in the patient’s EHR. A list of all total joint surgical patients was provided to the project leader to evaluate the completion of diabetes survival skill education through
retrospective review. The objective was met by comparing the number of patients who received diabetes education between the non-intervention group and the intervention group.

**Third Objective.** Evaluation of staff perception and feasibility of providing preoperative evaluation diabetes education was performed by providing a postintervention survey to preoperative evaluation staff who participated in the project implementation. The survey was administered via Qualtrics survey software. Participants received an email with the survey link and rated perception and feasibility of the intervention on a four-point scale from “definitely not” to “definitely yes”. Additionally, one question included an area to provide qualitative data about the intervention. The objective was met upon completion of the survey for the project leader to evaluate.

**Secondary Aim.** Evaluate the usefulness of succinct diabetes education for preoperative orthopedic surgical patients with diabetes.

**First Objective.** To assess the number of patients who received diabetes education prior to their orthopedic surgery a pre intervention survey was created by the project leader. This survey had two questions 1) Have you received formal diabetes education? And 2) If so, how long ago was it received? Participants could choose from more than one year, about a year, or less than a year. Preoperative evaluation staff provided this survey to the identified patients who would benefit from receiving diabetes education. No patient identifying information was included in the survey and preoperative evaluation staff stored completed surveys in a locked cabinet. The project leader collected completed surveys after the 8-week implementation period, recorded results, and disposed of the surveys in a confidential bin. This objective was completed upon completion of the intervention period and successful evaluation of survey results.
Second Objective. To compare preoperative clinic and immediate postoperative blood glucose levels in participants with diabetes before and after the intervention, a list of total joint surgical patients for June 1st, 2020, to July 31st, 2020 and March 1st, 2021, to April 30th, 2021 was provided to the project leader. The project leader performed a retrospective chart review and collected preoperative clinic and immediate preoperative blood glucose values for all total joint surgical patients with and without diabetes during the specified times. Blood glucose values were evaluated for glycemic control utilizing statistical analysis software, SPSS, in collaboration with Dr. Kesheng Wang, WVU School of Nursing’s statistician. A Shapiro Wilk test was performed to determine normality. For normally distributed data, a paired t test was performed. For non-normally distributed data, a Wilcoxon matched paired test was performed. This objective was successfully completed upon analysis of the data collected.

Third Objective. To compare surgical outcomes in patients with diabetes before and after the intervention, the project leader collected participants LOS during the retrospective chart review. Incidence of surgical associated infections was measured up to one month postoperatively and data was provided to the project leader by the orthopedic surgeon’s office. LOS was compared using SPSS for statistical analysis. A Shapiro Wilk test was performed to determine normality. For normally distributed data, an independent t test was performed. For non-normally distributed data, a Mann Whitney U test was performed. This objective was successfully completed upon analysis of the data collected.

Measures

The survey questions chosen to evaluate the outcomes of this project were adapted from current clinical practice guidelines from the American Diabetes Association stating all patients admitted to the hospital should receive diabetes education upon admission.
Prior to project implementation, total joint surgical patients presented for preoperative evaluations that were performed by preoperative evaluation staff. Implementation of this project did not alter this previously established process. Implementing the intervention without altering the current workflow allowed for a true evaluation of the current process. For this reason, selecting total joint surgical patients as the ideal population for the delivery of face-to-face diabetes education contributed to the success and efficiency of this project.

The COVID-19 pandemic contributed to unforeseen circumstances during project development and implementation and could have prevented or delayed patients from receiving a preoperative evaluation appointment or cancelling their procedure all together. We did not collect or control for a history of COVID-19 and the effects of COVID-19 on patients’ blood glucose and outcome measures. This could have increased or decreased blood glucose values, LOS, and incidence of surgical infections and not be attributed to the intervention of providing preoperative diabetes education, which will be considered when evaluating the data.

The project leader collected all data following the data intake form during the retrospective chart review allowing for consistency and completeness. Only patients who had both a preoperative evaluation blood glucose and an immediate preoperative blood glucose were included in statistical analysis. Partially completed data and was excluded.

As planned, the cost of this project to the organization was minimal. The project leader donated the educational packets provided during the implementation period. All project interventions were performed during regular working hours and did not require additional working time from the preoperative evaluation staff.
Analysis

To draw inferences from the collected data, analysis occurred comparing two groups: non-intervention vs. intervention and patients with diabetes vs. patients without diabetes. Quantitative data was analyzed using descriptive statistics. Preoperative evaluation blood glucose values were compared to immediate preoperative blood glucose values. Demographic data, including patient age, gender, and BMI, was analyzed using frequency statistics.

To determine statistical significance data was analyzed using the statistical analysis software platform, Statistical Product and Service Solutions (SPSS). Consultation with the WVU School of Nursing statistician ensured accurate analysis and interpretation of results. A Shapiro Wilk test was performed to determine normality. To compare two sets of data that come from the same participants, normally distributed data was analyzed using a paired t test and non-normally distributed data was analyzed using a Wilcoxon matched paired test. To compare two sets of data that come from two independent groups, normally distributed data was analyzed using an independent t test and non-normally distributed data was analyzed using a Mann Whitney U test.

Analysis of the non-intervention group compared to the intervention group and patients with diabetes to patients without diabetes was a method used to understand the intended variation in the data. Factors that could have contributed to unintended variation in the data include increased time between the two groups and comparing blood glucose values on the same patient that occurred over two separate occasions. This variation was attempted to be minimized by collecting data on the non-intervention group during an 8-week period immediately prior to the intervention group.
Ethical Considerations

Established evidence and guidelines that have improved patient outcomes in similar contexts were used in the design of this project, which is intended to translate those improved outcomes to patients with diabetes in this community hospital’s population. The motives of this project were to provide an unrealized benefit to the patient by proactively treating hyperglycemia, to prevent the harmful effects of uncontrolled diabetes, and to disseminate the results so that all patients may benefit from its findings. The project proposal was submitted and approved by the West Virginia University Institutional Review Board (IRB) in addition to the community hospital’s Chief Executive Officer (CEO) and IRB. This project did not begin until approval was obtained from the WVU IRB and community hospital’s CEO. The potential benefits to project participants outweighed foreseeable risks.

At the time of project development, the project leader was employed by the community hospital creating a potential conflict of interest. It is possible that the project leader’s employment was a motivator for the preoperative evaluation clinic nurse during the implementation of this project.

Results

The first step of this project was providing an educational session to preoperative evaluation staff to prepare them for providing preoperative diabetes education to identified patients who would benefit. This educational session occurred on February 15, 2021, which allowed for preoperative evaluation staff to be present for the face-to-face delivery. The educational session included background information, importance of providing preoperative DM education, clinical practice guidelines, and highlighted the new preoperative DM education session to be performed. The diabetes education session entailed completing the preoperative
diabetes education survey, reviewing the information card and diabetes education flyer with the patient, and sending the education booklet home with the patient to review. Due to COVID-19, the community hospital limited preoperative evaluations for total joint surgical patients to be performed by one preoperative evaluation nurse. The identified preoperative evaluation nurse was provided with the education packet for review. The project leader then performed a mock education session using preoperative evaluation nurse as the intended patient. To confirm teaching and successfully evaluate the education session, the preoperative evaluation nurse demonstrated the teach back method and provided the project leader a mock diabetes education session. The project leader provided the identified preoperative evaluation RN with the preoperative diabetes education surveys and education packets to be utilized for project implementation.

Preoperative evaluation appointments ideally take place five days before a scheduled procedure. On February 22, 2021, the preoperative evaluation nurse began identifying total joint surgical patients whose procedure was scheduled on or after March 1, 2021, who could benefit from diabetes education. The intervention period began on March 1, 2021, and ended on April 23, 2021.

During the intervention period, the project leader collected data for the non-intervention group through retrospective review. It was intended that the non-intervention group would consist of patients with and without diabetes who had total joint surgical procedures during an 8-week period immediately prior to the intervention group. Due to COVID-19, the local community hospital experienced reduced capacity and cancelation of elective surgical procedures during the intended period. After collaboration with the unit manager, it was determined that the non-intervention group data would be collected from June 1st, 2020, through
July 24, 2020, because it contained near normal surgical volume. The unit manager provided the student with a list of all total joint surgical procedures completed during the non-intervention period. The project leader then performed the retrospective review and collected evaluation data including preoperative evaluation blood glucose, immediate preoperative blood glucose, and LOS. Demographic data including history of diabetes, age, gender, and BMI were also obtained. Data was inserted into the data intake form (Appendix D) and stored on a password protected USB. No patient identifying information was collected.

Upon completion of intervention period, the unit manager provided the student with a list of all the total joint surgical procedures completed during the intervention period. The project leader then performed a retrospective chart review gathering the same information and utilizing the same form as the non-intervention group.

After all data was collected through retrospective chart review the project leader transferred the data from the password protected USB into SPSS for statistical analysis. First, demographic data between the two groups was analyzed using frequency statistics. Patient characteristics during the two respective periods are compared in Table 1. During the intervention period, 106 total joint surgical procedures were completed. Of the 106 procedures, 27 were identified to have a documented history of diabetes and 25 received preoperative diabetes education. During the non-intervention period, 118 total joint surgical procedures were completed. Of the 118 procedures, 25 were identified to have a documented history of diabetes and 0 received diabetes education. When comparing the two groups, little variance in age and BMI was found between patients with diabetes. Increased variance was found when comparing patients with diabetes to patients without diabetes. Patients were, on average, obese and predominately female.
Next, the project leader assessed blood glucose values. Descriptive statistics of blood glucose values on patients in both groups with and without diabetes were assessed. In both groups, patients with diabetes exhibited an eleven-point increase in blood glucose values from the preoperative evaluation appointment to the immediate preoperative period (Table 2).

Comparison of preoperative evaluation blood glucose to immediate preoperative blood glucose was only possible to perform on patients with a history of diabetes. Patients without a documented history of diabetes do not receive an immediate preoperative blood glucose evaluation, which is standard care at the local community hospital. A Shapiro Wilk test was performed to determine normality. Data for patients with diabetes in non-intervention group and intervention group was not normally distributed (p <0.05). A paired t test was omitted and a Wilcoxin test was utilized. A Wilcoxin test is equivalent to a paired t test and is used to compare two sets of data that come from the same participants. Performance of a Wilcoxin test on both

<table>
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<tr>
<th>Characteristic</th>
<th>Non-Intervention</th>
<th>Intervention</th>
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<tbody>
<tr>
<td>N Without Diabetes</td>
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<td>106</td>
</tr>
<tr>
<td>N</td>
<td>93</td>
<td>79</td>
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<td>68.6 ± 8.7</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
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<td>57 (72%)</td>
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<tr>
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<td>38 (41%)</td>
<td>22 (28%)</td>
</tr>
<tr>
<td>N With Diabetes</td>
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<td>27</td>
</tr>
<tr>
<td>Age</td>
<td>65.2 ± 8.4</td>
<td>69.5 ± 8.4</td>
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<tr>
<td>BMI (kg/m²)</td>
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</tr>
<tr>
<td>Female</td>
<td>8 (32%)</td>
<td>20 (74%)</td>
</tr>
<tr>
<td>Male</td>
<td>17 (68%)</td>
<td>7 (26%)</td>
</tr>
</tbody>
</table>

Note: N = number of patients, Age = years, BMI = body mass index
groups with a history of diabetes found no statistical significance when comparing preoperative evaluation blood glucose to immediate preoperative blood glucose (p > 0.05).

Of the 224 charts reviewed, POE blood glucose levels were not obtained for 3 patients with DM and 13 patients without diabetes. Morning of surgery blood glucose values were omitted on 2 patients with DM but only obtained on 6 patients without diabetes. All partially completed data was omitted during statistical analysis.

The project leader assessed LOS using a day’s hours: minutes format. Analysis determined the data was not normally distributed. Therefore, comparison of the two groups was performed using a Mann Whitney U test that determined there was no statistical significance in the LOS for patients with and without diabetes (p > 0.05). The LOS for patients with diabetes increased from 1 23:59 ± 1 05:32 in the non-intervention group, to 2:09:51 ± 1:04:11 in the intervention group (Table 2).
The completed preoperative diabetes education surveys were collected from the preoperative evaluation nurse when the intervention period ended. The preoperative diabetes education survey was created by the project leader utilizing current clinical practice guidelines for providing diabetes education. This survey had two questions 1) Have you received formal diabetes education? And 2) If so, how long ago was it received? Participants could choose from more than one year, about a year, or less than a year. The results to the surveys were entered into SPSS and frequency statistics were ran on the data. From the intervention group, 25 preoperative diabetes education surveys were completed. Forty eight percent of the patients reported never receiving formal diabetes education (n=12). Of the patients who had received formal diabetes education, 40% received it over a year prior to their preoperative evaluation appointment (Figure 1). No patients in the non-intervention group received preoperative diabetes education.

Figure 1

*Fig 1. Depicts the distribution of results obtained from preoperative evaluation surveys given to total joint surgical patients with a history of diabetes. Forty eight percent of participants reported they had not received previous diabetes education. In comparison, 52% reported they had received previous diabetes education, of which, 40% was conducted over a year prior and 8% conducted less than a year prior.*
The project leader contacted the orthopedic surgeon’s office one month following completion of the intervention phase. The representative from the office informed the project leader that there had been no increase nor decrease in surgical site infections when comparing data from the non-intervention group to the intervention group.

The project leader distributed the post intervention staff perception survey upon completion of the intervention phase. As previously described, only one preoperative evaluation clinic nurse was responsible for completing preoperative evaluation appointments. For this reason, only one post intervention staff perception survey was available for evaluation.

Contextual elements that interacted with the intervention is the limited data received from the orthopedic surgeon’s office regarding surgical associated infections. With the information provided the project leader was unable to run descriptive statistics on the data to compare patients with diabetes to patients without diabetes. The COVID-19 pandemic interacted with the intervention by reducing surgical volumes and limiting the preoperative evaluation staff who performed preoperative evaluations. There is potential that without the pandemic a larger sample size could have been seen. The post intervention staff perception survey was impossible to keep anonymous and the results given on the survey could be skewed due to inaccurate reporting.

**Discussion**

**Summary**

Per the first aim of the project, the project leader successfully implemented a succinct diabetes education intervention for identified preoperative surgical patients with diabetes. Implementing preoperative diabetes education significantly increased the number of patients who received diabetes education which aligns with the ADA clinical practice guidelines and contributes to the usefulness of this project. The increased variation in blood glucose values and
LOS between patients with diabetes and without diabetes characterizes the importance of identifying perioperative hyperglycemia during the preoperative period and represents the usefulness of having a standardized approach for identifying and educating patients with diabetes, which is the second aim of this project. Strengths of this project include implementation of the intervention without alteration of established workflow and a single preoperative evaluation nurse responsible for project implementation. The lack of current strategies in place to identify and manage hyperglycemia in the preoperative period was highlighted by maintaining the current workflow and highlights the need for change to occur. A single preoperative evaluation clinic nurse providing the intervention allowed for consistency of delivery.

**Interpretation**

It was intended to have significance for improved glycemic control, LOS, and SSI. Lack thereof could be due to the limited variables measured for determining glycemic control, the amount of time between the intervention and the day of the surgical procedure, and the high standard deviation seen in patients without diabetes.

We assessed glycemic control by preoperative evaluation and immediate preoperative blood glucose values because obtaining these variables was an established practice at the community hospital. Adding additional measures to assess glycemic control would have changed the current workflow, which was not the intention of this project. Additional measures that could have been assessed to determine glycemic control include hemoglobin A1C (HbA1c), fructosamine, intraoperative blood glucose, and post operative blood glucose values. HbA1c measures the average blood glucose level over the past 3 months which does not reflect immediate glucose control. Even though the community hospital does assess HbA1c on orthopedic patients with diabetes, we did not include this variable in our evaluation because
recent studies have shown when comparing preoperative blood glucose and HbA1c, preoperative blood glucose was associated with an increased 30-day mortality whereas HbA1c was not (Park et al., 2021). This suggests that immediate glucose control may be more critical than long term glucose control in patients undergoing non-cardiac surgery.

At the community hospital, a preoperative evaluation appointment ideally occurs within 5 days of the scheduled procedure. We did not collect specific data pertaining to the length of time between the preoperative evaluations and scheduled procedures for either group. When comparing the data between the non-intervention and intervention group for patients with diabetes, the results were almost identical. It is possible that the limited time between the intervention and the scheduled procedure did not allow enough time for improved glycemic control; but again, increasing the amount of time between the preoperative evaluation appointment and the day of surgery would have altered the current workflow, which was not the intent of this project.

This project was completed amongst the highest rates of diabetes and obesity in the nation. We did not assess the prevalence of patients without diabetes who experienced hyperglycemia during the preoperative period, but the high standard deviation seen in blood glucose values in patients without diabetes could have contributed to the lack of significance in our results. This variance demonstrates the clinical significance and imperative need to evaluate the immediate preoperative blood glucose value for all patients regardless of their history of diabetes.

The intervention of providing face-to-face diabetes education for total joint surgical patients significantly increased the number of patients who received diabetes education. This aligns with current clinical practice guidelines that recommends providing diabetes self-
management education to all hospitalized patients with diabetes upon admission (ADA, 2019). Although this intervention did not show significance for all of the outcomes, it was designed to align with current literature suggesting that diabetes education improves glycemic control and more specifically that face-to-face delivery of diabetes education results in a greater degree of glycemic control (Ellis, 2004).

The ability to evaluate staff perception and feasibility of the intervention was limited due to one preoperative evaluation clinic nurse performing the intervention. While this tremendously reduced the number of post intervention staff perception surveys available for evaluation, it provided an unexpected benefit of uniformity in the delivery of the intervention. Providing preoperative diabetes education was described as easy and feasible to incorporate into routine practice.

The cost of providing preoperative diabetes education was minimal and provided a standardized process for ensuring patients with diabetes received the education. Diabetes education is associated with fewer readmissions and a lower cost of care (Healy, 2013). This project highlights the opportunity the community hospital has to experience cost savings by implementing interventions that ensure all patients receive diabetes education.

Limitations

This project included a small sample size (n=25) and was conducted at a single facility which could have made it difficult to identify significant relationships within the data set and limits generalizability of the results. Inclusion of a non-intervention group for comparison sought to counter concerns with generalizability.

Factors that may have limited internal validity include not utilizing measures that were tested for reliability and validity, not assessing a preintervention staff perception survey, not
controlling the amount of time between preoperative evaluation appointment and the day of the procedure, and not assessing different forms of glycemic control. Including tested measures for studying processes and outcomes of the intervention, such as perception surveys and data intake tools, could have strengthened project results and led to a better understanding of the feasibility and staff perception of the intervention. Controlling the amount of time between diabetes education and the day of surgery would improve uniformity in the intervention and strengthen validity of project results. Assessing only one form of glycemic control could have limited the significance of project results.

To avoid selection bias, we did not limit participants. Participants were selected by convenience. All total joint surgical patients with and without diabetes were included; only partial joint surgical patients were excluded. Confounding variables such as smoking status could have contributed to the results.

The region experienced a surge of COVID-19 during the intended project implementation window and delayed the implementation, which had unknown effects on project results and resulted in the inability to anonymously determine staff perception of the feasibility of the intervention. COVID-19 infection data for the project population was not collected.

**Conclusions**

With over 88 million Americans with prediabetes, the incidence of diabetes is on the rise (ADA, 2020). The ADA estimates that 25% of patients with diabetes will require surgery (Loh-Trivedi, 2011). Total joint surgical procedures are projected to be the most common elective surgical procedure in the next decade (Kremers et al., 2015), all of which contributes to the usefulness of this project.
Providing diabetes education, via face-to-face delivery, has been shown to improve glycemic control (Ellis et al., 2003; Garg et al., 2018; Healy et al., 2013). Preoperative delivery of diabetes education can improve surgical outcomes and decrease the rate of readmission (Ellis et al., 2003). Providing preoperative diabetes education aligns with current practice guidelines that recommend providing diabetes education to all hospitalized patients with diabetes upon admission (ADA, 2019). Healthcare providers play a key role in providing patient education (Ellis et al., 2003; Healy et al., 2013; Umpierrez et al., 2012). Preoperative evaluation clinic staff reported implementing preoperative diabetes education was easy and did not interfere with their current workflow, which contributes to the sustainability of this project. While it is feasible for the preoperative evaluation staff to provide diabetes education to surgical patients who present for a preoperative evaluation, the community hospital should reinstitute their diabetes education service to ensure all hospitalized patients are receiving diabetes education.

All surgical patients, but especially those with diabetes are vulnerable to perioperative hyperglycemia. The local community hospital should develop a method to flag surgical patients with diabetes to ensure early identification and management of patients experiencing perioperative hyperglycemia. Structured order sets that provide computerized advice for glucose control should be implemented for all surgical patients, beginning in the preoperative surgical unit. Computerized physician order entry (CPOE) for insulin protocols significantly improves the time patients spend in a target glucose range, lowers mean blood glucose levels, and is not associated with an increase in hypoglycemia (ADA, 2019). Insulin should be initiated for hyperglycemia starting at a threshold of >180 mg/DL, for a goal of 140 – 180 mg/dL (ADA, 2019).
Lessons learned from this project should be taken to alter the intervention and re-start the PDCA cycle. In addition to developing a standardized method for managing preoperative hyperglycemia, it is recommended that the community hospital increase the amount of time between the preoperative evaluation appointment and the day of the procedure. A minimum amount of time between preoperative evaluation appointment and the surgical procedure should be determined and standardized while testing an intervention. To determine glycemic control, a fructosamine level should be drawn on all total joint surgical patients. Fructosamine is a marker of glucose control reflecting the average glycemic level over the preceding 2-3 weeks. In orthopedic patients, high fructosamine levels have been correlated to increased SSI, readmissions, and reoperations in contrast to a high HbA1c which has not (Shohat, 2017). Fructosamine measurement is quick, technically simple, inexpensive, precise, fairly free of interferences, unaffected by red blood diseases and easily automated for use with microsample volumes (Nansseu, 2015).

If making changes to the current workflow and altering the intervention leads to improved surgical outcomes in total joint surgical patients, providing preoperative diabetes education to improve glycemic control could be expanded into a larger population and potentially become a standard of care at the community hospital.
References


## Appendix A

### Budget Plan and Justification Form

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<th>Budget Categories</th>
<th>Personal Funds</th>
<th>Organizational Contributions</th>
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<td>Education for staff implementing</td>
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<td>in congruence with current</td>
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<td>benefits. Throughout implementation</td>
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Appendix B

Logic Model

![Logic Model Diagram]
Appendix C

**Evaluation Plan**

**Purpose Statement:** The purpose of this proposed project is to implement preoperative diabetes education for surgical patients with diabetes to improve glycemic control and surgical outcomes.

<table>
<thead>
<tr>
<th>Aim(s)</th>
<th>Outcomes</th>
<th>Objective/Criteria</th>
<th>Target Population</th>
<th>What Data to Collect</th>
<th>Collection Methods</th>
<th>Data Analysis</th>
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<td>Implement a succinct diabetes education intervention for preoperative orthopedic surgical patients with diabetes</td>
<td>Verbalization of education</td>
<td>Educate preoperative evaluation clinic staff about succinct preoperative diabetes education and patients who could benefit.</td>
<td>Staff</td>
<td>Teach back of diabetes education</td>
<td>Diabetes education using project leader as the patient</td>
<td>Quantitative analysis using descriptive statistics, independent t-test</td>
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<td>Documented diabetes education</td>
<td>Identify preoperative orthopedic surgical patients who could potentially benefit from preoperative diabetes education.</td>
<td>Surgical patients with diabetes</td>
<td>Incidence of diabetes education</td>
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<tr>
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<td>Feasibility of the intervention</td>
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<td>Staff</td>
<td>Perception Survey</td>
<td>Review of post intervention perception survey</td>
<td>Qualitative analysis</td>
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<td>LOS and SSIs</td>
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## Evaluation Plan Data Intake Tool

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Appendix E

Preoperative Evaluation Survey

1. Have you previously received diabetes self-management education?
   a. Yes
   b. No

2. If Yes, how long ago?
   a. Less than a year
   b. About a year
   c. Longer than a year
Appendix F

Post Intervention Staff Perception Survey

1. Did you feel comfortable providing diabetes education to surgical patients with diabetes?
   i. Definitely, Yes
   ii. Somewhat, it depended on the patient
   iii. Definitely not, I would have liked more education

2. Would you like to receive additional education on providing diabetes education?
   i. Definitely yes
   ii. Probably yes
   iii. Probably not
   iv. Definitely not

3. Do you think providing diabetes education preoperatively made a positive impact on surgical patients with diabetes?
   i. Definitely yes
   ii. Probably yes
   iii. Probably not
   iv. Definitely not

4. Do you think continuing to provide preoperative diabetes education will allow you to maintain your current workflow?
   i. Definitely yes
   ii. Probably yes
   iii. Probably not
   iv. Definitely not

5. Do you want to continue providing preoperative diabetes education to surgical patients with diabetes?
   i. Definitely yes
   ii. Probably yes
   iii. Probably not
   iv. Definitely not

6. Do you think the ADA education booklet is informative for surgical patients with diabetes?
   i. Definitely yes
   ii. Probably yes
   iii. Probably not
   iv. Definitely not

7. Overall, providing diabetes education preoperatively was an easy task.
   i. Definitely yes
   ii. Probably yes
   iii. Probably not
   iv. Definitely not

8. Would you be able to provide preoperative diabetes education to all surgical patients with diabetes who attend a preoperative evaluation?
   i. Definitely yes
   ii. Probably yes
   iii. Probably not
   iv. Definitely not

9. Additional comments:
Appendix G

Information Card

Stay on TOP of Your Blood Glucose!

T – target blood glucose 80-180 mg/dl preoperatively
O – optimize your length of stay by controlling your blood glucose
P – prevent infections by controlling your blood glucose preoperatively