ENHANCED GLYCEMIC RECOVERY AFTER CARDIAC SURGERY:
A QUALITY IMPROVEMENT PROJECT

by

Tyah Jo Haro

Copyright © Tyah Jo Haro 2014

A DNP Project Submitted to the Faculty of the

COLLEGE OF NURSING

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF NURSING PRACTICE

In the Graduate College

THE UNIVERSITY OF ARIZONA

2014
As members of the Doctor of Nursing Practice (DNP) Project Committee, we certify that we have read the DNP Project prepared by Tyah Jo Haro entitled "Enhanced Glycemic Recovery After Cardiac Surgery" and recommend that it be accepted as fulfilling the DNP project requirement for the Degree of Doctor of Nursing Practice.

Matthew J. Gallek, RN, PhD, CNRN  
Clinical Assistant Professor  
Date: November 18, 2014

Kathleen A. Piotrowski, DNP, CRNA  
Date: November 18, 2014

Brian Buchner, DNP, APRN, ACNP  
Clinical Assistant Professor  
Date: November 18, 2014

Final approval and acceptance of this DNP Project is contingent upon the candidate’s submission of the final copies of the DNP Project to the Graduate College.

I hereby certify that I have read this DNP Project prepared under my direction and recommend that it be accepted as fulfilling the DNP Project requirement.

DNP Project Chair: Matthew J Gallek, RN, PhD, CNRN  
Clinical Assistant Professor  
Date: November 18, 2014
STATEMENT BY AUTHOR

This DNP Project has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this DNP Project are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: Tyah Jo Haro

__________________________________
ACKNOWLEDGEMENTS

Firstly I would like to thank my doctoral project advisor and committee members for their ongoing support, late night feedback, guidance, excitement, and encouragement throughout my education at the University of Arizona. Thank you Dr. Matthew Gallek, for providing years of patience and encouraging feedback towards my academic schedule and final project. I appreciated your random phone calls and late night feedback of new avenues to consider in my final project. Dr. Gallek was the most relaxed and collected individual I have ever encountered at the College of Nursing, which was a perfect match for my anxious behavior patterns surrounding my academic success. Dr. Brian Buchner never ceased to amaze me in his ability for comprehensive and scholastic writing while working as a full time clinician across the country. I only hope to write as eloquently as he does in my future research endeavors. Without Dr. Kathleen Piotrowski, I am not sure my passion for adult cardiac surgery patients would have remained so enthusiastic the past few years. I appreciated her genuine interest and encouragement in my research exploration. I would also like to thank the family members of my advisor and committee members, as I know their time and energy are priceless to you, yet you have shared them with me.

I would also like to thank my family. My darling husband, Abel Haro, has patiently supported my entire nursing career since 2006. Many nights he allowed me to cry on his shoulder, closing my textbooks and providing tissues without saying a word. He also provided ongoing celebration of my victories, regardless of how minute in the grand scheme of the academic agenda. I will always be grateful for his love, compassion, and emotional and physical support while I worked to accomplish my dreams. My parents and sister have also played a large role of my support system. I will always be indebted to my parents for providing my undergraduate nursing education, as it encouraged my progression into a doctoral program. I appreciated my parents and sister’s authentic interest in how classes and my final project were developing. My family was always available to dance around the living room in celebration for me. I love you all.

Lastly, I would like to thank my colleagues, my friends: Jennifer Creighton, Kim Krmpotic, Jill Krmpotic, Elizabeth Giminski, Cassandra Jenks, and Shanon Harper. Enduring this program with brilliant minds and energetic hearts made my academic studies survivable. Your words of encouragement, hysterical methods of motivation, celebratory beverages, and ongoing friendship have meant the world to me. I would not be where I am today without all your support.
DEDICATION

I dedicate this project to all the current and future Adult Gerontology Acute Care Nurse Practitioners in the field of cardiac surgery to encourage your involvement in clinical leadership by translating evidence into bedside practice.
## TABLE OF CONTENTS

**LIST OF ILLUSTRATIONS** .................................................................................................................. 10

**LIST OF TABLES** .............................................................................................................................. 11

**ABSTRACT** ......................................................................................................................................... 12

**CHAPTER I: INTRODUCTION** ........................................................................................................... 13

- Etiology of Hyperglycemia ................................................................................................................. 13
- Neuroendocrine stress response ......................................................................................................... 14
- Pre-operative fasting ......................................................................................................................... 15
- Diabetes ............................................................................................................................................. 15
- Current Practice ............................................................................................................................... 16
  - Pre-operative ................................................................................................................................. 16
  - Intra-operative ............................................................................................................................ 17
  - Post-operative ............................................................................................................................. 17
- Significance to Healthcare .................................................................................................................. 18
  - Morbidity and mortality of hyperglycemia .................................................................................. 18
  - Cost related consequences of hyperglycemia ............................................................................. 19
- SCIP Guidelines ............................................................................................................................... 20
  - SCIP nursing compliance and hypoglycemia .......................................................................... 21
- Purpose and Aims ............................................................................................................................ 22
  - Implementation tool via PDSA cycles ......................................................................................... 23
  - Conceptual framework and change theory ............................................................................... 23
- Significance for the Doctorate of Nursing Practice ....................................................................... 25
- Conclusion ...................................................................................................................................... 26

**CHAPTER II: LITERATURE REVIEW** ............................................................................................... 28

- Literature Search ............................................................................................................................ 28
  - Search terms ............................................................................................................................... 28
  - Exclusion criteria ....................................................................................................................... 28
- Review of Literature Findings ........................................................................................................ 29
  - SCIP and traditional glycemic control in cardiac surgery .......................................................... 29
  - Nutritional fasting and aspiration precautions ........................................................................... 30
  - Nutritional fasting and hyperglycemia in general surgery ........................................................... 30
  - Nutritional fasting and hyperglycemia in cardiac surgery ......................................................... 32
- Limitations ...................................................................................................................................... 33
- Conclusion with PICOT .................................................................................................................... 34
LIST OF ILLUSTRATIONS

FIGURE 1. Three Stages of Lewin’s Change Theory Model. .............................................. 24
LIST OF TABLES

TABLE 1. Organizational Plan Inputs and Outputs. .............................................. 42
TABLE 2. Service Utilization Plan for the Hungry Sweet Heart Protocol................. 43
TABLE 3. Evaluation Measures .............................................................................. 46
ABSTRACT

Hyperglycemia in adult cardiac surgery may result in post-operative sternal wound infections, pneumonia, renal failure, increased length of stay, and cost. The Surgical Care Improvement Project (SCIP) (2006) requires blood glucose control in cardiac surgery at 6:00 am on post-operative day one (POD1) and post-operative day two (POD2) to be 200mg/dL or less. Enhanced Recovery After Surgery (ERAS) guidelines use a Maltodextrin 12.5% carbohydrate beverage six hours and two hours pre-operative of general surgery to improve post-operative outcomes, cost, and length of stay. One study replicated ERAS guidelines in adult coronary artery bypass grafting surgery patients finding patients had decreased length of stay and improved glycemic control six hours postoperatively. The purpose of this quality improvement project is to outline a proactive approach to the modifiable risk factor of pre-operative fasting. This quality improvement project describes a pre-operative fasting carbohydrate protocol for non-emergent, adults, scheduled for cardiac surgery at 10:00am or later, with a hemoglobin A1C of 8.4% or less, and a body mass index of 35 or less. The protocol is named the Hungry Sweet Heart Protocol and an implementation plan is described for a community hospital located in Tucson, AZ. Updating practices of strict NPO status prior ot cardiac surgery is a proactive measure to improve glycemic control and adherence to SCIP guidelines post-operatively. Interdisciplinary teams, including DNPs, are perfectly suited to guide this implementation.

Keywords: ERAS, cardiac surgery, glycemic control, hyperglycemia, PDSA, PDSA cycle
CHAPTER I: INTRODUCTION

Many variables complicate cardiothoracic surgery, and perfecting the surgical patient scenario has been a challenging art and science over the past century. Recent studies over the past 60 years have focused on glycemic control during the intraoperative and post-operative surgical time frame, with suggestions, interventions, and various protocols to improve clinical outcomes. Three main contributing factors to peri-operative hyperglycemia include neuroendocrine stress response (emotional and surgical), pre-operative fasting, and diabetes. With the increasing trend of intra-operative and post-operative glycemic outcomes complicated by diabetes, research findings suggest moving glycemic control management earlier in the peri-operative time frame. Forcing strict *nil pers os or nothing by mouth* (NPO) instructions the midnight before surgery, further exacerbates a metabolic response resulting in pre-operative and post-operative hyperglycemia (Feguri, Lima, Lopes, Roledo, Marchese, Trevisan, &… Aguilar-Nascimento, 2012). This paper outlines a protocol proposal to modify pre-operative fasting practices by using liquid nutrition prior to surgery to promote glycemic stability in postoperative cardiac surgery patients via a pilot study.

Etiology of Hyperglycemia

Multiple bodily processes are responsible for contributing to a state of hyperglycemia during the operative time frame such as an acute neuroendocrine stress response, fasting induced gluconeogenesis, and/or a chronic state of insulin resistance from diabetes. Although emotional anticipatory stress applies tension to the human body, a real physical stressor, such as a scalpel to the tissues or bone saw to sternum, elicits multiple physiologic stress pathways regardless of
anesthesia (Jakob & Stanga, 2010). As the stress response continues, electrolyte imbalances ensue, further affecting the patient’s recovery (Holt, 2012).

**Neuroendocrine stress response**

Hyperglycemia is often provoked during anesthesia secondary to excitation of the innate stress response system (Holt, 2012). Both an emotional stress response and a surgical stress response exist, which result in the same state of hyperglycemia. Patients, who are scheduled for cardiac surgery, instantaneously begin to provoke an innate stress response as anticipation overwhelms their conscious and subconscious thought processes. It has been found that 25% of patients presenting for elective cardiac surgery will be hyperglycemic as measured by fasting plasma glucose tests the morning of surgery (Hatzakorzian et al., 2011). Either, patients are undiagnosed diabetics, and/or the neuroendocrine stress response and/or pre-operative fasting have already manifested in elevated serum glucose prior to surgery (Hatzakorzian et al., 2011).

Surgically induced insulin resistance is explained by the neuroendocrine response. This process initiates a cascade of events resulting in hyperglycemia in cardiac surgical patients (Holt, 2012; Jakob & Stanga, 2010). Surgical tissue injury activates the systemic inflammatory response syndrome (Jakob & Stanga, 2010). The metabolic cascade results in increased oxygen consumption, release of adrenocorticotropicin (ACTH) with conversion to cortisol, epinephrine, norepinephrine, and insulin (Holt, 2012; Jakob & Stanga, 2010). The release of growth hormone compounds hyperglycemia by increasing gluconeogenesis and insulin resistance, while decreasing insulin sensitivity and glucose reuptake from muscles followed by diuresis leading to dehydration (Holt, 2012). The release of ACTH is the most problematic in the scope of cardiac surgery because it allows for the release of cortisol from the adrenal cortex, resulting in
gluconeogenesis in the liver increasing serum glucose (Abdelmalak, Caplan, Connis, Epstein, Nickinovich, Warner, … Weinlander, 2010; Holt, 2012). In addition to a neuroendocrine stress response, pre-operative fasting is another culprit responsible for hyperglycemia surrounding cardiac surgery.

**Pre-operative fasting**

According to Jakob and Stanga (2010) prolonged pre-operative fasting for cardiac surgery is correlated with increased incidence of hyperglycemia. The underlying mechanism is not completely understood, rather inferred from similar metabolic scenarios, such as malnutrition and starvation, which consequently mimics diabetes mellitus type two (Jakob & Stanga, 2010). Facilitation of glucose transportation is impaired and insulin receptor sites structurally change leading to insulin resistance, increased gluconeogenesis, decreased glycogen production, and hyperglycemia (Jakob & Stanga, 2010). Health care providers induce this metabolic cascade when strict NPO practices are followed, and functions as a modifiable risk factor towards glycemic management. In addition to pre-operative fasting, diabetes further complicates hyperglycemic states, surrounding surgery.

**Diabetes**

Hyperglycemia can also manifest from chronic metabolic dis-regulation found in diabetes (Kahn, Cooper, & Del Prato, 2014). Neuroendocrine feedback loops and islet beta cells of the pancreas are responsible for secretion of insulin to the body (Kahn, Cooper, & Del Prato, 2014). Trunk obesity, physical inactivity, and genetic predisposition contribute to the destruction of almost 80% of pancreatic beta cells resulting in a decrease of insulin production from the pancreas in Type II Diabetes (Kahn, Cooper, & Del Prato, 2014). If insulin resistance outweighs
the ability of islet beta cells to secret sufficient insulin, a chronic state of hyperglycemia becomes detectable (Kahn, Cooper, & Del Prato, 2014).

The most commonly used laboratory studies to diagnose and evaluate diabetic control include: a fasting plasma glucose, a non fasting plasma glucose, or a hemoglobin A1c (HgA1c) (ADA, 2013). Diabetic diagnosis is made from a fasting plasma glucose of 126mm/dL or greater, a random non-fasting plasma glucose of 200mg/dL, or a HgA1c of 6.5% or more (ADA, 2013). A HgA1c value is the gold standard for pre-operative planning in cardiac surgery since this diagnostic tool speaks to an average serum percentage of glucose bound to hemoglobin over a two-to-three month average (ADA, 2013). Nutritional fasting will not decrease HgA1c values during the peri-operative time frame. That being said, HgA1c is a direct indicator of length of stay in cardiac surgery patients irrespective of official diabetic diagnosis (Najafi & Goodarzynejad, 2012). Current practice trends focus on treating the neuroendocrine stress response responsible for hyperglycemia intra-operatively and post-operatively.

**Current Practice**

**Pre-operative.** Pre-operative fasting practice varies by hospital, surgeon, time of surgery, and is independent of diabetic diagnosis (Holt, 2012). Immediately prior to surgery patients are instructed to fast, or have nothing to eat or drink either 12 hours prior to surgery or starting at midnight prior to surgery (Holt, 2012). Variations also exist for management of hyperglycemia and sources of fluid hydration while NPO (Holt, 2012). Some pre-operative order-sets include being NPO after dinner, after 10pm, while being NPO after midnight is the most commonly used practice (Ljungqvist, 2012). Variations for NPO except medications also exist (Holt, 2012; Ljungqvist, 2012). Pre-operatively surgeons or anesthesiologists may prefer
use of crystalloid solutions such as normal saline, 5% dextrose, lactated ringer (although less common), and/or any variation of potassium replacement mixed into these solutions (Ljungqvist, 2012). Alternatively, if the patient was already admitted to the hospital and pre-operative care was being given on the medical floor, some providers might leave the patient on their medical-floor maintenance intravenous solutions until the patient is physically moved into the operating room (Ljungqvist, 2012).

**Intra-operative.** Anesthesiologists and Perfusionists are responsible for hemodynamic monitoring including glycemic control and stability in the operating room. Variation in monitoring FSBG ranges from 30 minutes to hours (Holt, 2012; Kalmovich, Bar-Dayan, Boaz, & Wainstein, 2012; Silinskie, Kirshner, & Hite, 2013). Intervention toward the glucose result varies from intravenous insulin boluses, a set rate of intravenous insulin, or a titrated infusion of intravenous insulin until surgery is complete and nursing staff manages glycemic control post-operatively (Holt, 2012, Silinskie, Kirshner, & Hite, 2013).

**Post-operative.** Patients recover in the intensive care units (ICU) with intravenous insulin infusions and set protocols for titration and blood glucose monitoring. Depending on hospital protocol, patients are kept on the insulin infusion for up to 48 hours postoperatively, or are transitioned to a subcutaneous sliding scale of insulin sometime after extubation from the mechanical ventilator (Silinskie, Kirshner, & Hite, 2013). The variation in practice speaks to the possibility for refining a standard of peri-operative time frames since glycemic control continues to be a challenge post-operatively.
Significance to Healthcare

The resulting state of hyperglycemia from surgery induced insulin resistance, metabolic cascade from required pre-operative fasting, and chronic insulin resistance from underlying diabetes create ongoing hyperglycemia in a continuous cycle during the peri-operative time frame. Insulin resistance results in hyperglycemia placing any surgical patient at high risk for postoperative complications, regardless of a diabetic history (Abdelmalak et. al, 2010). Such complications are directly related to being in a state of hyperglycemia up to 48 hours post-operatively (Killian, Russel, Keister, 2009). Since health care providers are contributing to the peri-operative hyperglycemia, a more proactive approach is warranted to further improve patient outcomes.

Morbidity and mortality of hyperglycemia. Abnormal glycemic control in the first 48 hours post-operatively is related to higher morbidity, mortality, length of stay, and hospital costs (Killian, Russel, and Keister, 2009). Short-term complications include, but are not limited to: nausea, vomiting, fatigue, poor vascular graft healing, hypoventilation, difficulty with extubation, renal failure, and lower lobe pneumonias (Killian, Russel, Keister, 2009). Long term complications include the aforementioned plus a weakened sternal bone, sternal wound re-opening, sternal wound infections, dialysis, and high mortality (Killian, Russel, Keister, 2009). Immediate pre-operative glucose greater than 125mg/dl is directly correlated with post-operative mediastinitis, a surgical site infection (Wilson & Sexton, 2003). Along with surgical site infections, major sepsis, cardiovascular complications, pneumonia, and thromboembolic incidents are of the largest concerns following surgery (Bratzler & Hunt, 2006). A pre-operative HgA1c greater than 8.6% is directly correlated with a four-fold increase in mortality with cardiac
surgery (Chuah, Papamargaritis, Pillai, Krishnamoorthy, & le Roux, 2013; Lauruschkat et al., 2005). Acute renal failure (ARF) with a glomerular filtration rate (GFR) less than 60mL/min is the largest predictor of 30-day mortality after cardiac surgery (Chuah et al., 2013; Kohl, Hammond, and Ochroch, 2013). Poor glycemic management is found to decrease wound healing, increase the risk for infection and pain, and lengthen hospital stay (Holt, 2012). All of these post-operative complications are connected to a state of pre-operative hyperglycemia and suggest the need for improved pre-operative glycemic control.

**Cost related consequences of hyperglycemia.** Hyperglycemia and elevated HgA1c levels are directly related to costly medical comorbidities such as mediastinitis, pneumonia, and renal failure (Chuah, Papamargaritis, Pillai, Krishnamoorthy, & le Roux, 2013; Lauruschkat et al., 2005; Wilson & Sexton, 2003). According to Centers for Medicare and Medicaid Services (CMMS) (2012), hospital stays with a primary diagnosis related group (DRG) of major cardiovascular procedures, including cardiac surgery, at Northwest Medical Center in 2012 averaged $105,640, of which Medicare part A and B paid an average of $16,556 (CMMS, 2012). In 2001, mediastinitis cost an average of an additional $51k for the patient (Latham et al., 2001). Treatment of in-patient pneumonia in Tucson, Arizona cost almost $35K (CMMS, 2012). Management of hospital stays regarding renal failure at Northwest Medical Center in Tucson, Arizona average $47K where Medicare part A and B paid an average of $10K towards that total cost (CMMS, 2012). Cardiac surgery is expensive to the consumer, let alone when management of co-morbidities arise compounding the final price of the hospital stay.

By comparison, a hemoglobin A1c serum test ordered within 12 hours prior to surgery is less than $10 (Latham et al, 2001). Obtaining a pre-operative hemoglobin A1c level would
provide a more precise informed surgical risk assessment, while also providing insight into potential peri-operative needs such as adjustments to meal planning, anti-hyperglycemic regiments, NPO schedules, and surgery schedules.

When Medicaid and Medicare benefits run out, the burden of paying the remainder falls upon the patient. Most time the hospital will absorb the costs of the stay as the patient is unlikely to afford such a gap in cost coverage by CMMS. Based on morbidity, mortality, and increased cost associated with hyperglycemia in cardiac surgery, national standards of care named the Surgical Care Improvement Project (SCIP), was created to motivate providers towards improving practice and patient outcomes to reach maximum reimbursement from CMMS (Bratzler & Hunt, 2006).

**SCIP Guidelines**

Surgical site infections and post-operative complications are a major concern for patient survival and provider reimbursement (Bratzler & Hunt, 2006). The Centers for Medicare and Medicaid along with the Centers for Disease Control and Prevention to formulate national standards in hopes to motivate providers towards improving the standard of practice through reimbursement funds (Bratzler & Hunt, 2006). Originally the first guideline emerged as a core measure named Surgical Infection Prevention (SIP) in 2003 (Bratzler & Hunt, 2006). Research began to highlight alternative complications to surgery other than infection, and the SIP core measure was further refined into SCIP in 2006 (Bratzler & Hunt, 2006). Core measure number four in the SCIP guideline states reimbursement will be provided when blood glucose, on postoperative day one (POD1) and postoperative day two (POD2), at 6:00am, are 200mg/dL or less (Bratzler & Hunt, 2006; Joint Commission, 2013).
With new SCIP guidelines being readily enforced by hospital administrators, nursing staff, and surgeons are making larger efforts to adhere to improving patient outcomes. The Society of Thoracic Surgeons understand the complexity and importance of glycemic control in cardiac surgery and further recommend maintaining serum glucose less than 180 mg/dl, for all patients despite of diabetes during the perioperative time frame (Giakoumidakis et al, 2013). Regardless of an optimum serum glucose being identified by thoracic surgeons, the problem stands with how to achieve these goals with 90% success or higher as the problem of hyperglycemia in cardiac surgery setting continues.

**SCIP nursing compliance and hypoglycemia.** In light of hyperglycemia in critical care of adults, Van de Bergh, Wouters, and Weekers, (2001) conducted a prospective randomized control study of 1548 adult surgical intensive care patients on mechanical ventilation, 977 of these patients were cardiac surgery patients. Tight glycemic control via use of continuous insulin infusions to maintain blood glucose between 80-110mg/dL versus conventional glycemic control between 180-200mg/dL was studied (Van de Bergh et al., 2001). Twice the amount of patients with conventional glycemic control required more than five days in the intensive care unit (Van de Bergh et al., 2001). Tight glycemic control reduced hospital mortality related to septicemia by a third, blood stream infections by almost half, and renal failure requiring dialysis by 41% (Van de Bergh et al., 2001). It was also noted tight glycemic control resulted in higher frequency (n=39 v 6 patients) of hypoglycemic events defined at 40mg/dL found to be indirectly associated with poor outcomes (morbidity of delirium, altered mental status, and mortality) (Van de Bergh et al., 2001).
Whitman and associates (2012) highlight concerns with aggressive strides towards glycemic management after cardiac surgery placing patients at risk for hypoglycemic events and harm. The notion arises from observation; most patients are treated similarly postoperatively in terms of glycemic management (Witman et al., 2012). Most patients are placed on a standard insulin drip protocol after surgery, and up to 15% of those patients, suffer hypoglycemic events of blood glucose less than 70mg/dl, which is not a reported value to Centers for Medicare and Medicaid (Whitman et al., 2012). Additionally, nursing non-compliance has been observed with insulin drip protocols in attempt to prevent hypoglycemic events of their patients (Whitman et al., 2012).

Purpose and Aims

Lack of clearly defined standards of practice or protocols set to monitor and manage hyperglycemia in non-emergent, adult, cardiac surgery patients highlight the importance for a necessary change. The current management of hyperglycemia in cardiac surgery has been a reactive approach, and calls for proactive approach to reach SCIP guidelines and national quality standards. This quality improvement project describes a pre-operative fasting carbohydrate protocol mimicking ERAS guidelines for non-emergent, adult, cardiac surgery patients, with a hemoglobin A1C of 8.4% or less, and a body mass index of 35 or less. The protocol is named the Hungry Sweet Heart Protocol and will be initiated via a pilot Plan, Do, Study Act (PDSA) implementation tool. Specific aims include:

1. Achieve glycemic control as defined by SCIP with FSBG 200mg/dL or less via a new pre-operative protocol. The pre-operative carbohydrate beverage protocol, named the
Hungry Sweet Heart Protocol, will be administered six hours prior and two hours prior to cardiac surgery at Northwest Medical Center in Tucson, Arizona.

2. Implementation of the new protocol will be achieved via a pilot PDSA implementation tool for Northwest Medical Center in Tucson, Arizona.

3. Data collection of blood glucose on POD1 and POD2 at 6:00am for evaluation of SCIP compliance,

4. Data collection of morbidity at 30 days (ARF by GFR less than 60mL/min, SSI, pneumonia, and CLABSI) and mortality at 30 days post-operatively, and


Implementation tool via PDSA cycles. The Plan, Do, Study, and Act (PDSA) tool will guide this quality improvement project by serving as a guideline for translating evidence based findings into clinical practice via a cyclical process allowing for assessment of new information and adaption to implementation (Institute for Healthcare Improvement [IHI], 2014). The PDSA tool allows for: testing of a change in healthcare within a single cycle and repetition of PDSA cycles as needed to elicit a desired outcome (IHI, 2014). Each phase of the cycle requires interdisciplinary teamwork, to formulate a specific plan, initiate the plan, analyze the results, and make adjustments for a potential next cycle (IHI, 2014). Using a PDSA tool allows for real-time adjustments using a scientific method to improve patient care (IHI, 2014).

Conceptual framework and change theory. Nursing is a balanced art between a scientific career and an individual passion to improve the health of others; and adapts as the field of health care continuously changes (Rodgers, 2005). It applies knowledge, art, and inventive
ideas to provide superior health care (Bishop & Scudder, 1997). Health care will continually change and therefore nursing conceptual views must also allow flexibility and use theory to support change in a health care facility (Pepper, 1942).

Theories used in nursing research help identify current health and health care system problems and aid in clinical protocol development. Lewin’s Change Theory (LCT) acknowledges how changing the routine practices of a system are frequently met with negative attitudes and resistance (Lewin, 1951). Changing patterns, behaviors, and traditional practices of an individual is difficult, but changing these at a group and system level can be impossible to overcome without understanding how to successfully initiate change. Lewin’s (1951) Change Theory guides change initiation in stable hospitals, when adequate time is provided to precipitate a non-emergent change.

Changing pre-operative fasting traditions to cardiac surgery require a three-phase process to understand, educate, and empower groups towards a successful change in practice (Lewin,
1951). Three stages to Lewin’s Change Theory can be seen above in Figure 1. Three stages of Lewin’s Change Theory model. *Unfreezing*, is the first phase of LCT, where a nurse leader such as a DNP is identified as a change agent within the group, who analyzes the literature for gaps in health care, and creates a sense of urgency to achieve improved outcomes with a selected solution (Lewin, 1951). It is imperative to strengthen the positive driving forces within the organization (Lewin, 1951). Positive driving forces, which support this change, include educating the staff of specific details listing improved morbidity, mortality, reimbursement, length of stay, and decreased cost (Lewin, 1951).

Efforts to overcome restraining forces or obstacles to change, such as administration and/or health care providers who are resistant to change, can be weakened with education of literature supporting the change financially and in terms of improved patient outcomes (Lewin, 1951). *Transitioning*, the second stage of LCT, involves using a detailed plan to accomplish the change such as a comprehensive implementation tool (Lewin, 1951). A strong leader is necessary to educate, support, coach, and clearly communicate to the health care team towards abating fears and staying optimistic towards accomplishing the end goal (Lewin, 1951). Once the end goal of changing pre-operative fasting traditions is stabilized, the final phase of LCT, *refreezing* takes place (Lewin, 1951). This last step finalizes change through culture acceptance and policy improvements to support the new protocol into routine practice (Lewin, 1951).

**Significance for the Doctorate of Nursing Practice**

Expanding knowledge through evidence based research to create the highest patient care standards are fundamental to all health care providers, Nurse Practitioners (NPs) included. Family and Acute Care NP roles struggle to manage glycemic control in a peri-operative setting.
Comprehension of such devastating comorbidities with the most current research will allow NPs the advantage to managing these diseases medicinally and surgically.

There is often a lag between the newest evidence and current practice measures. Bridging the gap between translating the newest research into bedside practice is a role unique to a Doctorate of Nursing Practice (DNP) practitioner (Vincent, Johnson, Velasquez, & Rigney, 2010). DNP practitioners are fundamental in closing this gap as their clinical exposure allows insight for translating research findings into physical practice (Vincent et al., 2014). The DNP scope of practice is a creative solution to merge a clinician’s role with a research role in order to provide the best care to patients.

**Conclusion**

Hyperglycemia can manifest as an acute response to surgical trauma or to a pre-operative state of fasting. It can also manifest as a chronic condition, where Hgb AIC values are greater than 6.5% and lead to difficult management of glycemic control surrounding surgery. Morbidity, mortality, length of stay, and cost are all increased with hyperglycemia and resultant hypoglycemia from strict insulin infusion protocols. National SCIP guidelines acknowledge the negative correlations between hyperglycemia and cardiac surgery patients, and therefore have mandated a controlled serum glucose value by 6:00am on POD1 and POD2. Nursing non-compliance with protocols and hypoglycemic events are limiting the success of standard SCIP requirements. Traditional peri-operative glucose management is unique to each hospital and surgeon, but typically includes eight hours or more of nutritional fasting prior to surgery, followed by an insulin infusion, which lasts anywhere up to 48 hours postoperatively. The goal is to change the standard of practice by implementing a new pre-operative carbohydrate protocol.
via pilot PDSA guidelines. Pilot PDSA cycles and Lewin’s Change Theory will provide the framework to support implementation and evaluation this change in practice.
CHAPTER II: LITERATURE REVIEW

Literature Search

Comorbidities such as diabetes and cardiac surgery are well-researched topics. The preventative intervention, of carbohydrate loading prior to general surgery has been explored. However application of those findings to cardiac surgery are less widely researched. A review of the literature with specific search terms, exclusion criteria, limitations, are listed in (Appendix A). Attention to detail regarding study design, sample setting, intervention and outcome, presence of statistical significance, internal and external validity were thoroughly assessed. A PICOT question was formulated to guide review of the literature for purposes of this quality improvement implementation project. In adult diabetic patients (P), how does having a carbohydrate drink Maltodextran 12.5% six hours and two hours pre-operative of open heart surgery (I) affect serum glucose levels (O) within the first 48 hours post-operatively (T)?

Search terms. The literature review was narrowed using specific search terms. Two databases were used: Cumulative Index of Nursing and Allied Health Literature (CINAHL) and PubMed. For potential search duplication, search terms are listed in detail in (Appendix A).

Exclusion criteria. Thousands of results returned from the aforementioned search terms. Therefore, exclusion criteria were placed. The search was narrowed to exclude research findings from 2008 and older, pediatric populations of 17 years of age or younger, and non-English articles. This search yielded 653 articles, of which seven articles research findings specifically met the PICOT question and were designed with the highest level of evidence based practice research will be discussed at length to follow.
Review of Literature Findings

**SCIP and traditional glycemic control in cardiac surgery.** McDonell et al (2013) wanted to better understand four specific components to cardiac surgery and hyperglycemia in compliance with national quality measure standards through a retrospective study. Between 2008 and 2011, 832 patients who underwent cardiac surgery and received continuous intravenous insulin (CII) at the start of surgery were reviewed (McDonell et al, 2013). CCI is continued for a minimum of 18 hours in the ICU, until subcutaneous sliding scale insulin conversion was made and sampling via arterial line or finger stick every hour (McDonell et al, 2013). Blood glucose values were recorded for comparison at 6:00am on post-operative day one, and again at 6:00am on post-operative day two (McDonell et al, 2013).

After review of the data, a total of 55 patients were found to be SCIP outliers regardless of CCI (McDonell et al, 2013). Variables for failure to meet SCIP from highest occurrence to lowest include: “delay in initiating insulin infusion, inadequate transition from CCI to subcutaneous sliding scale, no cause, CCI protocol violation, lapse in glucose monitoring, no transition to subcutaneous sliding scale” (McDonell et al, 2013, p. 592). Demographics of the outliers were found to be diabetic (33 of the 55) and a higher hemoglobin A1c (8.74+/- 2.25 for outliers versus 7.59 +/- 2.90, P< 0.0009) Postoperative outcomes for the outliers were not statistically significant for increased thirty-day mortality, occurrence of myocardial infarction, permanent stroke, multisystem failure, deep sternal wound infection, ventilator support greater than 24 hours, or atrial fibrillation (McDonell et al, 2013). Hospital stay was roughly 2.5 days shorter for patients who met SCIP requirements for blood glucose control (McDonell et al, 2013). Review of the records revealed diabetic, and obese patients with higher HgA1c are at
highest risk for sub-optimal glucose control as defined by SCIP measures, with standard of practice CII infusions, and additional interventions are warranted, perhaps even pre-operatively (McDonell et al 2013). Pre-operative diet orders, such as NPO status, were not mentioned and can serve as a possible unidentified variable to glycemic control.

**Nutritional fasting and aspiration precautions.** American Society of Anesthesiologists (ASA) formulated standards of NPO practice in 1946 based on the conceptual notion that a stomach of at even 25mL of solid or liquid food prior to surgery would place patients at high risk Mendelson’s Syndrome or aspiration of gastric contents into the lungs resulting in aspiration pneumonia (Mendelson, 1946). Additionally a full stomach was thought to lead to hyperglycemia, higher cost, and increased length of stay (Apfelbaum, Caplan, Connis, Epstein, Nickinovich, Warner, & Weinlander, 2011). Updates to the ASA guidelines after extensive review of randomized control trials, observational studies, and case studies were presented (Apfelbaum et al., 2011). Review of the literature found statistically insignificant correlations of aspiration based on gastric content volume intra-operatively (Apfelbaum et al., 2011). Results provided consensus of permission of clear liquids, defined as water, fruit juices, coffee, or carbohydrate drinks two to four hours prior to elective surgery for adults (Apfelbaum et al., 2011).

**Nutritional fasting and hyperglycemia in general surgery.** Pre-operative traditions of nutritional fasting are slowly evolving based on ASA guidelines. Enhanced Recovery After Surgery (ERAS) guidelines were initially developed for gastrointestinal surgeries and are the foundation towards evolving pre-operative fasting traditions (Fearon, Ljungqvist, & Von Meyenfeldt, 2005). National Anesthesiology Associations endorses ERAS protocol of solid food
up to six hours prior to non-cardiac surgery, and clear liquid carbohydrates 12.5% up to two hours prior to surgery (Willcutts & Ziegler, 2013). The goal of the ERAS protocol is to improve patient subjective outcomes such as thirst, nausea, and energy in post-operative recovery of general surgery (Willcutts & Ziegler, 2013). Additionally ERAS has been shown to prevent surgery-induced insulin resistance (Willcutts & Ziegler, 2013). The evolution of pre-operative fasting protocols aim to prevent post-operative hyperglycemia, resultant insulin resistance and catabolism from the metabolic response due to fasting (Willcutts & Ziegler, 2013). Finding statistical significance and meaningful improvement to patient outcomes are still to be researched (Willcutts & Ziegler, 2013).

In efforts to replicate the ERAS protocol from Fearon, Ljungqvist, and Von Meyenfeldt, (2005), Tamura, Yatabe, Kitagawa, Yamashita, Hanazaki, and Yokoyama, (2013) studied six randomized adults with the use of two meals of liquid carbohydrate 18% solution (CHO) the evening before and the morning of surgery versus those who fasted since 9 pm the evening prior to general surgery. The first meal was 375mL of 18% CHO between 9:00 pm and 12:00 pm (Tamura et al., 2013). The second meal was 250mL of 18% CHO at 6:30am the morning of surgery (Tamura et al., 2013). Anesthesia initiated a hyper-insulinemic normoglycemic clamp, similar to those used in cardiac surgery, at 8:30am in all patients (Tamura et al., 2013).

Although serum glucose was similar in both groups at start time of anesthesia, the test group required more glucose (11 vs 6) and less insulin during surgery, and less circulating ketones after surgery (22 versus 124) (Tamura et al., 2013). Insulin sensitivity as measured by glucose and insulin demand with resulting ketone values indicate 18% CHO pre-operative to general surgery was safe and successful (Tamura et al., 2013).
A meta-analysis of six randomized control trials comprised of 452 patients undergoing major open colorectal surgery were reviewed for comparison of ERAS protocols versus conventional pre-operative fasting practices in length of stay, return of bowel function, mortality, and readmission rates (Varadhan, Neal, Dejong, Fearon, Ljungqvist, & Lobo, 2010). Patients who received ERAS guidelines had a shorter length of hospital stay by two and a half days, and suffered 25% less mortality (Varadhan et al., 2010). Return of bowel function and readmission rates were statistically insignificant (Varadhan et al., 2010). This meta-analysis did not comment on glycemic assessment (via fasting glucose values or HgA1c values) or glycemic control post-operatively. Additionally this review was focused on open colorectal surgery.

**Nutritional fasting and hyperglycemia in cardiac surgery.** Tuttnauer and Levin, (2006) highlight the importance of hyperglycemic management in cardiac surgery patients from the associated poor outcomes. Further exploration of nutritional fasting with cardiac surgery is warranted and aggressive management is recommended (Tuttnauer & Levin, 2006). In this current literature search, only one article was found to have researched ERAS protocol in cardiac surgery.

Availability of data regarding pre-operative fasting versus liquid carbohydrate in cardiovascular surgery is scarce (Feguri et al., 2012). Forty patients scheduled for coronary artery bypass grafting (CABG) on and off cardiopulmonary bypass were randomized to into the test group of: 400ml (six hours pre-operatively) followed by 200ml (two hours pre-operatively) of 12.5% Maltodextrin, versus a control of NPO except water pre-operatively (Feguri et al., 2012). Patient results were free from aspiration, bronchospasm, mediastinitis, stroke, acute myocardial infarction, or death in both groups (Feguri et al., 2012). Atrial fibrillation occurred
equally in both groups and this is a common morbidity after cardiac surgery (Feguri et al., 2012). CABG patients in the CHO test group averaged moved from the ICU 24 hours faster and experienced an average shorter length of stay by two days versus the control group (Feguri et al., 2012). Although insulin resistance was equal in both groups, the control group had worse glycemic control at six-hour post-operative interval (Feguri et al., 2012). With safety and efficacy shown, this appears to provide a starting point for making changes to strict NPO status prior to CABG surgery (Feguri et al., 2012). However, this was a small sample at a single center outside the United States. Attempts to replicate these results in the United States with the same and expanded populations of cardiac surgery such as valve replacements, tumor removals, and/or surgery to the thoracic aorta are warranted (Feguri et al., 2012).

**Limitations**

The largest and most concerning limitation is the how the ERAS protocol is lacking in direct application in cardiac surgery in the United States (Fearon, Ljungqvist, & Von Meyenfeldt, 2005; Tamura et al., 2013; Willcutts & Ziegler, 2013). Even though application of ERAS protocol to general surgery was successful for avoiding aspiration pneumonia, and improving post-operative nausea and vomiting; longevity of the results for a 48-hour monitoring time frame, and specification of surgery type were lacking (Tamura et al., 2014). Small sample size also requires expansion and replication to cardiac surgery (Tamura et al., 2014). Feguri and associates (2012) provided the only research trial of ERAS to cardiac surgery. This study was heavily limited by sample size, application within a health care system outside the United States where SCIP guidelines are not applicable. Replication of Feguri and associates (2012) is warranted with expansion to all cardiac surgeries, geographical location, population diversity for
gender, age, pre-existing conditions, and facility sites. Strengths of the research include: achievement of participant saturation, using varied cardiac surgeries, diabetic, and non-diabetic populations. Quality of the studies was strong; but improvements were identified for future research to improve internal and external validity. Across all studies, limitations of gender were heavily skewed towards male populations, single surgical facilities, and single care units. Sample sizes should be increased and population demographics expanded to improve generalizability.

**Conclusion with PICOT**

A literature review based on the PICOT question: in adult diabetic patients (P), how does having a carbohydrate drink Maltodextran 12.5% six hours and two hours pre-operative of open heart surgery (I) affect serum glucose levels (O) within the first 48 hours post-operatively (T) provided strengths and limitations to support this project in movement forward with a concept of ERAS protocols in general surgery to cardiac surgery. Traditional attempts for glycemic control in cardiac surgery revolve around intra-operative and post-operative use of continuous insulin infusions. SCIP guidelines mandate improved glycemic control on POD 1 and POD 2, and current adherence is finding difficulty meeting 100% compliance, necessitating a change in current practice. The research synthesis provided evidence of successful application of ERAS to general surgery and coronary PCI towards improving morbidity, mortality, and cost. Only one published article was found on application of ERAS to cardiac surgery to improve glycemic control and patient outcomes. Even though the study found success, replication is warranted. Based on the successful outcomes of avoiding aspiration pneumonia by using ERAS protocols and their replications within various general surgery populations improved patient length of stay
and overall cost; outlining implementation guidelines to cardiac surgery pre-operative practice would be the next step in changing best practice measures.
CHAPTER III: HUNGRY SWEET HEART PROTOCOL

The new protocol is based on ERAS guidelines to provide carbohydrate beverages at six hours and two hours pre-operative to major surgery. Feguri and associates (2012) applied ERAS guidelines to adult cardiac surgery patients. The title of the protocol stems from the notion that strict NPO status induces hunger and hyperglycemia in cardiac surgery patients, thus the Hungry Sweet Heart Protocol.

Pre-Operative Surgical Clearance

This quality improvement protocol proposal will apply ERAS guidelines to adults, 18 years of age and older, with a HgA1c 8.4% or less, and a BMI less than 35, who are scheduled for non-emergent cardiac surgery at Northwest Medical Center, Tucson, AZ starting at 10am or later, with initial FSBG between 61 mg/dL to 199mg/dL. The program coordinator will evaluate all patients who are scheduled for cardiac surgery for potential inclusion of the protocol. Pre-operative surgical clearance measures will require all pre-operative diagnostics to be completed within six hours prior to surgery but not more than three days prior to surgery including: physical exam, chest x-ray, 12 lead electrocardiogram, echocardiogram, complete blood count, comprehensive metabolic panel, urinalysis with differential if indicated, and a hemoglobin A1c. Multiple cardiac surgeries are possible in a single day at Northwest Medical Center. For the purposes of this protocol implementation, only patients scheduled as the second cardiac surgery of the day will be included, or a surgery scheduled to start at 10:00am or later. The final step to protocol inclusion is the pre-operative FSBG obtained six hours pre-operatively to surgery.
Eight Hours Pre-Operative

Patients will be instructed on allowance of solid food up to eight hours prior to surgery scheduled start time, and clear liquids up to six hours prior to surgery. Clear liquids are limited to: tea, water, coffee without milk, juices without pulp, and carbonated beverages. The patient must arrive to Northwest Medical Center between seven and six hours pre-operatively for the general hospital admission process through the Pre-Operative surgical wing. Patients will arrive to the hospital pre-operative waiting room for admission.

Six Hours Pre-Operative

Once the patient has been officially admitted to the surgical pre-operative wing of the hospital, the nurse will take the patient to the pre-operative bay. If the initial FSBG is 125mg/dL or greater the patient will receive a subcutaneous insulin injection according to the sliding scale orders in (Appendix B). If the initial FSBG is greater than 200mg/dL the pre-operative nurse will provide congruent sliding scale insulin, and will also notify the program coordinator as this patient is now disqualified from the protocol and will not receive the intervention beverage. The Hungry Sweet Heart Protocol will begin six hours prior to surgery by declaring the patient NPO except medications, record an initial finger blood glucose check, and then have the patient consume of 400ml of 12.5% Maltodextrin. The patient has three minutes to finish the beverage; once the beverage is complete the pre-operative nurse will document “Protocol Start Time.” The patient is to remain strict NPO, except medications, after this initial dose at the six hour protocol start time.
Two Hours Pre-Operative

Two hours pre-operatively the patient will consume the second and final dose of 200ml of 12.5% Maltodextrin. The patient has three minutes to consume this final dose. Nursing documentation of dose delivery and consumption time is required as “Second Dose Completion.”

Strict NPO except medications will again continue until post-operative recovery takes place in the cardiac intensive care unit.

30-Day Post Operative

Patients will require a post-operative follow up visit with the surgeon to evaluate for occurrences of morbidity. This visit will occur 30-days post-operatively to the surgery date. This visit can take place in the hospital, if the patient is still in the hospital or has returned. Otherwise this visit will take place at the surgeon’s clinic office. A physical exam, laboratory data, and a chest x-ray will be obtained for assessment and diagnosis of ARF, SSI, pneumonia, or CLABSI.

Data Collection Planning

A data collection spreadsheet will be used with this pilot phase and each cycle thereafter to collect information specific to the patients who are participating in the study for later correlation analysis. Anonymous record locator numbers will be assigned to individual patients by the program coordinator to maintain HIPPA compliance. Data to evaluate will include: age, gender, HgA1c value, BMI, pre-operative finger stick blood glucose value (FSBG), protocol start time, second dose completion, intra-operative hourly FSBG, FSBG at 24 hours, FSBG at 48 hours post-operative, morbidity at 30 days (ARF GFR less than 60mL/min, SSI, pneumonia, and CLABSI) and mortality at 30 days post-operative.
Feasibility of Intervention

Cost analysis of the protocol intervention is a necessary component of a pilot PDSA implementation. The cost of cardiac surgery is over $100K for Northwest Medical Center in 2012. Maltodextrin 12.5% solution is a sweet polysaccharide chain mixed with water (BevMD, 2014). Clearfast®, is a 12 ounce or 355mL, preoperative carbohydrate beverage, approved by the ASA and EARS society (BevMD, 2014). The first five ingredient list of Clearfast® is filtered water, Maltodextrin 12.5%, crystalline fructose sugar, natural flavors, sodium citrate, see (Appendix C) for the remaining ingredient list for this individual bottle of white grape flavor (BevMD, 2014). Nutritional facts per 12 ounce serving include 230 calories, 0g fat, 180mg of sodium, 45mg of potassium, and 59g of carbohydrate of which 21g are from sugar (BevMD, 2014). Purchase of this pre-packaged beverage is available on Amazon (2014) at $19.95 per bottle with a maximum of 30 bottles per purchase order. Purchase is also through the western distributor at WestCon Medical Industries (BevMD, 2014). Purchase of this product would require discussion with key stakeholders, as the literature review provided is based on the sole ingredient of Maltodextrin 12.5% and with a different intervention volume of 400mL and 200mL.
CHAPTER IV: PILOT PDSA IMPLEMENTATION

Method

Based on Lewin’s Change Theory Unfreezing begins with a Quality Improvement meeting. The Quality Improvement meeting will speak to an agenda including topics: evidence of background information, cost related consequences, morbidity, mortality based on literature review findings, and the solution to the problem via a new pre-operative intervention. The Quality Improvement meeting includes an audience of key stakeholders: Administration, Chief Medical Officer, Chief Nursing Officer, Director of Pharmacy, Director of Critical Care, and the Director of the Operating Room. Educating stakeholders with recent research will reduce potential resistance to change so planning may continue.

Per Lewin’s Change Theory, the Transition phase necessitates a strategic plan to implement the desired change to gain trust of the group. A PDSA implementation tool will outline the process to make this change to practice. The first cycle in a PDSA implementation is traditionally termed a pilot phase (IHI, 2014). Since the PDSA tool is a cyclical process (IHI, 2014), a primary objective for the pilot phase is required and based on the aims identified earlier. The pilot objective of the project aims will still require standard intra-operative and post-operative glycemic care with continuous insulin infusions and hourly titrations per individual hospital protocols. Finally, once all components of the PDSA implementation tool have lead to the desired outcome, Refreezing will take place to finalize the resultant amendments to the Hungry Sweet Heart Protocol to support continued use and a culture change within the hospital.
Plan

The first step within a pilot phase PDSA cycle is to *Plan* by developing a process for the health care members administering the protocol and the patients involved in the protocol itself, see the Hungry Sweet Heart Protocol plan (Appendix D). The Hungry Sweet Heart Protocol will be initiated via a pilot PDSA implementation tool at a level three-acuteity hospital Northwest Medical Center in Tucson, Arizona, which provides routine and emergent cardio-thoracic surgery to adults via a fully equipped 40-bed pre-operative room, 20-bed operating room, and a 16-bed cardio-thoracic intensive care unit. Implementation of the plan components will start on January 1st, 2015.

Organizational plan inputs include human and non-human participation for the PDSA process and the Hungry Sweet Heart Protocol (Table 1). Human inputs for the PDSA process implementation include creating and educating an inter-disciplinary team including: protocol-educator, cardio-thoracic surgeons, anesthesiologist/certified registered nurse anesthetists, perfusionists, acute-care nurse practitioners, pre-operative nurses, intensive care nurses, and pharmacists. Human inputs for implementation of the Hungry Sweet Heart Protocol will include all non-emergent, male and female, adults, ages 18 and older, scheduled for cardiac surgery, who are not on a mechanical ventilator when the surgery is scheduled. Cardiac surgeries include: coronary artery bypass grafting, valve repair, valve replacement, thoracic aortic aneurysm repair, and/or any combination of these. The non-human inputs for the PDSA process include creating pre-operative Hungry Sweet Heart Protocol pamphlets for in-service education and clinical reference during the *Do* phase. Organizational plan outputs are required to deliver the intervention. Plan outputs include financial planning to provide a single day, two-hour, formal
educational orientation held in the hospital’s education classroom for the interdisciplinary care team on the Hungry Sweet Heart Protocol via pilot PDSA implementation. The first hour is for education of literature review, morbidity, mortality, cost consequences, and protocol timeline. The second hour is split into a 30-minute question and answer session, followed by a 30-minute allotment for competency testing. Competency of the new protocol will be determined by scoring 90% or higher on a 15-question independent, multiple choice, paper test, which is administered immediately following the educational lecture, see (Appendix E) for a sample competency test. A single remediation is possible within 48 hours of the initial test. Education and competency testing will be required annually for all interdisciplinary team members who participate in the PDSA implementation.

<table>
<thead>
<tr>
<th>TABLE 1. Organizational Plan Inputs and Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Input</strong></td>
</tr>
<tr>
<td><strong>Pilot PDSA Implementation</strong></td>
</tr>
<tr>
<td><strong>Hungry Sweet Heart Protocol</strong></td>
</tr>
</tbody>
</table>

Note. This table lists the human and non-human inputs needed for the initiation of the Hungry Sweet Heart Protocol via a pilot PDSA implementation tool.
Service utilization of the Hungry Sweet Heart Protocol serves as the screening method to identify appropriate patient participation for this intervention (Table 2). Providers will evaluate and agree to surgery, of which the program coordinator will schedule the surgery and screen for protocol inclusion based on the criteria previously mentioned. This will allow appropriate communication and planning for anesthesia, pharmacy, and nursing departments to prepare accordingly to deliver the intervention in accordance with the PDSA implementation. Service utilization outputs include data collection for the number of patients who were qualified and were included in the protocol, and achieved glycemic control by POD1 and POD2, without any morbidity or mortality events within the first 30 days.

**TABLE 2. Service Utilization Plan for the Hungry Sweet Heart Protocol.**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hungry Sweet Heart Protocol</td>
<td>Data collection:</td>
</tr>
<tr>
<td>Program Coordinators:</td>
<td>1. Number of patients who were included in the protocol,</td>
</tr>
<tr>
<td></td>
<td>2. And achieved glycemic control by POD1 and POD2,</td>
</tr>
<tr>
<td></td>
<td>3. Without associated morbidity or mortality events.</td>
</tr>
<tr>
<td>1. Schedule surgery</td>
<td></td>
</tr>
<tr>
<td>2. Screen patients for</td>
<td></td>
</tr>
<tr>
<td>protocol sample inclusion</td>
<td></td>
</tr>
</tbody>
</table>

According to the *Plan* portion of the PDSA implementation tool, once patients are screened for inclusion, pre-operative paper instructions will be discussed with the patient. If the patient is arriving to surgery as an out-patient, they will arrive to the pre-operative waiting room between seven hours pre-operatively and no later than six hours pre-operatively to their scheduled surgery start time. If the patient arrives later than six hours pre-operatively they cannot be included in the sample participation. Arriving at this time allows time for check in and admission to the pre-operative rooms where the protocol implementation can begin. If the
patient was admitted to the hospital the previous to the non-emergent scheduled surgery, the clinical nurses will follow the protocol pamphlet guidelines.

Specific data need to be collected in the subsequent phase of the PDSA cycle, and are planned for accordingly. Patient demographics such as age, gender, pre-operative HgA1c value, and BMI will be collected at their pre-operative surgery clearance appointment. On admission to the hospital pre-operative center data such as pre-operative finger stick blood glucose value, first dose completion, start time of protocol, and second dose completion will be collected by the pre-operative nurse. Pre-operative start time, and intra-operative hourly FSBG will be recorded by the anesthesia group during surgery. Post-operatively in the ICU data to collect include POD1 FSBG, POD2 FSBG, occurrences of morbidity within 30 days (ARF GFR less than 60mL/min, SSI, pneumonia, and CLABSI), and any occurrences of mortality at 30-days post-operative. If the patients are discharged from the ICU and or the hospital prior to the 30-day data collection, the program coordinator will contact the patients via phone call to remind them of their post-operative discharge appointment. Patients are required to attend a 30-day post-operative to surgery date, follow up visit with the cardiac surgeon to evaluate for occurrences of morbidity (ARF, SSI, pneumonia, or CLABSI).

Do

After the plan is complete, the Do phase calls for initiation of the Hungry Sweet Heart Protocol with simultaneous data collection. Therefore, each cycle length is not time dependent, instead is based on patient sample size. After the first cycle, Study and Act phase will take place before moving on to the next PDSA cycle with expanded patient sample. If initial results from the first cycle are free from morbidity or mortality, patient participation will increase by the rule
of “5x5” (IHI, 2014). Cycle two would include 25 patients and cycle three would include 125 patients (IHI, 2014). Cycles will continue for a total of three cycles or a single calendar year, whichever comes first. If or when a total of three cycles are achieved this would result in a final participation count of 155 patients. This patient volume will provide enough cardiac surgery participants for reflection and evaluation during each study phase prior to Refreezing the protocol.

**Study**

The Study phase is twofold including analysis of protocol data and analysis of the pilot PDSA implementation tool. This phase will summarize what was learned, and determine if the project aims were met with statistics to describe the outcome (IHI, 2014). Data collection in the study phase will be divided into two sections: protocol data collection and PDSA implementation data collection. Data collection items for the study phase include: patient age, gender, HgA1c value, BMI, protocol start time, pre-operative FSBG, pre-operative start time, FSBG POD1, FSBG POD2, morbidity at 30 days (ARF by GFR less than 60mL/min, SSI, pneumonia, and CLABSI), and mortality at 30 days.

The Hungry Sweet Heart Protocol will be evaluated next (Table 3). Outcome measures of the implementation tool evaluate if the change in practice was successful. Outcome measures of the first, second, and third aims of the project are evaluated by review of blood sugar values on POD1 and POD2 to evaluate the percentage of compliance or outliers to SCIP national standards achieving 200mg/dL or less at 6:00am. Outcome measures of the fourth aim evaluate for instance of morbidity and mortality at 30 days. Process measures allow evaluation of the organizational plan to determine if inputs or outputs need adjustment. Process measures of the
fifth and final aim evaluate education process, difficulty of instructions, difficulty with protocol implementation, and time allotment for protocol implementation. Determining if the change made in one environment disrupted balance in another environment is done through evaluation of balancing measures. Balancing measures of the fifth aim evaluate patient sample inclusion. These components of protocol evaluation are necessary to identify areas of improvement within the Study phase so outlined changes can be made in the Act phase.

<table>
<thead>
<tr>
<th>Aim</th>
<th>Outcome Measure</th>
<th>Process Measure</th>
<th>Balancing Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot PDSA Implementation Tool of the Hungry Sweet Heart Protocol to achieve 100% compliance of blood glucose values at POD1 and POD2 at 6:00am of 200mg/dl</td>
<td>Instance of blood glucose values at POD1 and POD2 at 6:00am being 200mg/dl or less</td>
<td>Instance of Outliers: 201mg/dl or more</td>
<td>Instance of Mortality</td>
</tr>
<tr>
<td>Evaluation of Morbidity (ARF GFR less than 60mL/min, SSI, pneumonia, and CLABSI) and mortality at 30 days post-operatively</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation method of interdisciplinary team protocol compliance via survey</td>
<td>Was more/less education needed?</td>
<td>Did all qualified patients receive the protocol?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Where the instructions difficult to follow?</td>
<td>Did any non qualified patients receive the protocol?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Was it difficult to implement the protocol?</td>
<td>How many non-qualified surgery patients received the protocol?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Was there enough time for implementation pre-operatively?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Evaluation of the pilot PDSA implementation tool is based on data collection from the interdisciplinary team survey and is available for review in (Appendix F). The survey has five main categories of questions: education time allowance, protocol inclusion sample, protocol instructions, difficulty of implementation, and time for implementation. Quantitative data will be extracted based on yes or no answers and qualitative data will be categorized based on common word extraction from subjective answers to why or why not questions. A statistician will assist and serve as support to the DNP champion in evaluation of the data in the first cycle. In cycles thereafter, the DNP will evaluate the data alone. Based on evaluation of the protocol and the pilot PDSA implementation tool allow for improvements in the next cycle.

Act

The final phase of the PDSA cycle is the Act phase. It is highly anticipated the outcomes of the first Do and Study phase warrant adjustment (IHI, 2014). This final step in the cycle allows decisions to surface about which specific changes need to be made to the original Hungry Sweet Heart Protocol. The process is then cycled back to the Plan phase and repeated until the desired objective is met: 100% compliance of POD1 and POD2 FSBG at 6:00am are 200mg/dL or less or a full year has passed, whichever comes first.

Ethics and Human Subjects

This quality improvement project describes an implementation to change pre-operative adult cardiac surgery practice measures. Human subjects for participation are not required until a go-live scenario exists to implement the Hungry Sweet Heart Protocol. A formal ethics committee review with Institutional Review Board (IRB) will be required when Northwest Medical Center agrees to implement this quality improvement project to review the rights and
welfare of participants. Informed consents will not be required since this would be a quality improvement measure to practice. Ethical concerns to be addressed with IRB include sample inclusion and exclusion criteria of pre-operative HgA1c values and BMI as these are associated with poor outcomes in cardiac surgery. Potential poor outcomes from consuming a carbohydrate beverage prior to cardiac surgery include but are not limited to increased risk of morbidity (induced hyperglycemia leading to ARF with a GFR less than 60mL/min, SSI, pneumonia, and CLABSI) or mortality.

**Conclusion**

Updating practices of strict NPO status prior to cardiac surgery is a proactive measure to improve glycemic control and adherence to SCIP guidelines post-operatively. Implementation of the Hungry Sweet Heart Protocol with a PDSA tool provides an outline of the process to translate a change to practice. Repetition of the PDSA cycle allows for real-time modifications to bedside practice. Interdisciplinary teams, including DNPs, are academically and clinically prepared to guide this implementation.
CHAPTER V: SUMMARY

Morbidity and mortality associations with hyperglycemia and post-operative surgical outcomes in cardiac surgery patients serve as a strong motivating factor to proactively attempt to improve glycemic control in adult cardiac surgery patients. SCIP guidelines require blood glucose on POD1 and POD2 at 6:00 am to be 200mg/dL or less to improve post-operative morbidity of renal failure, infections, length of stay, and mortality measures. Northwest Medical center in Tucson, AZ provides non-emergent adult cardiac surgery and is currently using pre-operative cardiac surgery protocols requiring adults to endure strict NPO fasting for eight hours or more prior to surgery. Feguri et al., (2012) found such aggressive fasting prior to adult cardiac surgery may not be necessary. In accordance with ERAS protocols, Feguri et al., (2012) used pre-operative carbohydrate beverages at six and two hour intervals prior to cardiac surgery to improve glycemic control postoperatively. Although the Feguri et al., (2012) study was limited to size and post-operative timing measurements, the applicability to Northwest Medical Center remains a possibility.

Details on how to implement a new protocol at Northwest Medical Center, which mimics ERAS and Feguri et al., (2012) guidelines, were provided in this project via a pilot PDSA implementation tool. Lewin’s Change Theory provided support in preparing the hospital for overcoming resistance to change within an organization in order to implement a new protocol. Pilot PDSA implementation process measures of new pre-operative non-emergent adult cardiac surgery protocol, named the Hungry Sweet Heart Protocol were specifically outlined including organizational plan inputs and outputs for educating staff. Evaluation measures of the new
protocol and the implementation process were outlined to allow insight of feasibility and necessary improvements in the next PDSA cycle.

**Strengths, Weakness, and Limitations**

Using a protocol designed after previously established ERAS guidelines serve as a strength to implementation. Implementation of this protocol does not require purchasing new equipment or hiring new staff. The education process, as outlined in the organizational plan, only requires two hours of staff time for training to achieve competency, which serves as a cost effective strength towards implementation. The Hungry Sweet Heart Protocol intervention of Maltodextrin 12.5% carbohydrate drink has the potential for subjective sweet taste by protocol patients. Patients may also report less nausea, upset stomach, or anxiety pre-operatively since they will not be required to endure strict NPO status prior to major cardiac surgery. The patient sample criteria include diabetic populations, and allow participation with a HgA1c up to 8.4%. Many of the strengths listed here are anticipated, and will not be surely known until the first pilot cycle with evaluation is complete in the *Study* phase of the PDSA tool.

Weaknesses of implementation at Northwest Medical Center include the possibility for organizational resistance to change, lack of compliance with the PDSA cycle, or the lack of compliance delivering the protocol. Cost of the Maltodextrin 12.5% drink to the hospital and the patient could be a positive or negative component to implementation and will not be fully known until formal evaluation of post-operative morbidity and mortality cost analysis are complete after the first PDSA cycle. Another obstacle to compliance with the pilot PDSA plan are the operating room schedules, and the possibility of scheduled cardiac surgeries being re-scheduled for more emergent procedures. Once feasibility of the new protocol is evident, it may be
possible/impossible to plan for a designated operating room for scheduled procedures only.

Lastly, this new protocol and pilot study are limited to non-emergent, adult, cardiac surgery patients, with a HgA1c of 8.4% or less, admission FSBG < 200mg/dL and a BMI less than 35, at a single facility.

**Future Research**

After the pilot study confirms feasibility of the implementation process, formal PDSA cycles will follow. Once the protocol has been successfully implemented and *Refrozen* as a permanent protocol, dissemination of the protocol can span across Arizona and the United States. Future research would need to expand inclusion criteria for patient participation to include HgA1c > 8.4, initial FSBG > 200mg/dL, and BMI> 35. DNPs are well suited to evaluate current research, conduct future research, and apply the newfound concepts within everyday practice to improve the standard of practice. Ongoing evaluation of current practice trends within adult cardiac surgery is essential to improving patient outcomes now and in the future.
APPENDIX A:

LITERATURE SEARCH TERMS
LITERATURE SEARCH TERMS

**CINHAL Search Terms:**
- Open heart surgery + glucose → yield 10 results
- Cardiac surgery + glucose → yield 69 results
- Heart surgery + glucose → yield 80 results
- Heart surgery + glycemic control → yield 44 results
- Pre operative + glucose → 5 results
- Diabetes + heart surgery → 105 results
- Fasting + cardiac surgery → 8 results
- Carbohydrate + cardiac surgery → 3 results
- Fasting + surgery + hyperglycemia → 12 results
- Enhanced recovery after surgery + carbohydrate → 5 results

**PubMed Search Terms:**
- Cardiac surgical procedures + glucose → 223 results
- Hyperglycemia + cardiac surgical procedures → 106 results

**Inclusion Criteria**
- Date range 2009-2014
- Age 18 and up

**Selected Articles**
- 50 articles
APPENDIX B:

INITIAL FSBG SLIDING SCALE INSULIN ORDERS
### INITIAL FSBG SLIDING SCALE INSULIN ORDERS

<table>
<thead>
<tr>
<th>Glucose Level (mg/dL)</th>
<th>Subcutaneous Novolin R dose (units)</th>
<th>Recheck FSBG</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60</td>
<td>None</td>
<td>Initiate hypoglycemia protocol, 15 minutes</td>
</tr>
<tr>
<td>61 - 124</td>
<td>None</td>
<td>Initiation of anesthesia</td>
</tr>
<tr>
<td>125 - 149</td>
<td>2</td>
<td>Initiation of anesthesia</td>
</tr>
<tr>
<td>150 – 199</td>
<td>4</td>
<td>Hourly</td>
</tr>
<tr>
<td>200 - 250</td>
<td>8</td>
<td>Notify program coordinator, as patient is now disqualified for protocol inclusion</td>
</tr>
</tbody>
</table>
APPENDIX C:

CLEARFAST NUTRITION FACTS
CLEARFAST NUTRITION FACTS

WHITE GRAPE

Nutrition Facts
Serving Size: 12 fl oz (355 ml)
Servings Per Container: 1

Amount Per Serving
- Calories: 220
- % Daily Value:
  - Total Fat: 6g
  - Sodium: 1mg
  - Potassium: 240mg
  - Total Carbohydrate: 55g
  - Sugars: 21g
  - Protein: 0g

Vitamin A: 50%  Vitamin C: 35%
Selenium: 10%

INGREDIENTS: Filtered Water, Minor Electrolytes, Natural Flavors, Fumaric Acid, Citric Acid, Malic Acid, Monopotassium Phosphate, Zinc Sulfate, Vitamin A Palmitate, Sodium Chloride.
APPENDIX D:

HUNGRY SWEET HEART PROTOCOL PLAN
HUNGRY SWEET HEART PROTOCOL PLAN

Who:
Male & Female Adults, 18 y.o. or older, HgA1c 8.4% or less, BMI less than 35, scheduled for cardiac surgery (non-emergent and non-intubated), arrive to pre-operative admission on time, admit FSBG < 200mg/dL

What:
Hungry Sweet Heart Protocol using 12.5% Maltodextrin solutions:
1st Dose: 400ml 6 hours pre-op
2nd Dose: 200ml 2 hours pre-op

Where:
Northwest Medical Center,
Tucson, AZ

When:
Start date: January 1st, 2015
Pilot Cycle length: 5 patients
APPENDIX E:

SAMPLE COMPETENCY TEST
## SAMPLE COMPETENCY TEST

<table>
<thead>
<tr>
<th>Sample Competency Test</th>
<th>Circle One</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hemoglobin A1c of 8.5% and higher is associated with four time increased risk of</td>
<td>True / False</td>
</tr>
<tr>
<td>mortality in adult cardiac surgery patients?</td>
<td></td>
</tr>
<tr>
<td>2. Hyperglycemia of 200mg/dL or higher is associated with poor outcomes?</td>
<td>True / False</td>
</tr>
<tr>
<td>3. Cardiac surgery costs over $100K/patient in 2012 at Northwest Medical Center and a</td>
<td>True / False</td>
</tr>
<tr>
<td>pre-operative carbohydrate beverage cost less than $20?</td>
<td></td>
</tr>
<tr>
<td>4. Three contributing factors to pre-operative hyperglycemia include: eating cookies,</td>
<td>True / False</td>
</tr>
<tr>
<td>diabetes, and stress?</td>
<td></td>
</tr>
<tr>
<td>5. Nutritional fasting induces a neuroendocrine stress response and increased</td>
<td>True / False</td>
</tr>
<tr>
<td>circulating glucose?</td>
<td></td>
</tr>
<tr>
<td>6. The Hungry Sweet Heart Protocol has specific patient inclusion criteria including:</td>
<td>True / False</td>
</tr>
<tr>
<td>age 18 or older, scheduled cardiac surgery, BMI &gt; 40, and HgA1c &lt;8.5%?</td>
<td></td>
</tr>
<tr>
<td>7. Protocol must start for the second cardiac surgery of the day, and/or at 10am or</td>
<td>True / False</td>
</tr>
<tr>
<td>later, to allow eight-hour pre-operative instruction timeline?</td>
<td></td>
</tr>
<tr>
<td>8. The patient must be admitted to pre-operative waiting room immediately prior to six</td>
<td>True / False</td>
</tr>
<tr>
<td>hours pre-operatively?</td>
<td></td>
</tr>
<tr>
<td>9. If the admission finger stick blood glucose (FSBG) is &gt; 200mg/dL the patient is</td>
<td>True / False</td>
</tr>
<tr>
<td>excluded from the protocol implementation?</td>
<td></td>
</tr>
<tr>
<td>10. The patient is to remain strict NPO and no medications after admission to the</td>
<td>True / False</td>
</tr>
<tr>
<td>pre-operative waiting room?</td>
<td></td>
</tr>
<tr>
<td>11. The patient will receive three doses of Maltodextrin 12.5%?</td>
<td>True / False</td>
</tr>
<tr>
<td>12. The first dose of Maltodextrin 12.5% is at six hours pre-operatively and completion</td>
<td>True / False</td>
</tr>
<tr>
<td>of the beverage initiates “Protocol Start Time?”</td>
<td></td>
</tr>
<tr>
<td>13. The second dose of Maltodextrin 12.5% is given an hour prior to surgery, and the</td>
<td>True / False</td>
</tr>
<tr>
<td>nurse documents “Second Dose Completion” time?</td>
<td></td>
</tr>
<tr>
<td>14. Anesthesiology providers manage glycemic monitoring and intervention as frequently</td>
<td>True / False</td>
</tr>
<tr>
<td>as needed in the operating room?</td>
<td></td>
</tr>
<tr>
<td>15. Post-operative day (POD) 1 and POD2 glucose must be under 201mg/dL at 6:00am to</td>
<td>True / False</td>
</tr>
<tr>
<td>meet the aims of the protocol implementation and SCIP guidelines?</td>
<td></td>
</tr>
</tbody>
</table>

**Answer Key**

1. True
2. False; 125mg/dL
3. True
5. True
6. False; BMI < 35
7. True
8. True
9. True
10. False NPO except medications to allow the intervention dose of Maltodextrin 12.5%
APPENDIX F:

INTERDISCIPLINARY TEAM SURVEY
**INTERDISCIPLINARY TEAM SURVEY**

<table>
<thead>
<tr>
<th>Interdisciplinary Team Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. Was the education training sufficient for you to feel comfortable using the protocol?</td>
</tr>
<tr>
<td>b. Why or Why not?</td>
</tr>
<tr>
<td>c. Would you like more time spent on protocol education?</td>
</tr>
<tr>
<td>d. Would you like less time spent on protocol education?</td>
</tr>
<tr>
<td>2a. Did you use the protocol on all qualified patients as identified by the program coordinator?</td>
</tr>
<tr>
<td>b. Why or Why not?</td>
</tr>
<tr>
<td>c. Did you use the protocol on patients not qualified for participation?</td>
</tr>
<tr>
<td>d. Why or Why not?</td>
</tr>
<tr>
<td>e. How many non-qualified patients received the protocol? (Circle One)</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>3a. Were the protocol instructions easy to follow as part of the Interdisciplinary Team?</td>
</tr>
<tr>
<td>b. Why or Why not?</td>
</tr>
<tr>
<td>4a. Did you find it difficult to implement the protocol in qualified patients?</td>
</tr>
<tr>
<td>b. Why or Why not?</td>
</tr>
<tr>
<td>5a. Did you have enough time to implement the protocol in qualified patients?</td>
</tr>
<tr>
<td>b. Why or Why not?</td>
</tr>
</tbody>
</table>
REFERENCES


