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DOCTOR OF NURSING PRACTICE (DNP) PROGRAM

A DNP PROJECT TITLE:

Evaluation of an Evidence Based Educational Module on Glycemic Control of Targeted Temperature Management Patients in the Critical Care Setting

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Abstract

Critically ill patients are at risk of developing stress induced hyperglycemia (SIH), a process that is associated with increased mortality and adverse outcomes (American Diabetes Association, 2017; Silva- Perez, 2017). During times of stress norepinephrine is released through activation of the sympathetic nervous system. To sustain these periods of stress and maintain energy production, epinephrine inhibits insulin secretion causing glucose levels in the blood to rise (Röder, Wu, Liu, & Han, 2016). Organizations including *The American Diabetes Association (ADA)* and *The Society of Critical Care Medicine* recommend that glucose levels be maintained under 180 mg/dL with intravenous insulin as the treatment of choice. The ADA then explains the need for policy, protocol, and proper education to ensure evidence based care for patients. To successfully implement evidence based medicine "multidisciplinary interaction and ongoing staff education [is required] to ensure optimal patient outcomes (ADA, 2017; Kelly, 2014; p. 219). After review of the glycemic control of patients undergoing targeted temperature management (TTM) after cardiac arrest at a New Jersey hospital, data revealed that patients remained in a hyperglycemic state for more than 24 hours post initiation of TTM. The purpose of this quality improvement project was to improve upon the glycemic control of TTM patients through the use of an educational module emphasising the importance and rationale behind glycemic management. Education was provided to the nursing staff who was responsible for the care of these TTM patients regarding the rationale behind glycemic control and current guidelines. An unpaired t- test was run comparing the mean glycemic values at 12 hours and 24 hours. Using an alpha value of 0.05 it was determined that there was no statistical significance between average glycemic values of TTM patients at 12 hours before education (M: 210.67 mg/dL, SD: 72) and after education (M: 202 mg/dL, SD: 72); (t= 0.263, *P*=0.79). It was also determined that at 24 hours, there was no statistical difference between the pre education group of TTM patients (M: 191.96 mg/dL, SD: 75.19) and the post education group of TTM patients (M: 208.5 mg/dL, SD: 70.5); (t= 0.603, *P*: 0.55) and in fact the mean at 24 hours increased after education Using SPSS, a Pearson product- moment correlation was run to determine if any relationship existed between the mean glucose values of the TTM patients and the use of intravenous insulin (*r=-.314, n=37, p=.058*), the use of corticosteroids (*r=-469, n= 37, P= .003*), the use of vasopressors (*r=-.062, n= 37, P=0.714),* the number of vasopressors (*r=-.058, n= 37, P=0.732),* use of continuous dextrose infusions (*r=-.124, n=37, P= 0.465)* and previous diagnosis of diabetes (*r=-.616, n=37, P= <0.001).* Over all conclusions drawn from this quality improvement project was that the sample size between the groups were too small to adequately determine statistical significance. Adequate education on guidelines and protocols may in fact improve provider guideline adherence, but a larger sample size is needed.

Introduction

Each year, in the United States, over 300,000 people suffer from out of hospital cardiac arrest; roughly 11% will survive (American Heart Association, 2017). Those who survive are often left with devastating neurological deficits due to hypoxic brain injury. Over the years, studies have been carried out to improve the neurological outcomes for the survivors of cardiac arrest who remain in a comatose state. In 2002, two major randomized control trials revealed that by placing a comatose, post-cardiac arrest patient in an induced hypothermic state reduced brain injury and significantly improved neurological outcomes (Bernard et al, 2002; Holzer et al, 2002). After the publication of these trials, various studies have been conducted to perfect the implementation and maintenance of these hypothermic patients using targeted temperature management (TTM), in hopes to improve neurological outcomes to a greater extent.

While research has shown that TTM is an effective therapy, translating this evidence into practice can be challenging. To improve the management of these patients it is recommended that facilities develop standard operating procedures to ensure safe, efficient, quality of care (Storm, 2017). Standard operating procedures outline a specific set of practices that are to be utilized for the management of patient care under specific circumstances in the form of policies, protocols and order sets (Storm, 2017). In 2005, the American Heart Association (AHA) created guidelines to aid in the clinical management and protocol development of this patient population. Since then, the AHA has continuously updated these guidelines so that they best reflect the most current evidence available. Recommendations provided in the guidelines include specific areas of patient management including hemodynamic monitoring, temperature management, respiratory management, seizure management and neuroprognostication. After the AHA recommended that TTM be the standard of care for post cardiac arrest patients remaining in a comatose state, over 450 hospitals in the United States have implemented it into practice (University of Pennsylvania, 2016).

Although the AHA provides recommendations, the 2015 guidelines do not provide recommendations in regards to glycemic control. The current guidelines state that “No data suggests that the approach to glucose management chosen for other critically ill patients should be modified for cardiac arrest patients (Callaway et al, 2015; p. S470).” However, the glycemic management of the critically ill has been outline by organizations including *The American Diabetes Association (*ADA)*, The Society of Critical Care Medicine* (SCCM) and *The American Association of Clinical Endocrinologist* (AACE). Specifically in regards to hyperglycemia, it is recommended that critically ill patients, including those suffering from myocardial infarction and ischemia, maintain a blood glucose level less than 180 mg/dL as anything above this number has been associated with increased mortality and adverse outcomes (American Diabetes Association, 2018; Jacobi et al, 2012). The AHA and ADA also explain that to provide the most consistent, evidence based care, organizations should develop a set of policies and procedures to care for these critically ill patients (American Diabetes Association, 2015; Callaway, 2015). Studies have shown that both policy adherence and patient outcomes can improve by having standardized operating procedures and an adequately educated staff (Kim et al, 2015). Unfortunately, while the AHA, ADA, SCCM, and AACE provide evidence based guidelines to care for the critically ill, facilities still lack or fail to follow standard operating procedures, including glycemic control polices, often leading to inconsistent patient care between providers (American Diabetes Association, 2018; Storm et al, 2017).

A review of the glycemic control of TTM patients at a community hospital revealed that the glucose management can improved. It was found that for the first 12 hours after TTM initiation, 60 percent of these patients remained in a hyperglycemic state (blood glucose > 180 mg/dL), while 40 percent remained hyperglycemic for over 24 hours with few maintained on insulin infusions. Therefore, the purpose of this quality improvement project was to improve the glycemic control, specifically in TTM patients, through the use of an educational module regarding TTM rationale, the adverse outcomes of hyperglycemia in the critically ill and the hospitals hyperglycemia policy and protocol.

Background and Significance

Cardiac arrest can be triggered by a variety of factors. Regardless of the cause, cardiac arrest results in the cessation of cerebral blood flow consequently depriving the brain of oxygen. Even if only for a brief amount of time, the lack of cerebral perfusion significantly alters cellular function and can lead to cell death (Uchino, 2016). The only way to non-invasively overcome this ischemic state, perfuse the brain and attempt to achieve return of spontaneous circulation (ROSC) is through cardiopulmonary resuscitation (CPR). Unfortunately, reperfusion of the tissue in itself leads to cerebral damage. During cerebral reperfusion using CPR, a series of reactive oxygen species (free radicals) are formed contributing to cellular damage. These free radicals intensify endothelial injury and are responsible for the deterioration of neural cell membranes and organelles (Uchino, 2016). This endothelial injury results in an increased permeability of the vessel walls with subsequent leakage of intravascular fluid resulting in both cerebral and peripheral edema. Once cardiac arrest has been reversed and a patient has regained spontaneous circulation, cerebral injury continues due to a systemic inflammatory response which can last for several days (Fukuda, 2016). A post cardiac arrest brain injury can leave patients with devastating neurological deficits including altered mental status, coma or even brain death. To alter these detrimental effects of cardiac arrest and resuscitation, TTM is utilized.

Targeted temperature management, previously referred to as induced hypothermia or therapeutic hypothermia, involves purposefully inducing a comatose cardiac arrest survivor into a hypothermic state (Mathiesen et al, 2015). Currently there are four phases of TTM; induction, maintenance, re-warming, and normothermia. Patients are induced to a hypothermic state between 32 and 34 degrees Celsius, maintained at this temperature for at least 24 hours then gradually rewarmed at a rate of 0.25 degree Celsius to normothermia of 36 degrees Celsius. Patients are then maintained in a normothermia state to circumvent detrimental neurological effects that may arise from rebound hyperthermia (Callaway et al, 2015).

Evidence of TTM was first released in 2002 when two separate randomized control trials (RCT) investigated the neurological outcomes of comatose cardiac arrest survivors. During the first study, known as the Hypothermia after Cardiac Arrest Study Group, or HACA Trail, comatose cardiac arrest survivors who were induced into a hypothermic state for 24 hours were compared to a survivor group maintained at normothermia. Neurological outcomes were determined using the cerebral performance category (CPC) score. Favorable neurological outcomes included patients with CPC scores of one or two deeming a “good cerebral recovery” or “moderate cerebral disability”, respectively. In the hypothermia group, 55% of the patients had a favorable neurological outcome when compared to 36% of those in the normothermia group (risk ratio, 1.40; confidence 95 percent confidence interval, 1.08 to 1.81). In the second study, Bernard et al (2002) conducted similar research in Melbourne, Australia. They too compared comatose cardiac arrest survivors induced into a hypothermic state for 12 hours against those in a normothermic group. Of the patients who underwent induced hypothermia, 49% had favorable neurological outcomes and were either discharged home or to a rehabilitation center. In contrast, 26% of the normothermia survivors had favorable neurological outcomes (p=0.011). Pathophysiology studies have revealed that for every degree Celsius drop in core temperature there is a seven to eight percent decrease in cerebral oxygen consumption ultimately decreasing the production of reactive oxygen species (Fukuda, 2016). At the same time, there is a downregulation of inflammation, preservation of the blood-brain barrier and a decrease in intracranial pressures through the use of TTM (Rinon, 2017).

As patients are impacted by cardiac arrest and post arrest injuries, they may also suffer the effects hyperglycemia. For healthy individuals, homeostatic glycemic control is maintained by an intricate network of hormones and organs including the brain, liver, pancreas, intestines and skeletal muscles. The pancreas plays a key role in regulation of metabolism and digestion through a variety of pathways and cell types. Specifically in regards to glucose control, a large portion of the pancreas is comprised of beta cells and alpha cells responsible for insulin and glucagon production, respectively. The liver is responsible for storing glucose in the form the glycogen. As glucose levels in the blood decline, glucagon is released from the alpha cells of the pancreas, triggering hepatic cells to breakdown glycogen stores into glucose, a process known as glycogenolysis. Glucose is then released into the blood stream where it can be utilized by the tissues. Conversely, when blood glucose levels are elevated, the pancreas releases insulin from beta cells to promote glucose uptake into the tissues to be converted into energy in the form of adenosine triphosphate or ATP (Röder, Wu, Liu, & Han, 2016). During times of stress, such as critical illness, the catecholamine norepinephrine is released through activation of the sympathetic nervous system (Röder, Wu, Liu, & Han, 2016). To sustain these periods of stress and maintain energy production, epinephrine inhibits insulin secretion causing glucose levels in the blood to rise. This rise in blood sugar, also known as stress induced hyperglycemia (SIH), is often experienced by critically ill patients (Silva- Perez, 2017). During SIH there is an increased release of glucagon and cortisol that causes an increase of blood glucose, inhibition of insulin production and increase in insulin resistance by the tissues (Silva - Perez, 2017). The increase of endogenous catecholamines and the administration of catecholamine containing vasopressors increase glycogenolysis in the liver and skeletal muscle further increasing the blood glucose level (Nohra, Guerra & Bochicchio, 2016). Medical treatment alone increases blood glucose levels through the use dextrose containing intravenous medications, exogenous glucocorticoids and vasopressors, persistence bedrest and the use of parental nutrition (Silva- Perez, 2017). Specifically for critically ill patients' suffering from acute myocardial infarction, this hyperglycemic state has been associated with increased mortality and adverse outcomes (Bernhard, Monteiro & Smith, 2003). At the same time, Bernard, Monteiro and Smith (2003) explain that even short peaks of hyperglycemia can lead to exaggerated oxidative stress and endothelial injury. Tang, Long, and Liu explain that oxidative stress from reactive oxygen species further contribute to the development of hyperglycemia (2014). As previously mentioned, studies have shown that patients who suffer from cardiac arrest sustain a systemic production of reactive oxygen species as a result of reperfusion that leads to endothelial injury (Uchino, 2016; Nohra, Guerra & Bochicchio, 2016). This reperfusion injury combined with hyperglycemia may increase endothelial injury to a greater extent. Controlling this hyperglycemic state can in turn decrease the accumulation of ROS to promote endothelial tissue healing (Nohra, Guerra & Bochicchio, 2016).

Numerous studies have been conducted to perfect the management of patients undergoing TTM and improving the care of critically ill patients as a whole. The AHA provides recommendations and guidelines regarding hemodynamic goals, seizure management, respiratory goals, and neuroprognostication (Callaway et al, 2015). Like previously mentioned, however, the AHA does not provide specific recommendations for glucose management for TTM patients. With the publication of the 2015 guidelines, the AHA had reviewed only three studies regarding glucose control in TTM patients journaled in 2008, 2009, and 2010. In their recommendations they implied that the glycemic control of TTM patients should be cared for based on evidence supporting the treatment of other critically ill patients (Callaway et al, 2015). Although the AHA does not provide specific glucose management recommendations, other organizations have developed evidenced based guidelines and recommendations for the glycemic control of critically ill patients as a whole. These organizations include *The American Diabetes Association (*ADA)*, The Society of Critical Care Medicine* (SCCM) and *The American Association of Clinical Endocrinologist* (AACE).

The *American Association of Clinical Endocrinologists* and *American Diabetes Association* released a combined statement regarding the glycemic control of critically ill patients in 2009. In their report, it stated “On the basis of the available evidence, insulin infusion should be used to control hyperglycemia in the majority of critically ill patients in the ICU setting, with a starting threshold of no higher than 180 mg/dL (10.0 mmol/L). Once IV insulin therapy has been initiated, the glucose level should be maintained between 140 and 180 mg/dL (7.8 and 10.0 mmol/L), and greater benefit may be realized at the lower end of this range (Mogissi et al., 2009; p. 6).” In 2012, SCCM released guidelines for glucose management in the critically ill patient. Their recommendations state, “…similar to the *American Diabetes Association’s* guidelines for the initiation of insulin for a glucose threshold no higher than 180 mg/dL, and that a more stringent goal of 110- 149 mg/dL may be used if there is documented low rate of severe hypoglycemia (Jacobi et al, 2012; p. 3253).” The most current recommendations continue to come from *The American Diabetes Association.* In 2017, the ADA released results from a meta-analysis that was conducted focusing on glucose control for hospitalized patients; the review included the largely popular NICE-SUGAR study. In this meta-analysis the ADA concluded that "This evidence established new standards: insulin therapy should be initiated for treatment of persistent hyperglycemia starting at a threshold greater or equal to 180 mg/ dl (10.0 mmol/L). Once insulin therapy is started, a target glucose range of 140- 180 mg/dL (7.8- 10.0 mmol/L) is recommended for the majority of critically ill and non-critically ill patients. More stringent goals, such as <140 mg/dL, (<7.8 mmol/L) may be appropriate for selected patients, as long as this can be achieved without significant hypoglycemia (ADA, 2017; P. 5121)."

In order to achieve the glycemic ranges recommended, intravenous insulin infusion is the best method (ADA, 2018). Intravenous insulin infusions are easily titrated, have no absolute contraindications and are rapidly effective (Kelly, 2014). The article "*Continuous Insulin Infusion: When, Where and How?"* published in the ADA's supplemental journal, *Diabetes Spectrum: A publication of the American Diabetes Association* addresses the use of intravenous insulin infusions, the barriers associated with its use and recommendations on how to overcome these barriers. Barriers mentioned regarding the use of intravenous insulin included the "fear of hypoglycemia, confusion regarding appropriate targets, lack of administration support and resistance to change (Kelly, 2014; p. 219)" To overcome these barriers it is suggested that key staff members provide education regarding the importance of glycemic control and develop evidence based policies and protocols to aid in the care of these hyperglycemic patients. Both the AHA and ADA explain the need for policy, protocol, and proper education to ensure evidence based care for patients. The ADA explains that guidelines and protocols for glycemic management are often implemented inconsistently within hospitals and that through the use of protocols and policies, patient glycemic management can improve (ADA, 2017). To successfully implement these protocols “multidisciplinary interaction and ongoing staff education [is required] to ensure optimal patient outcomes (Kelly, 2014; p. 219).

Needs Assessment

Guideline adherence seems to be an issue internationally and locally. Storm et al (2017) surveyed 268 intensive care units (ICU) from 14 European countries to assess their adherence to guidelines and their use of standard operating procedures. Standard operating procedures include protocols and order sets which are developed to guide providers in the management of patient care as a means to adhere to set guidelines. Although 68% of the organizations surveyed had adopted the use of standard operating procedures, it was found that some hospitals operating procedures lacked the evidenced based guideline for patient care. Researchers concluded that in order to promote patient safety, it is crucial that formalized operating procedures and education regarding TTM is mandatory. Kim et al (2016) conducted a similar study interviewing 21 hospitals in South Korea to identify barriers for implementation of standard operating procedures. Three common barriers were revealed; healthcare professional’s perceptions of TTM, lack of interdisciplinary collaboration and organizational resources. It was concluded that “promoting inter-professional and interdisciplinary collaboration through educational activities… may facilitate adherence to TTM guidelines, especially in hospitals with limited human resources in critical care (p. 8).”

The United States also has difficulty with properly implementing TTM. Researchers at Beth Israel Deacones Medical Center in Boston, MA set out to assess the adherence to TTM guidelines, determine barriers to their implementation and improve the management of this patient population. They found the main barriers to the implementation of guidelines included lack of provider knowledge, unclear personnel roles, limited resources, and provider skepticism due to level of morbidity and mortality suffered by cardiac arrest survivors (Williams et al, 2013). To break down these barriers and improve guideline adherence, researchers shared the latest AHA recommendations through formal and informal education and designed documentation and provider order sets. Although patient outcomes were not revealed, they found that after the implementation of both education and provider order sets the percentage of patients eligible for TTM had increased. In addition, they noted a significant reduction in time of initiation of TTM therapy and patient care was executed in a safer and more efficient manner (Williams et al, 2013). By adapting the same principals as this study, informal and formal education provided to interdisciplinary teams at other facilities may improve the efficiency of care and outcomes of these comatose, cardiac arrest patients.

Aside from having positive impact on patient outcomes, following certain guidelines can impact organizations on a financial level. Retrospective analysis has shown that hyperglycemia is associated with poor patient outcomes across a multitude of illnesses including ischemic and hemorrhagic stroke, acute myocardial infarction, arrhythmia, congestive heart failure, pulmonary embolism and sepsis (Jacobi et al, 2012). According to the *American Diabetes Association,* randomized control trials explain that there is a strong association between inpatient hyperglycemia and increased length of hospital stays, infections and complications overall (2017). These complications have a large impact on cost. A meta- analysis conducted by the SCCM found one study that reported a $2,638 per patient savings after initiation of an intensive insulin protocol. Another study assessed by the SCCM revealed a 17% decrease in length of stay, $1580 per patient savings, and substantial savings associated decreased use of mechanical ventilation (Jacobi et al, 2012).

To evaluate glycemic management locally, control of blood glucose in TTM patients was reviewed at a community hospital in New Jersey. Initially the goal of this project was to assess how well the current hospital practices reflected the current AHA guidelines in all areas including cardiovascular care, hemodynamic management, temperature management through induction, maintenance rewarming and normothermia, neurologic care including seizure and sedation management, respiratory care including ventilation and oxygenation, glucose control and neuroprognostication. However, due to time constraints, only one aspect of guideline adherence was addressed; glycemic control. The assessment of the organization included a review of the current TTM and glycemic policies and clinical management of TTM patients. A local scopeessment was conducted through direct observation by the primary investigator along with a review of the TTM database. Interviews were carried out with key stakeholders including critical care nursing staff, critical care providers, medical residents and professional development personnel. The assessment revealed that the facility initially incorporated TTM into practice in 2013. When TTM was first implemented, over 40 educational modules were developed and taught across multiple disciplines throughout the organization. Since its initial implementation, the policy and operating procedures have been reviewed and updated several times.

The initial TTM policy in 2013 had stated that nursing staff was to notify the physician when the blood glucose levels were greater than 110 md/dL. This remained in the policy up until 2015 when the policy was revised. At that time, glycemic control for TTM patients was removed from the policy as the AHA recommended no change in glycemic control for post cardiac arrest patients compared to other critically ill patients. In 2016 the hospital adopted the most current glycemic protocol for hypoglycemia, hyperglycemia and NPO patient that *recommends* surgical ICU, medical ICU and coronary care unit (CCU) patients hyperglycemic targets *should* be between 140- 180 mg/dL and intravenous insulin drip should be used to maintain this target (Hackensack Meridian Health, 2016; p. 3).” Because the policy only recommends that patients remain in this blood, it’s possible that this glucose range is overlooked.

Currently, the critical care committee maintains de- identified records of TTM patients and frequently updates this database. Included in this data base is glucose measurement of TTM patients from the start of TTM induction until the end of normothermia. When review of this database took place, the primary investigator focused on TTM patients from 2016 to 2018 as this time frame reflected the use of the most current glycemic control policies. Since 2016, the hospital has collected data on 27 of its last 40 TTM patients. Review of the data pertaining to glycemic control revealed that within the first 12 hours of TTM induction 63% (17 out of 27 patients) of these patients had an average glucose level greater than 180 mg/dL, 40% greater than 200 mg/dL and 15% greater than 300 mg/dL. Within 24 hours 37% of the patients had an average glucose measurement greater than 180 mg/dL, 26% had greater than 200 mg/ dL, and 11% greater than 300 mg/dL. Although it is not mentioned in the 2016 policy, the ADA, SCCM and AACE recommend that intravenous insulin therapy should be initiated for persistent hyperglycemia to maintain a blood glucose between 140 – 180 mg/dL (ADA, 2018; Jacobi et al, 2012). Only 4 of the 17 hyperglycemic reviewed patients had an insulin infusion started within the first 12 hours, one of which was not started until hour 12. At the same time only eight total patients of the 17 hyperglycemic patients had an insulin infusion within the first 24 hours. Other medical interventions that may have impacted glucose, including subcutaneous insulin injections, use of corticosteroids, use of vasopressors, previous diagnosis of diabetes, or what medications mixed in dextrose were continuously infusing were not available on the hospitals current database.

After discussion with the intensivists, critical care nursing staff, medical residents and staff from professional development, it was determined that there was room for improvement in regards to the glycemic control specifically for TTM patients. As previously mentioned the hospital's hyperglycemic protocol only *recommends* maintaining a glucose between 140- 180 mg/dL. Because it is only a recommendation and not mandatory, it is possible that the importance of euglycemia is overlooked. Guidelines and policies are developed to ensure that patients are receiving safe, effective, efficient, and equitable care. Unfortunately, without proper education, these policies and protocols may be neglected. This needs assessment and below mentioned review of literature led to the impression that with the development of an educational TTM program for the nursing staff and staff involved in the management of TTM patients, specifically referencing the glycemic control of this patient population, glucose control may improve.

Problem/ Purpose Statement

The ADA explains that glycemic protocols and procedures are often inconsistently implemented. Studies also suggest that by providing education regarding the rationale behind TTM, guideline and protocol adherence can improve. It was determined that TTM patients at a community hospital in New Jersey remained in a hyperglycemic state for long periods of time. The purpose of this project was improve upon the glycemic control of TTM patients through the use an educational module regarding TTM and glycemic control rationale with a focus current guidelines and the hospitals glycemic policies and protocols.

Clinical Question

Will the implementation of interdisciplinary education regarding the rationale and protocol regarding glycemic management improve the glycemic control of TTM patients?

Aims & Objectives

Quality patient care requires implementing the most current evidence-based knowledge into practice. This quality improvement project will provide an educational program to improve knowledge of the rationale, evidence-based guidelines and hospital policies used in the glycemic management of patients undergoing TTM. The objectives of this project are to: (1) educate the medical residents, critical care and emergency department providers, and critical care and emergency department nurses on the rationale behind TTM and glycemic control; (2) educate on the guidelines set forth by ADA, SCCM, AACE and hospitals glycemic control policies (3) improve adherence to the hospital policy specifically in the area of glycemic control; (4) and evaluate the impact policy adherence has on glycemic control of TTM patients.

Review of Literature

For the purposes of this project, targeted temperature management (TTM) is defined as the purposeful induction of hypothermia to decrease brain injury in patients who remain in a comatose state after surviving a cardiac arrest (Callaway et al., 2015). Standard operating procedures are protocols and order sets developed to guide providers in the management of patient care to best adhere to set guidelines (Storm et al, 2017). Interdisciplinary teams consist of individuals from different professionals and disciplines including physicians, nurses, nurse managers, medical residents, pharmacists, social workers, case managers, physical therapists and patient care assistants (Nancarrow et al, 2013). A literature review was conducted to investigate four concerns: 1) the impact standard operating procedures for TTM had on patient outcomes; 2) the impact standard operating procedures for TTM had on provider adherence to policy and guidelines; 3) the impact TTM education had on management of patient care and 4) the impact standard operating procedures and interdisciplinary provider education had on patient outcomes.

This review of the literature was conducted through the use of these six databases: CINAHL, EBSCOhost, PubMed, Ovid MEDLINE, Scopus, and ClinicalKey. Initially searching CINAHL using key terms *therapeutic hypothermia, protocol* and *education,* twenty six articles resulted. When the filters “Full Text” and publication date parameters of 2013- 2018 were applied, the search narrowed to two articles. However, when inserting these key terms into EBSCOhost, 54,760 articles resulted. When the aforementioned filters were applied, the resulted narrowed to 2,477. These same filter parameters were then used for searching additional combinations of keywords including *targeted temperature management, evidence based practice, guideline adherence, critical care, compliance, critical care providers, interdisciplinary, quality improvement, patient outcomes, barriers, United States, intensive care unit* and *critical care unit* within the mentioned databases. Inclusion criteria included national and international systematic reviews, original research and quality improvement studies that included only patients undergoing TTM after cardiac arrest. Exclusion criteria included neonatal and pediatric patients as well as TTM patients who suffered from a traumatic brain injury or stroke. In addition, any studies prior to 2013 were excluded to include only the most recent literature.

Large organizations, including the American Heart Association and the Australian Resuscitation Council (ARC) developed guidelines to assist providers with adherence to current evidence based practice. However, implementing these guidelines into practice continues to be a challenge. Milonas et al (2017) conducted a retrospective audit to determine the compliance of TTM guidelines set forth by the Australian Resuscitation Council at two hospitals in Melbourne, Australia. Both hospitals allegedly practiced TTM according to ARC guidelines. To review the compliance researchers compared the management of these TTM patients with respect to induction of TTM, systolic blood pressure parameters, ventilation management, blood glucose control, anti-arrhythmic medication use, induction and use of anticonvulsants, all of which are outlined in the ARC guidelines. After collecting data on 100 randomly selected TTM patients they found that there was a great deal of variability in post resuscitation care and adherence to the National guidelines were inconsistent. With the findings of this study researchers explain that strategies to implement current evidence is urgently needed.

There are consistent reports across many studies that suggest that by having standard operating procedures, compliance to guidelines and policies improve. However, it is found that many barriers exist to their implementation. Kim et al (2016) found that barriers for facilitating TTM guidelines included the healthcare professional's perceptions of TTM, weak interdisciplinary collaboration and the lack of resources provided by the organization. Storm et al (2017) surveyed ICUs from 14 European countries and found that although standard operating procedures can improve the quality and safety of patient care, there is a need for educating staff on the current guidelines. Although 68% of these European hospitals incorporated these standard procedures, the care provided varied greatly, often not following set national guidelines.

When reviewing the literature to assess how education and standard operating procedures impact provider guideline adherence and patient outcomes, only two studies were found. One study from Italy and one from Cleveland, Ohio. In 2014 Pellis et al. released the results of a four year implementation strategy study carried out based on the idea that limited implementation strategies were the main barriers to proper TTM adoption. In Pordenone, Italy, these researchers implemented these procedures and performed audits of compliance and patient outcomes after sixteen months to address any issues related to their use. Halfway through the four years they introduced continuous professional development courses to provide education on TTM and post-resuscitation care. Data was collected on patients prior to the implementation of the standard operating procedures, after their implementation and then after the implementation of education. Researchers found a statistically significant improvement in mortality and patient outcome by 64% and 82%, respectively ($p<0.05$) after the introduction of education. Although patient outcomes improved, researchers did not assess compliance to guidelines or elaborate on how education was provided.

In 2017 Wyse and McNett conducted a similar study at the MetroHealth System in Cleveland, Ohio. They assessed how the implementation of TTM protocols impacted patient mortality, length of stay and neurological status at discharge. The researchers implemented a TTM protocol and provided specialized training regarding the protocol and equipment including proper documentation, methods of cooling, maintenance and rewarming to the nursing staff. A retrospective chart review of 239 TTM patients was conducted before the protocol and 20 patients after the protocol. The results of this study found that mortality of those undergoing TTM decreased after the protocol was implemented. Mortality rate prior to implementation was 89.4% and dropped to 75% ($p<0.05$). At the same time there was an increased percentage of patients discharged home after the implementation of the protocol (21.5% compared to 5.1 %; $p<0.05$). These findings suggested that the implementation of both education and standard operating procedures improved patient outcomes. However, one major limitation to this study is the large difference in sample size between patients before protocol use and after protocol use. At the same time, although patient outcomes improved, adherence to guidelines were not assessed.

Although it is well studied that standard operating procedures and education may improve guideline adherence and improve patient outcomes, there is little information on how education is provided or how education is provided to an interdisciplinary team in the acute care setting. At the same time, despite the evidence that suggest education may impact provider adherence to guideline and improve patient outcomes, acute care settings continue to neglect providing this education. This may be due to the fact that little research is available regarding its importance, resistance to change and lack of personnel. With the lack of research available, it appears that there is a gap in knowledge regarding the importance of providing education when implementing the evidence behind TTM.

Theoretical Framework

The overall purpose of this project was to improve the glycemic control of patients undergoing TTM. To implement this project the framework *Plan – Do- Study- Act* (PDSA) was utilized. This framework consists of a four stage cycle used to adapt changes aimed at improvement of a problem (Taylor, 2013). The origination of the PDSA framework dates back to the sixteenth century and is based largely on the scientific underpinnings of knowledge development established by Galileo Galilei, Francis Bacon, and John Dewey. With the influence of these individuals, Walter A. Stewhart and Edward Deming created the cyclic representation of a scientific process. Originally, the PDSA framework was known as the Stewhart Cycle and consisted of three steps; specification (Plan), production (Do), and inspection (Study). With the use of this cyclic progression new knowledge was implemented and perfected. In 1951, Deming revised the cycle adding a fourth component, redesigning the implementation. Over the years Deming has perfected and reintroduced the framework multiple times resulting in the current model of *Plan- Do – Study –Act* (Moen, 2009).

As stated in the framework title, the four stages are *Plan, Do, Study*, and *Act.* During the *Planning* phase the researcher must ask “Where does practice need improvement? Where can the practice be more efficient? What are we trying to accomplish?” Based on the answers to these questions, a plan can be devised to improve the problem at hand. Once these questions are answered and a plan is developed, that plan can be implemented. This is the *Do* phase of the PDSA cycle. Once the practice change has been rolled out, the results are then studied to determine if there was a change. This phase is known as *Study*. By studying the results, the researcher can determine if the plan achieved the desired outcome and determine if changes in the process need to be made. If changes with the original plan are needed, the researcher must *Act* on these changes and create a new plan to improve those needs. At this time the cycle then repeats itself (Taylor, 2013; Moen, 2009). This PDSA framework was used to implement an educational program for providers in direct contact with patients undergoing TTM (Appendix B). The problem found was the glycemic control of TTM patients at a community hospital and the need for education pertaining current guideline and hospital policy. The *Plan* was to improve glycemic control of TTM patients through the use of education provided to the staff responsible in the care of this patient population. Once education was provided, management of patient care and recommended protocol adherence was to be reviewed through conducting a chart review of all TTM patients. Data was then to be collected on patients prior to the implementation of the educational modules and after. The two sets of data were then to be compared to determine if there was an improvement in following the recommended glucose range of 140-180 mg/dL as stated in the hospital protocol and current guidelines.

The *Do* phase of the PDSA cycle included implementing the *Plan*. As stated above, the education would be provided to the interdisciplinary team regarding the rationale of TTM and glycemic control and the hospitals protocols. During the *Study* phase, the researcher would review the results of the process. At that time data would be collected as mentioned in the *Plan*. At the same time feedback would be collected from staff regarding education provided. Once this has been completed, the next phase of the cycle could begin. At this time the researchers can now *Act* on the findings. As pertaining to this TTM project, feedback from staff would be valuable. Questions such as “Did the education fit your learning needs? Was the education provided easy to follow? Did the education improve your understanding and rationale of TTM?” At the same time using the data collected from the patient records, adherence to the recommended glycemic control protocol would be determined. For example, the new policy recommends patients to be started on insulin infusions when blood glucose levels exceeded 180 mg/dL, chart reviews will determine if this occurs. For patients who have glucose levels above 180 mg/dL and were not started on an insulin infusion, reasons for lack of insulin infusion will be determined. Based on these results, changes can be made to aspects of the education provided that may not have be being carried out adequately. At this point, the cycle continues and the research plans to implement the improvements that are needed.

Methodology

Study Design

The design of this Doctorate of Nursing Practice (DNP) project was a quality improvement study using the framework of *Plan Do Study Act*. This DNP project assessed the effect of an educational module on guideline and hospital protocol adherence, specifically pertaining to the glycemic control of TTM patients. Current evidence based practice states that patients in the critical care units should have blood glucose levels maintained between 140 mg/dL and 180 mg/dL and “should follow unit specific protocols for IV insulin drip to maintain that target (Hackensack Meridian Health, 2016; p. 3).” However, 63 percent of the last 27 TTM patients average blood glucose levels were greater than 180 mg/dL, 40 percent were greater than 200 mg/dL, and 15 percent were greater than 300 mg/dL in the first 12 hours of TTM. Therefore, the main goal of this DNP project was to improve the glycemic control of TTM patients and maintain a target glucose level as recommended in the hospitals the glycemic protocol parameters and as recommended evidence based practice.

Prior to the start of this study approval was obtained from the hospitals Research council, Nursing Executive Board and the Institutional Review Board (IRB) from both the Hackensack Meridian Health System and Rutgers University. After IRB approval from both organizations, a retrospective chart review was conducted to collect data pertaining to glucose management of TTM patients prior to the educational module being presented. Once data collection was completed, contact was made with the nurse managers of the critical care units and emergency department for the recruitment of staff nurses to participate in an educational module regarding the rationale behind TTM and the glycemic management of this patient population as outlined in the hospital policies. Multiple attempts were made to secure a time to provide the educational module to the medical staff, but unfortunately schedules did not match up. Therefore, only the nursing staff received education on glycemic control and TTM patients; medical residents and medical doctors did not. After education was provided to the nursing staff a retrospective chart review of all TTM patients who were admitted after education was provided was conducted to determine if glycemic control had improved.

Setting

This quality improvement project was conducted at a 388 bed, Magnet recognized community hospital in New Jersey ([redacted].org, 2018). The hospital has received three consecutive Magnet recognitions since 2004 displaying its nursing excellence and is also home to an internal medicine residency program. Among the services provided at this facility are emergency medicine, critical care, interventional cardiovascular care and diagnostic imaging. The facility is also home to a 12 bed intensive care unit and an eight bed coronary care unit where TTM patients are cared for by critical care nurses, intensivists and medical residents.

This organization takes pride in both its staff and patients as seen through their overarching mission on providing the highest quality of care to all. Multiple committees, including Practice Guidelines, Nursing Research Council and Quality Improvement are dedicated to ensuring that the most current evidence is being utilized at this facility. Aside from the current members, these committees welcome the input of staff from all departments and disciplines. With missions such as this, the organization is welcoming to new knowledge particularly if it impacts the implementation of current evidence based care. The hospital is also a teaching hospital, home to an internal medicine residency program accredited by the Accreditation Council for Graduate Medical Education. Among many areas of teaching, the residency program provides workshops for the medical residents that are organized by senior medical residents and faculty intensivist. The faculty intensivists are also strengths to the organization. Since the incorporation of intensivists to the critical care units in 2014, evidence based practice has been welcomed to an even greater extent, greatly improving the quality of care of this organizations critical patients.

Study Population and Recruitment

The sample size of participants was 85 staff members. This included 33 of emergency department (ED) nurses and 52 critical care nurses. Inclusion criteria for this project's participants included staff in direct care of patients undergoing TTM. Exclusion criteria included staff whose primary position was on non- critical care units including medical surgical, labor and delivery, and telemetry. Study participants were recruited using convenience sampling. The primary purpose of utilizing this sample population was to target the staff that are responsible for the direct management of care for patients undergoing TTM.

Once IRB approval was obtained, contact was made with the two Chief Medical Residents, intensivists, nurse managers of the critical care units and emergency department and the director of the facilities staff development. Contact was initially made through email in order to set up an in person meeting. After meeting with the facilities staff development, who ultimately determines what education is to be provided to staff, it was determined that the learning module would be made mandatory for all critical care and ED nurses to complete. Unfortunately, after multiple discussions with the Chief Medical Residents and medical staff, the medical staff was unable to participate in this project do to scheduling conflicts and lack of online learning module access.

Study Intervention

Participants took part in a mandatory online education module created by the primary investigator (PI). The education module was uploaded onto the hospitals online learning management system. Participants were required to review the online module and answer 10 questions reviewing the material at the end of the presentation. Question topics include how hyperglycemia negatively impacts the critically, what glycemic range the critically ill should be maintained, the use of IV insulin, and questions regarding the hospitals glycemic policy. To successfully complete the module, all questions had to be answered correctly with a score of 100 percent. The educational module was available over a four week period. Each week, the staff development department provide the PI with the number of completed online modules. After discussion with the education department and the nurse managers of both the ED and critical care units the modules were mandatory for staff to complete.

The educational presentation was developed by the primary investigator with the assistance and supervision from the medical director of the ICU and members of staff development. Education provided was in a power point format, took approximately one hour to complete and included the following information:

1. Overview of primary and secondary brain injury experienced by cardiac arrest patients (fifteen minutes)
2. Rationale behind TTM and the importance of glycemic control (twenty minutes)
3. Guidelines and policy for glycemic control (twenty five minutes)

Data from TTM patients was collected after all participants successfully completed the online module. The primary variable to be collected after education was the glucose levels of all TTM patients admitted after education had been provided and how glucose levels were maintained (i.e. insulin drip or subcutaneous insulin injections) to determine if average levels were less than 180 mg/dL as stated in the hospital policy.

Outcome Measures

Data was collected through retrospective and prospective chart reviews of TTM patients prior to and after the education module was provided to the critical care and ED staff nurses. The hospital maintains a database of all patients who have undergone TTM since its inception in 2013. A list of patients who have undergone TTM was provided to the PI by the assistant nurse manager of the ICU at the facility. The assistant nurse manager had pre- approved access to the TTM database and agreed to provide the PI a list of names of the previous TTM patients using an excel spreadsheet. This excel spread sheet was saved and accessed on the secure computer system, on site, at the facility. Access to this excel spread sheet containing patient names was not accessed outside of the secure network. Data collection sheets did not include any patient identifiers. Upon completion of the data collection, the excel sheet containing list of names was destroyed. The TTM patients on this list included the last 27 patients since 2016 who underwent TTM prior to education as these patients made it evidence that a large percentage of patients remained hyperglycemic for well over 12 hours of TTM induction. After education was completed by all participates, data was collected for three months from all TTM patients after education had taken place.

Data retrieved from retrospective and prospective chart review and the reason for that collection included:

1. Age
    a. Demographics
2. Gender
    a. Demographics
3. Average glucose value between hours zero (Initiation of TTM) to hour 12
    a. To determine if glycemic control had improved after the implementation of the educational module
4. Average glucose value between hours zero (Initiation of TTM) to hour 24
    a. To determine if glycemic control had improved after the implementation of the educational module
5. Every finger stick glucose levels from time zero (initiation of TTM) up to 24 hours from the initiation of TTM.
    a. Finger stick values will be utilized instead of glucose measurements from a chemistry as finger stick values are how nurses titrate intravenous insulin infusions.
6. How hyperglycemia was managed i.e. subcutaneous insulin injections versus intravenous insulin infusions versus no treatment.

   a. As previously mentioned, the ADA and SCCM report that hyperglycemia should be managed through the use of intravenous insulin therapy.
   b. To compare the glycemic control of patients maintained on intravenous insulin therapy to patients maintained on sub cutaneous insulin therapy
7. Possible confounding variables that can impact glycemic control including the use of medications mixed in dextrose, corticosteroids use, pressor use and previous diabetes diagnosis.
   a. As previously mentioned medical treatment alone increases blood glucose levels through the use dextrose containing intravenous medications, exogenous glucocorticoids, and vasopressors, persistence bedrest and the use of parental nutrition (Silva- Perez, 2017).

Glucose values and glycemic control measures were found in patient's electronic health record. As evident in the electronic health record, finger stick glucose measurements were documented on all TTM patients every four hours, as followed by the hospitals TTM policy. For patients maintained on continuous insulin infusions, glucose measurements were assessed and documented every hour as followed by the hospitals glycemic policy. Data retrieved was documented in an SPSS spread sheet in a format resembling the attached data collection document located in Appendix G and Appendix H. As previously mentioned, this chart review was completed using the hospitals electronic health records that are only accessible through the organizations private server. All data was collected onsite. All patient data collected was saved and maintained at the medical facility using their secure network and all patient identifiers have been destroyed since the conclusion of this project.

After the implementation of the educational module a prospective chart review was conducted on TTM patients to determine if recommended glycemic values set forth by organizations including ADA, SCCM, and AACE and the hospital policy had improved. Like the current database, data collected included each finger stick blood glucose levels assessed in the first 24 hours. This data was then divided into average glucose levels within the first 12 hours of TTM and the first 24 hours of TTM. Like the retrospective data, prospective data included how glucose levels were managed; i.e. subcutaneous insulin, intravenous insulin therapy or no treatment and variable that could impact the glycemic values including corticosteroids, vasopressor and medications mixed in dextrose. Data retrieved was documented in an SPSS spread sheet such as the one located in Appendix I and Appendix J.

Risk, Harms and Ethics

The risks associated with the participants involved in this quality improvement project were minimal. Risks regarding patient data was also deemed minimal. Throughout the data collection process, patient identifiers including medical record numbers of TTM patients were maintained in the facility under the secure network. At commencement of the project, all patient identifiers were deleted.

Consent Procedures

After discussion with the facilities staff development and the IRB, consent procedures were deemed unnecessary as the educational module completed by the participants was deemed mandatory. However, participants were able to speak with and ask questions of the PI throughout this entire quality improvement project process.

Subject Costs and Compensations

There were no cost incurred by the participants of this project. Participants were awarded one continuing education unit (CEU) for completing the one hour educational module once they correctly answered all ten post questions.

Resources Needed

All costs were paid for by the primary investigator. The hospital provided the space needed for the educational presentation at no cost. The hospital provided the computer and space needed for data collection. Data collection was conducted during the primary investigators personal time.

Evaluation

Data Maintenance and Security

All patient data collected was saved and maintained at the medical facility using their secure network. No data including possible patient identifiers was accessed or reviewed outside of the secure, hospital network. To access the secure network a password and username was needed.

Results

There were 52 critical care nurses and 33 emergency department nurses that participated in the mandatory glycemic control educational module regarding targeted temperature management patients. Each participant successfully completed a post-test containing 10 questions. Successful completion of the educational module was determined by completing the posttest with 100% accuracy. Prior to the implementation of the module, a retrospective chart review was conducted to collect data regarding glycemic control and possible confounding variables. These variables included the use of intravenous insulin, administration of corticosteroids, vasoactive medications, medications mixed in dextrose such as D5W, D5NS, and D51/2NS and the number of vasoactive medications that were used. Retrospective data was collected from 27 TTM patients prior to education and 11 TTM patients after education. Data was collected from all TTM patients after the implementation of the module between the months of May 2019 and July 2019. Eleven patients underwent TTM between these time periods. One of the 11 TTM patients were excluded from the study due to their survival being less than 12 hours.

Prior to education 63% (17 out of 27 patients) of TTM patients had an average glucose level greater than 180 mg/dL, 40% greater than 200 mg/dL and 15% greater than 300 mg/dL in the first 12 hours. Within 24 hours 37% of the patients had an average glucose measurement greater than 180 mg/dL, 26% had greater than 200 mg/ dL, and 11% greater than 300 mg/dL. After education was provided, 50% (five out of 10 patients) of TTM patients had an average glucose level greater than 180 mg/dL, 40% greater than 200 mg/dL and 10% greater than 300 mg/dL within the first 12 hours. Within the first 24 hours of TTM initiation, 50% (five out of 10 patients) of TTM patients had an average glucose level greater than 180 mg/dL, 50% had greater than 200 mg/Dl and 20% had greater than 300 mg/dL.

At the conclusion of the data collection, a Shapiro- Wilk test was used to determine if the mean glucose levels were normally distributed. Because the data was normally distributed, an unpaired t-test was used to determine if statistical significance existed between the mean averages of glucose measurements of patients before education was provided to staff and after. A t- test was run comparing the mean glycemic values at 12 hours and 24 hours. Using an alpha value of 0.05 it was determined that there was no statistical significance between average glycemic values of TTM patients at 12 hours before education (M: 210.67 mg/dL, SD: 72) and after education (M: 202 mg/dL, SD: 72); ($t= 0.263$, $P=0.79$). Using the same alpha value of 0.05 it was also determined that at 24 hours, there was no statistical difference between the pre education group of TTM patients (M: 191.96 mg/dL, SD: 75.19) and the post education group of TTM patients (M: 208.5 mg/dL, SD: 70.5); (t= 0.603, *P*: 0.55) and in fact the mean at 24 hours increased after education.

As previously mentioned the ADA recommends the use of IV insulin for patients in the medical ICU with glucose values above 180 mg/dL. Prior to education being provided to the nursing staff, only four of the 17 TTM patients who remained hyperglycemic were maintained on an insulin infusion. After education, only one of the five TTM patients who remained hyperglycemic were maintained on insulin infusion. Using SPSS, a Pearson product- moment correlation was run to determine if any relationship existed between the mean glucose values of the TTM patients and the use of intravenous insulin (Table 1). There was a weak, negative correlation between glucose and IV insulin use that was statistically insignificant (*r=-.314, n=37, p=.058*). A Pearson product- moment correlation was run to determine if any relationship existed between the mean glucose values and the use of corticosteroids (Table 2). There was a moderate, negative correlation between glucose and corticosteroid use that was statistically significant (*r=-469, n= 37, P= .003*). A Pearson product- moment correlation was run to determine if any relationship existed between the mean glucose values and the use of vasopressors (Table 3). There was negligible, negative correlation between glucose values and vasopressor use that was not statistically significant (*r=-.062, n= 37, P=0.714).* A Pearson product- moment correlation was run to determine if any relationship existed between the mean glucose values and the number of vasopressors the TTM patient was treated with (Table 4). There was negligible, negative correlation between glucose values and number of vasopressors used that was not statistically significant (*r=-.058, n= 37, P=0.732).* A Pearson product- moment correlation was run to determine if any relationship existed between the mean glucose values and the use of continuous dextrose infusions (Table 5). There was a small, negative correlation that was not statistically significant (*r=-.124, n=37, P= 0.465).* A Pearson product-moment correlation was run to determine if any relationship existed between the mean glucose values and previous diagnosis of diabetes (Table 6). A moderate, negative correlation was found between glucose values and diagnosis of diabetes that was statistically significant (*r=-.616, n=37, P= <0.001).*

Pearson Correlations

Table 1

		Average glucose value in the first 24 hour of TTM	Was the patient treated with IV insulin at any time in the first 24 hours of TTM
Average glucose value in the first 24 hour of TTM	Pearson Correlation	1	-.314
	Sig. (2-tailed)		.058
	N	37	37
Was the patient treated with IV insulin at any time in the first 24 hours of TTM	Pearson Correlation	-.314	1
	Sig. (2-tailed)	.058	
	N	37	37

Table 2

		Average glucose value in the first 24 hour of TTM	Were corticosteroids administered at any time in the first 24 hours of TTM
Average glucose value in the first 24 hour of TTM	Pearson Correlation	1	-.469**
	Sig. (2-tailed)		.003
	N	37	37
Were corticosteroids administered at any time in the first 24 hours of TTM	Pearson Correlation	-.469**	1
	Sig. (2-tailed)	.003	
	N	37	37

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3

		Average glucose value in the first 24 hour of TTM	Were vasopressors or catecholamine drips administered in the first 24 hours of TTM
Average glucose value in the first 24 hour of TTM	Pearson Correlation	1	-.062
	Sig. (2-tailed)		.714
	N	37	37
Were vasopressors or catecholamine drips administered in the first 24 hours of TTM	Pearson Correlation	-.062	1
	Sig. (2-tailed)	.714	
	N	37	37

Table 4

		Average glucose value in the first 24 hour of TTM	Number of vasopressors or catecholamine administered in the first 24 hours
Average glucose value in the first 24 hour of TTM	Pearson Correlation	1	-.058
	Sig. (2-tailed)		.732
	N	37	37
Number of vasopressors or catecholamine administered in the first 24 hours	Pearson Correlation	-.058	1
	Sig. (2-tailed)	.732	
	N	37	37

Table 5

		Average glucose value in the first 24 hour of TTM	Use of Continuous Dextrose Infusion
Average glucose value in the first 24 hour of TTM	Pearson Correlation	1	-.124
	Sig. (2-tailed)		.465
	N	37	37
	Pearson Correlation	-.124	1

Use of Continuous Dextrose Infusion (e.g. D5W, D5NS, D51/2NS)	Sig. (2-tailed)	.465	
	N	37	37

Table 6

		Average glucose value in the first 24 hour of TTM	Did the patient have a history of diabetes prior to TTM initiation
Average glucose value in the first 24 hour of TTM	Pearson Correlation	1	-.616**
	Sig. (2-tailed)		.000
	N	37	37
Did the patient have a history of diabetes prior to TTM initiation	Pearson Correlation	-.616**	1
	Sig. (2-tailed)	.000	
	N	37	38

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

Discussion of Findings

Post cardiac arrest patients undergoing TTM are a complicated patient population. Caring for and managing this patient population entails precise assessment and treatment of nearly all systems of the body. In order to aid practitioners in the complex care of these patients, evidence based guidelines and policies are developed. Tackling all aspects of the TTM guideline adherence set forth by AHA is beyond the scope of this project. Therefore only one, sometimes forgotten, area of focus was chosen; glycemic control. The ADA explains that even with guidelines and protocols, glycemic protocols are often implemented inconsistently (ADA, 2017). Studies suggest that by providing education regarding set forth guidelines, evidence based care can improve (Kelly 2014). Guidelines created by organizations including ADA, SCCM, and AACE highly recommend that patients in medical ICU's should have glucose levels maintained between 140- 180 mg/dL. Patients who remain hyperglycemic for long periods of time are associated with adverse outcomes and longer length of stays (American Diabetes Association, 2017). After review of the TTM database, it had been determined that TTM patients at a community hospital in New Jersey remained in a hyperglycemic state for long periods of time. Therefore, the purpose of this project was to improve upon the glycemic control of TTM patients by providing education to the staff regarding the current glycemic recommendations for this patient population.

Based on the results, no statistical significance was found between the glucose values of TTM patients before the staff was educated or after. As shown in the above results, it is worth mentioning that there was a small decrease in the percentage of patients who remained hyperglycemic in the first 12 hours, falling from 63% to 50%. Although this is some improvement, the difference in sample size between the two groups (N= 27 pre education; N=10 post education) may have impacted this result. Even though there was a small improvement between the two groups at the 12 hour mark, the percentage of patients who remained hyperglycemic at the 24 hour mark actually increased. At the same time, the use of IV insulin decreased in the group after education when it was hypothesized that it would increase. Only one patient out of the five who were hyperglycemic was treated with an insulin infusion.

Glycemic values can be difficult to control in the intensive care unit as many confounding variables and medical interventions impact glucose levels. To determine reason for the high glycemic levels in this patient population Pearson Correlations between different confounding variables were run. Unfortunately, as the result show, there were no statistically significant relationships between glucose levels and IV insulin use, vasopressor use, and use of continuous dextrose containing medications. There was, however, a weak negative correlation found to be statistically significant between glucose values in the first 24 hours of TTM and the use of corticosteroids (*r=-.469, n=37, P=.003)*. Based on the results of this particular project, it shows that as the use of corticosteroids increases, the glucose values decrease. This results does not go along with the multitude of studies that already exist that have shown with much larger sample sizes that the use of corticosteroids actually increase blood glucose levels rather than decrease glucose levels.   At the same time a moderate, negative correlation was found between glucose values and diagnosis of diabetes that was statistically significant (*r=-.616, n=37, P= <0.001).* This result is showing that those patients who have a diagnosis of diabetes prior to their cardiac arrest and TTM, had lower average blood glucose levels compared to those who did not have a history of diabetes. To further interpret the validly of this results, a much larger sample size would be needed.

Limitations

This quality improvement project had two major limitations. The first limitation was the sample size of TTM patients in both the pre- education group (n= 27) and post education (n=10). Due to the nature of this patient population, this group of patients is not frequently admitted to the hospital. It takes longer than three months to acquire the sample size needed to study this patient population, a time frame that is not within the time limitations of this project. The second limitation to this project was the participants that education was provided too. Education was not able to be completed by the medical residents or intensivists of the critical care and ED units due to scheduling. Although the nursing staff is able to alert medical staff regarding the patient's glucose values, treatment is ultimately decided on by the medical practitioner. At the same time it was unable to be determined why patients who were not treated for their hyperglycemia. The purpose of this project was to inform the staff the importance of adequate blood sugar control and how it impacts the patients based on current, evidence based guidelines. The goal was to not only improve patient care but to also improve guideline and policy adherence. As previously mentioned, barriers to adequate blood sugar control include "fear of hypoglycemia, confusion regarding appropriate targets, lack of administration support and resistance to change (Kelly, 2014; p. 219)." Because these barriers technically were never addressed with those responsible for ordering treatment measures, it is to no surprise that there was no statistical difference between the two TTM groups.

Implications for Clinical Practice

Although the sample size of this project is very small, the findings of this project raise questions about current practice. The glycemic control of this patient population still can be improved. The results of this project suggest that educating the nursing staff alone is not enough. As previously mentioned in the literature review and needs assessment, true interdisciplinary education may be necessary to improve guideline and policy recommendation adherence (Kim et Al, 2016). Specific actions that can be taken to improve this clinical practice are to continue following the framework that this project was based on; *Plan, Do, Study, Act.* With the conclusion of this project, we are at the study and act phase. The next step to improve this issue is to study the results and act on the limitations. Understanding and correcting why interdisciplinary education was unable to be provided is key to further improving the glycemic control of these patients. Providing education to the larger interdisciplinary team may have a greater impact and provide better control of the glycemic values of this patient population.

Implication for Healthcare Policy

At this time, no policy change would need to happen based on the findings of this project. The policy in place already recommends that patients in the medical ICU should have glycemic values between 140- 180 mg/dL and also recommends the use of IV insulin. This policy is already in line with the guidelines provided by ADA, SCCM, and AACE. The issue appears to lie within informing and educating the entire interdisciplinary team of these recommendations.

Implications for Quality/ Safety

Quality improvement is trying to constantly improve upon the way we care for patients, the constant need to provide the best, evidence based care. This project was an attempt at improving the care of this patient population. Based on the results, we can do better. This project may have been the first step in improving the glycemic control of TTM patients using the *Plan, Do Study Act* framework. As mentioned, this framework is based on a continuum, a constant circle to continuously improve the care that is provided. Based on the results of this project, we can still strive to improve the quality of care that we provide and improve the glycemic control of these patients.

Implications for Education

This project does bring implications for education. As mentioned in the literature review, ongoing, multidisciplinary education may impact guideline and policy adherence. Based on the results of this project, there may be two ways that education can be improved. It is possible that the education provided did not meet the learning needs of those who participated. Verbal feedback provided to the PI from the staff revealed that some participants felt that the information provided was too in depth. For this reason, further projects may choose to assess the learning styles of the nursing staff to better tailor the education provided. Additionally, the results of this project may also show the importance of interdisciplinary education. Only the nursing staff was educated for this project. Nurses can inform the medical staff regarding the glucose values of the TTM patients but it is up to the practitioner to decide to treat these glycemic values. Due to extenuating circumstances, this project was unable to provide interdisciplinary education in its's entirely. Half of the interdisciplinary team, represented by the nurses, were well informed but the other half, represented by the medical staff, was not. This project may imply that better education should be given to the interdisciplinary team as a whole in order to adequately assess if education can impact guideline and policy adherence.

Conclusion

Conclusion and Plans for Future Scholarship

The ADA explains that the best way to care for the critically ill is to create policies and protocols based on guidelines. However, it is also mentioned that protocols for glycemic control are often implemented inconsistently and to successfully implement these protocols, ongoing staff education is required (ADA, 2017; Kelly 2014). This project was an attempt to improve upon the successful implementation of the policies and protocols that were already in place at this facility guided by the notion that ongoing education was required for success. It was anticipated that the educational module provided would indirectly improve the glycemic control of TTM patients at this local community hospital. As previously mentioned, 63 percent of TTM patients had an average glucose level greater than 180 mg/dL. Based on review of the literature it was hypothesized that by providing interdisciplinary education to the nursing and medical staff that the percentage of patients with average glucose levels greater than 180 mg/dL would decline thus improving glycemic control guideline and policy recommendation adherence. As mentioned, a true interdisciplinary educational module was not able to be given. The plan for future scholarship is to complete a true interdisciplinary educational module for the care of TTM patients. Initially future projects would be focusing on glucose alone, as there is still clearly room for improvement. Eventually, future scholarship plans are to provide a true, interdisciplinary educational module on all aspects of TTM and the importance of each specific areas of patient management including hemodynamic monitoring, temperature management, respiratory management, seizure management and neuroprognostication. Because policies and guidelines are created to guide practitioners in the care of patients, abiding to the policy ensures that patients are receiving safe, effective, and equitable care. When guidelines and policies are abided by, patients are receiving the best evidence based care to ensure that they will have every chance possible to achieve their greatest recovery.

References

American Diabetes Association. (2017). 14. Diabetes Care in the Hospital:Standards of Medical Care in Diabetes—2018. *Diabetes Care*, *41*(Supplement 1), S144-S151. doi: 10.2337/dc18-s014

American Diabetes Association (2017). Diabetes care in the hospital. Sec. 14. In Standards of Medical Care in Diabetes- 2017. *Diabetes Care 2017; 40(Suppl. 1):S120-S127.* Doi: 10.2337/dc17-s017

American Heart Association. (2017). *Cardiac Arrest Statistics*. *Cpr.heart.org*. Retrieved 14 February 2018, from http://cpr.heart.org/AHAECC/CPRAndECC/General/UCM_477263_Cardiac-ArrestStatistics.jsp

Callaway, C. W., Donnino, M. W., Fink, E. L., Geocadin, R. G., Golan, E., Kern, K. B., . . . Zimmerman, J. L. (2015). Part 8: Post–Cardiac Arrest Care. *Circulation, 132*(18 suppl 2). doi:10.1161/cir.0000000000000262

Bernard, S., Buist, M., Monteiro, O., & Smith, K. (2003). Induced hypothermia using large volume, ice-cold intravenous fluid in comatose survivors of out-of-hospital cardiac arrest:. *Resuscitation*, *56*(1), 9-13. http://dx.doi.org/10.1016/s0300-9572(02)00276-9

Fukuda, T. (2016). Targeted temperature management for adult out-of-hospital cardiac arrest: current concepts and clinical applications. *Journal of Intensive Care*, *4*(1). http://dx.doi.org/10.1186/s40560-016-0139-2

Hackensack Meridian Health. (2016). *Glycemic Protocols: Hypoglycemia, hyperglycemia, NPO*. [Hospital policy document]

Holtzer, M., Cerchiari, E., Martans, P., Roine, R., Sterz, F., & Eisenburger, P. et al. (2002). The hypothermia after cardiac arrest study group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. *ACC Current Journal Review*, *11*(4), 82. http://dx.doi.org/10.1016/s1062-1458(02)00735-3

Jacobi, S., Bircher, X., Krinsley, A., Agus, A., Braithwaite, A., Deutschman, A., Freire, A., et al. (2012). Guidelines for the use of an insulin infusion for the management of hyperglycemia in critically ill patients. Critical Care Medicine, 40(12), 3251–3276. doi:10.1097/CCM.0b013e3182653269

Kelly, J. L. (2014). Continuous Insulin Infusion: When, Where, and How? *Diabetes Spectrum : A Publication of the American Diabetes Association*, *27*(3), 218–223. http://doi.org/10.2337/diaspect.27.3.218

Kim, Y., Park, K., Lee, S., & Jo, S. (2016). Implementation of the guidelines for targeted temperature management after cardiac arrest: A longitudinal qualitative study of barriers and facilitators perceived by hospital resuscitation champions. *BMJ Open*, *6*(1), doi:10.1136/bmjopen-2015-009261

Mathiesen, C., McPherson, D., Ordway, C., & Smith, M. (2015). Caring for Patients Treated With Therapeutic Hypothermia. *Critical Care Nurse*, *35*(5), e1. doi:10.4037/

Milonas, A., Hutchinson, A., Green, J., Considine, J., Charlesworth, D., & Doric, A. (2017). Post resuscitation management of cardiac arrest patients in the critical care environment: A retrospective audit of compliance with evidence based guidelines. *Australian Critical Care, 30*(6), 299-305. doi: 10:1016/j.aucc.2016.12.001

Moen, R. (2009). *Foundation and History of the PDSA Cycle*. *Deming.org*. Retrieved 23 February 2018, from https://deming.org/uploads/paper/PDSA_History_Ron_Moen.pdf

Moghissi, E., Korytkowski, M., Dinardo, M., Einhorn, D., Hellman, R., Hirsch, I., Inzucchi, S., et al. (2009). American Association of Clinical Endocrinologists and American Diabetes Association consensus statement on inpatient glycemic control. Diabetes care, 32(6), 1119. doi:10.2337/dc09-9029

Nancarrow, S. A., Booth, A., Ariss, S., Smith, T., Enderby, P., & Roots, A. (2013). Ten principles of good interdisciplinary team work. *Human Resources for Health*, *11*, 19. http://doi.org/10.1186/1478-4491-11-19

Nohra, E., Guerra, J., & Bochicchio, G. (2016). Glycemic management in critically ill patients. *World Journal Of Surgical Procedures*, *6*(3), 30-39. doi: 10.5412/wjsp.v6.i3.30

Pellis, T., Sanfilippo, F., Roncarati, A., Dibenedetto, F., Franceschino, E., Lovisa, D., & ... Mione, V. (2014). Clinical Paper: A 4-year implementation strategy of aggressive post-resuscitation care and temperature management after cardiac arrest. *Resuscitation*, *85*1251-1256. doi:10.1016/j.resuscitation.2014.05.019

Röder, P. V., Wu, B., Liu, Y., & Han, W. (2016). Pancreatic regulation of glucose homeostasis. *Experimental & Molecular Medicine*, *48*(3), e219–. http://doi.org/10.1038/emm.2016.6

Silva-Perez, L. J., Benitez-Lopez, M. A., Varon, J., & Surani, S. (2017). Management of critically ill patients with diabetes. *World Journal of Diabetes*, *8*(3), 89–96 http://doi.org/10.4239/wjd.v8.i3.89

Storm, C., Nee, J., Sunde, K., Holzer, M., Hubner, P., Taccone, F. S., & ... Fries, M. (2017). Clinical paper: A survey on general and temperature management of post cardiac arrest patients in large teaching and university hospitals in 14 European countries—The SPAME trial results. *Resuscitation*, *116*84-90. doi:10.1016/j.resuscitation.2017.03.038

Tang, Y., Long, J., & Liu, J. (2014). Hyperglycemia-Associated Oxidative Stress Induces Autophagy. *Autophagy: Cancer, Other Pathologies, Inflammation, Immunity, Infection, And Aging*, 105-115. doi: 10.1016/b978-0-12-405530-8.00008-x

Taylor, M., McNicholas, C., Nicolay, C., Darzi, A., Bell, D., & Reed, J. (2013). Taylor MJ, McNicholas C, Nicolay C, et al Systematic review of the application of the plan–do–study–act method to improve quality in healthcare BMJ Qual Saf 2014;23:290-298. *BMJ Quality & Safety*, *23*(4).

Williams, D., Calder, S., Cocchi, M., & Donnino, M. (2013). From Door to Recovery: A Collaborative Approach to the Development of a Post-Cardiac Arrest Center. *Critical*

Care Nurse, *33*(5), 42. doi:10.4037/ccn2013341

Wyse, J., & McNett, M. (2016). Targeted Temperature Management: Effects of Initial Protocol Implementation on Patient Outcomes. *Dimensions Of Critical Care Nursing*, *35*(4), 229. doi:10.1097/DCC.0000000000000191

Uchino, H., Ogihara, Y., Fukui, H., Chijiiwa, M., Sekine, S., Hara, N., & Elmér, E. (2016). Brain injury following cardiac arrest: pathophysiology for neurocritical care. *Journal of Intensive Care*, *4*, 31. http://doi.org/10.1186/s40560-016-0140-9

University of Pennsylvania. (2016). *Hospitals the cool*. *www.med.upenn.edu*. Retrieved 14 February 2018, from https://www.med.upenn.edu/resuscitation/hypothermia/ cooling_list.shtml

Appendix A: Evidence Table

Student: Sara Owen **DNP Project Chair:** Helen Miley

PICO Question: Will the implementation of interdisciplinary education regarding the rationale behind TTM and the importance of hospital policy adherence improve the provider adherence to hospital policy specifically in the areas of hemodynamic control and discontinuation of sedation? If policy adherence is improved, will this impact patient cerebral performance category (CPC) scores?

Evidence Table

Article #	Author & Date	Evidence Type	Sample, Sample Size, Setting	Study Findings that help answer EBP question	Limitations	Evidence Level and Quality
1.	Storm et al, 2017	Research: Quasi-Experimental	268 ICUs from 14 European countries were contacted regarding their treatment regimen for targeted temperature management (TTM) patients.	Found that TTM treatment widely varies between institutions. Standard operating procedures (SOP) had been implemented in 68% of hospitals interviewed. This study found that SOP can improve quality and safety of patient care. At the same time, this article explains that current knowledge and education of protocols is crucial. **Support for EBP question:** This article supports the need for educating staff on the current guidelines for TTM and the impact of protocol adherence	This study was conducted after the most recent TTM trial but prior to the release of the 2015 TTM guidelines	Level: III Quality: High
2.	Oddo et al, 2016	Non Research: Literature Review	Setting: NA Sample Size: 72 reviewed articles	Discusses First line medications for sedation in brain injuries i.e. propofol and midazolam Propofol can be used as a sedative and anticonvulsant at the same	Did not provide methods (Exclusion/ inclusion) on choosing which	**Level:** V Quality: High

				time recommended for control of intracranial pressure(ICP); Propofol minimally affected by renal failure Midazolam more susceptible to tissue accumulation than propofol and can delay accurate neuroprognostication; however midazolam may be preferred in patients with hemodynamic instability Use of RASS score to determine level of sedation Depolarization is a pathological brain condition found in acute brain injuries. Ketamine associated with lowest incidence of depolarization. High boluses of opioids can cause increased ICP and cerebral vasodilation while drastically decreasing MAP **Support for EBP question:** This review provides evidence and rationale for medications utilized during TTM, a topic that will be provided when educating staff on TTM protocols	articles were being reviewed	

3.	Wyse & McNett, 2016	Research: Retrospective cohort study	Sample Size: 259 TTM patients Setting: [redacted]	Retrospective analysis found a decrease in mortality after a new protocol was implemented **Support for EBP question:** This article provides data regarding the impact on patient outcomes when guidelines and protocols are in place. At the same time discusses potential barriers to guideline adherence	Single site, retrospective design, small sample size	Level II Quality: High
4.	Kim et al, 2015	Research: Longitudinal Qualitative	Setting: Community and tertiary care centers in South Korea Sample Size: 21 hospitals resulting in 40 interviews	Researchers conducted interviews with hospital resuscitation champions from the ICU and ED to identify barriers for facilitating TTM guidelines. Results showed three major themes of barriers including: healthcare professional's perceptions, interdisciplinary collaboration and organizational resources. This study concluded that "Promoting interprofessional and interdisciplinary collaboration through educational activities… may facilitate adherence to TTM guidelines, especially in hospitals with limited human resources in critical care (p. 8)." **Support for EBP question:** This article supports the need for educating staff on the current guidelines for TTM to improve adherence	Emergency Physicians were not participants; study results from Korea and may have different perceptions and opinions from other countries	Level: III Quality: High

5.	AHA, 2015	Non-Research: Clinical Practice Guideline	These are the guidelines set forth by the American Heart Association developed by conducting an in depth review of the current literature pertaining to TTM. ILCOR recommendations and GRADE classification systems were used to determine the level and quality of the evidence reviewed.	**Support for EBP question:** Throughout these guidelines there are recommendations pertaining to the care of patients undergoing TTM based on the most current literature. These areas include hemodynamic parameters, vasopressor use, seizure management, neuroprotective recommendations and ventilation/ oxygenation recommendations. At the same time, the guidelines emphasis the need for continuous quality improvement in all areas of cardiac resuscitation including post cardiac arrest care. These guidelines explain that "Routine implementation of existing post-cardiac arrest protocols and order sets helps maintain consistent and optimal care to attenuate the detrimental effects of post-cardiac arrest syndrome (Part 4, p. 12)." By having a standardized protocol and order set for TTM, consistent and optimal care can be achieved.	These guidelines were last updated in 2015	Level: IV Quality: High
6.	Mathiesen et al, 2015	Research and Non-Research: Expert opinion with literature review of RCT and quasi-	Sample: Provides review of 19 articles; mix of RCT and quasi- experimental studies	Literature review provides evidence behind the making of Lehigh Valley's protocols/ policies Expert opinion explains that there are 5 critical elements of success	This is based on one institutions interprofessional team	Literature Review Level: II Quality: High Expert Opinion: Level: V

		experimental studies	Setting: [redacted] Allentown, PA	to translate evidence into practice. These include: interprofessional stakeholders, coordination of care delivery, education, interprofessional case analysis, and participation in a global database. **Support for EBP question:** This article supports the need for educating staff on the current guidelines for TTM to improve adherence		Quality: High
7.	Pellis et al, 2014	Research: Quasi-Experimental	[redacted] Pordenone (Italy) 57 historical controls (Pre- SOP) 129 Intervention subjects (Post- SOP/ education)	Developed standard operational procedures (SOP) for TTM; two years post implementation, developed continuous educational courses on TTM Used CPC score to determine neurological impairment post TTM Results: 81% improvement of favorable neurological outcome with implementation of SOP and education **Support for EBP question:** Article shows that lack of awareness, skepticism and structured post – resuscitation care are the main barriers to TTM. By formulating proper SOP	Small sample size; limited to one facility	Level: II Quality: High

				and education, patient outcomes can improve		
8.	Weng et al, 2013	Research: Qualitative	Setting: Regional hospitals in Taiwan Sample: Randomly selected 11 of the 65 regional hospitals in Taiwan to represent four different locations (northern, southern, eastern, western)	This study compared and contrasted beliefs regarding EBP among healthcare professions including physicians, nurses, pharmacists and allied healthcare professionals. Researchers provided a questionnaire measuring "…awareness of, beliefs in, attitudes toward, knowledge of, skills in, barriers to, and implementation of EBP (p. 2)." Findings suggest that beliefs and attitudes regarding EBP is positive, however the knowledge and skills in EBP is lacking among all groups. However, physicians implemented EBP the most out of all groups. Greatest barriers found with implementing EBP included lack of time and insufficient knowledge and skill sets **Support for EBP question:** The findings of this study provide support of the need to better	Results obtained from foreign country; may have different beliefs or perceptions than U.S.; Self-administered survey	Level:III Quality: High

				disseminate evidence based findings into clinical practice		
9.	Williams et al, 2013	Research: Quasi-Experimental	Setting: [redacted] Boston, MA	Explains barriers of implementation of TTM guidelines including lack of provider knowledge, unclear personnel roles, limited resources, questioning validity of research and level of morbidity and mortality Educated staff in prehospital EMS, ED, ICU Adopted cardiac consulting team and computerized physician order sets to support clinical guidelines Improved percentage of eligible TTM patients, significant reduction in initiation of therapy and goal temperature **Support for EBP question:** This article supports the need for educating staff on the current guidelines for TTM	Limited to one medical center	Level: II Quality: High
10.	Boyce et al, 2012	Research: Qualitative	Setting: 700 bed tertiary hospital in Australia	Researchers compared current practice at Australia hospital to the guidelines set forth for TTM. Researchers found that adherence to guidelines were subpar even though TTM policy/ protocols	Small sample size; results of frequent education and impact on adherence is not	Level: V Quality: High

			Sample: Cardiac Arrest patients undergoing TTM Sample Size: 33 patient cardiac arrest patients	were in place. They were able to create strategies to improve adherence including frequent education sessions with ICU staff regarding TTM and guidelines. **Support for EBP question:** This article supports the need for educating staff on the current guidelines for TTM	included in study; For some patients Data gathered lacked proper documentation; unable to check accuracy of data collected; limited to a single site;	
11.	Kilgannon et al, 2008	Research: Quasi experimental	[redacted] Induced Hypothermia (HT) (now referred to as TTM) education was provided for ED nurses and physicians with implementation of a standardized order set for HT induction and maintenance 103 cardiac arrest patients 69 patients assessed for HT eligibility HT attempted on 23 patients	This study found that the use of standardized order sets improved the time to goal temperature, while temperature goals throughout the stages of HT were reliably achieved. Success rate of achieving target temperature was 96% after implementation of the standardized order set compared to 62.5% without it. Median time to reach goal temperature was decreased from 5-9.2 hours to 4.4 hours. **Support for EBP question:** This study assists with the EBP question showing that a standardized order set can improve adherence to targeted temperature management guidelines.	Patients undergoing HT received different modalities including cold saline infusion (no longer recommended), external cooling, and ice packs. Patients who did not receive HT based on clinician judgment were not reviewed. Determining the deciding factor as to why these patients did not undergo HT is not discussed. Determining why these patients did	Level: II Quality: Good

					not undergo HT could assess the clinicians understanding of eligibility criteria for HT.	
12.	Bernard et al, 2002	Research: Randomized Control	77 Cardiac arrest patients 34 Normothermia (control) 43 Hypothermia (Intervention) Four emergency departments in Melbourne, Australia	This RCT is one of the first studies to show evidence that induced hypothermia positively impacts neurological outcomes of post- cardiac arrest comatose patients. This study was released the same month that the HACA trial. Although multiple studies have been conducted since the population of this RCT, current TTM recommendations are based largely on these findings. **Support for EBP question:** This study, although outdated, will contribute to the background of TTM and where it began.	Possible bias due to the inability to blind clinicians to the patients treatment group; method of randomization; outdated	Level: I Quality: Good
13.	Holzer et al, 2002	Research: Randomized control	275 Cardiac Arrest patients 138 normothermia (control group) 137 hypothermia (intervention) Setting: 9 medical centers from five different European countries	This study, known as the HACA trial, is the original article that tested targeted temperature management, originally known as therapeutic hypothermia. The main findings provide evidence that induced hypothermia positively impacts neurological outcomes of post- cardiac arrest comatose patients. Although multiple studies have been conducted since the publication of this RCT, current TTM	Attending physicians managing the care of these patients could not be blinded. The patient population studied were at high risk of brain damage due to	Level: I Quality: Good

				recommendations are based largely on these findings. **Support for EBP question:** This study, although outdated, will contribute to the background of TTM and where it began.	significant no flow time Only included cardiac arrest patients caused by ventricular fibrillation	

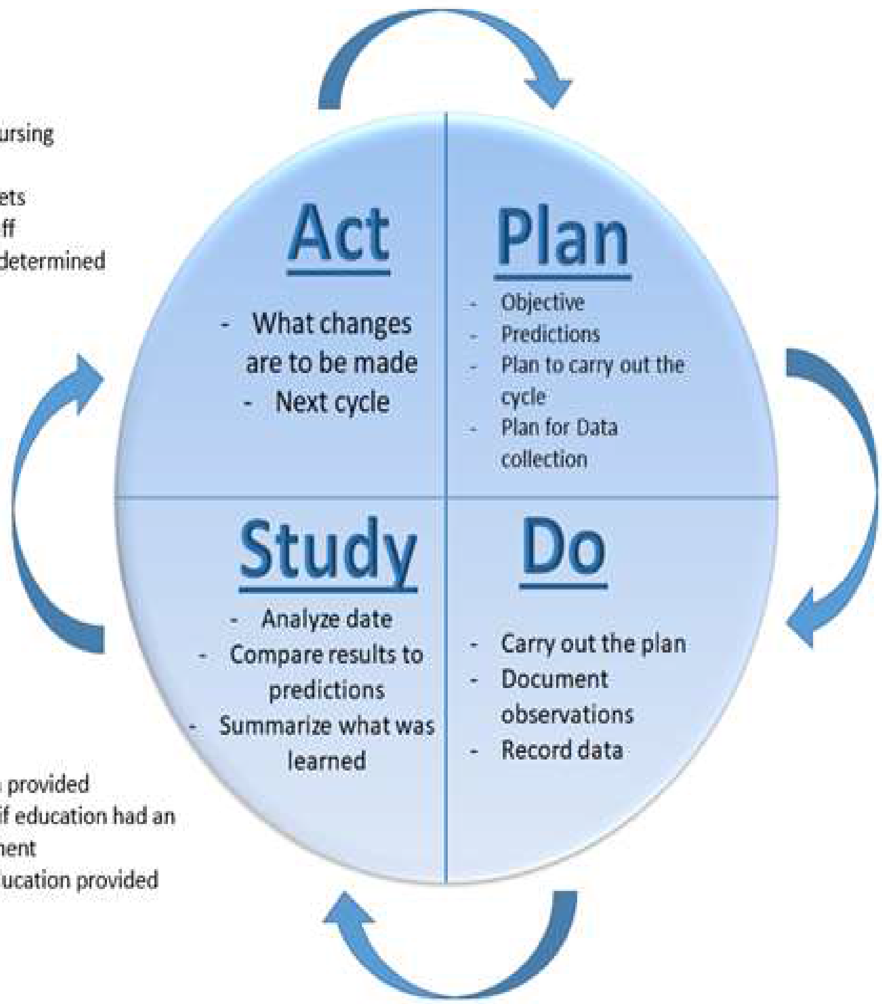
Appendix B: Concept Map

Act

- Share results with ICU director and nursing leadership
- Continue use of protocol and order sets
- Address concerns/ feedback from staff
- Change education based on barriers determined

Plan

- To improve provider and staff adherence to current glycemic guidelines through the use of an educational module provided to the staff including intensivists, medical residents, nurse managers and staff nurses of the critical care units and emergency departments
- Retrospectively evaluate management of care and glycemic values of TTM patients prior to and after implementation of education. Variables evaluated will include age, sex, glucose measurements at the start of TTM and up to 24 hours post start of TTM, average glucose over the first 12 hour period and first 24 hour period, how glucose values were managed (i.e. SubQ insulin, continuous insulin infusions or no treatment)



Study

- Analyze data.
- Compare data before after education provided
- Based on data collection determine if education had an impact on patient glycemic management
- Evaluate staffs feedback regarding education provided

Do

- Provide education on guidelines of TTM and hospital policy and protocol to ED and ICU staff including intensivist, medical residents, nurse managers and staff nurses under the supervision of [redacted] MD
- Collect feedback from staff regarding education provided and ease of use of new protocol and order sets
- Collect same data described in "Plan" on TTM patients who have been treated after education has been provided

Appendix C: Citi Training

CITI PROGRAM

Completion Date 25-Apr-2018
Expiration Date 24-Apr-2021
Record ID [redacted]

This is to certify that:

Sara Owen

Has completed the following CITI Program course:

Basic/Refresher Course - Human Subjects Research (Curriculum Group)
Biomedical Research Investigators (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Meridian Health

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w80a8a7ce-5eaf-4437-9e93-828ec748b717-26907792

Appendix D: Site Agreement

[redacted]

Date: *[11/01/2018]*

Re: Letter of Cooperation for [redacted]

Dear *Sara Owen*

This letter confirms that I, as an authorized representative of [redacted] allow you access to conduct study related activities at the listed sites, as discussed with you and briefly outlined below, and which may commence when you provide evidence of IRB approval for the proposed project.

- **Research Site(s)**: [redacted]
- **Study Purpose:** The purpose of this quality improvement (QI) project is to improve the glycemic control, specifically in TTM patients, through the use of an educational module that includes the adverse outcomes of hyperglycemia in the critically ill and the hospitals new, revised TTM and hyperglycemia policy and protocol.
- ***Study Activities:*** After IRB approval, a retrospective chart review will be conducted to collect data pertaining to glucose management of TTM patients. Once data collection is complete, medical personnel responsible for the management of TTM patients, including physicians, medical residents and nurses from the critical care units and emergency department, will then complete an educational module regarding the overview of primary and secondary brain injury experienced by cardiac arrest patients, rationale behind TTM and the importance of glycemic control and the new TTM and glycemic control policy and protocols. After education is provided, a prospective chart review will be completed to determine if glycemic control has improved.
- **Site Support**: With IRB approval, [redacted] will allow the Private Investigator to retrieve patient data from on-site medical records.
- **Data Management:** Data retrieved from both retrospective and prospective TTM patient and the reason for that collection is as follows:
    1. Age
        a. To assess if there is correlation between age and glycemic values within this patient population
    2. Gender
        a. To assess if there is correlation between gender and glycemic values within this patient population
    3. Average glucose value between hours zero (Initiation of TTM) to hour 12
        a. To determine if glycemic control has improved after the implementation of the educational module
    4. Average glucose value between hours zero (Initiation of TTM) to hour 24

        a. To determine if glycemic control has improved after the implementation of the educational module
    5. Every finger stick glucose levels from time zero (initiation of TTM) up to 24 hours from the initiation of TTM.
        a. Finger stick values will be utilized instead of glucose measurements from a chemistry as finger stick values are how nurses titrate intravenous insulin infusions.
    6. How hyperglycemia is managed i.e. subcutaneous insulin injections versus intravenous insulin infusions versus no treatment.
        a. As previously mentioned, the ADA and SCCM report that hyperglycemia should be managed through the use of intravenous insulin therapy.
        b. To compare the glycemic control of patients maintained on intravenous insulin therapy to patients maintained on sub cutaneous insulin therapy
    7. When insulin therapy was initiated and the length of time to achieve target glucose levels less than 180 mg/dL.
        a. The timing of insulin therapy will be collected as evidence shows that target glucose ranges should be achieved within 3-12 hours from the start of insulin (Kelly, 2014).
    8. Possible confounding variables that can impact glycemic control including the use of medications mixed in dextrose, corticosteroids use, pressor use and previous diabetes diagnosis.
        a. Medical treatment alone increases blood glucose levels through the use dextrose containing intravenous medications, exogenous glucocorticoids, and vasopressors, persistence bedrest and the use of parental nutrition (Silva- Perez, 2017).
    - Glucose values and glycemic control measures can be found in patient's electronic health record. Currently finger stick glucose measurements are documented on all TTM patients every four hours. For patients maintained on continuous insulin infusions, glucose measurements are assessed and documented every hour. Data retrieved will be documented in an excel spread sheet in a format resembling the attached data collection document. This chart review will be completed using the hospitals electronic health records that are only accessible through the organizations private server. All data will be collected onsite. All patient data collected will be saved and maintained at the medical facility using their secure network.
    -
- **Anticipated End Date:** *July 2019*

We understand that this site's participation will only take place during the study's active IRB approval period. All study related activities must cease if IRB approval expires or is suspended. I understand that any activities involving Personal Private Information or Protected Health Information may require compliance with HIPAA Laws and Rutgers Policy.

Our organization agrees to the terms and conditions stated above. If we have any concerns related to this project, we will contact the Principal Investigator, Sara Owen. For concerns regarding IRB policy or human subject welfare, we may also contact the Rutgers IRB (see orra.rutgers.edu/hspp).

Regards,

[redacted]

[redacted]

Appendix G: Gantt Chart

Activity	**May ‘18**	**June ‘18**	**Aug ‘18**	**Sept ’18**	**Oct ‘ 18**	**Nov ‘18**	**Dec ‘18**	**Jan ‘19**	**Feb ‘19**	**March ‘19**	**April ‘19**	**May ‘19**	**June ’19**	**July ‘19**
Complete DNP Project Proposal	■													
Present DNP Project Proposal to DNP Team	■													
Present Project to [redacted] Research Council		■	■											
[redacted] Approved Project			■											
Submit to [redacted] IRB				■										
Obtain [redacted] IRB Approval							■							
Submit to Rutgers IRB approval							■							
Obtain Rutgers IRB									■					
Create Educational Module									■					
Meet with Staff Development									■	■	■	■	■	■
Meet with ICU/ED Medical director									■					
Meet with Chief Medical Residents									■					
Meet with ICU/ED Nurse manager									■					
Carry out Education Module for Nurses											■			
Start Retrospective Data Collection											■			
Finalize Retrospective Data Collection											■			
Prospective Data Collection												■	■	■
Finalize Data Collection														■
Data Analysis														■
Final write up														■
Dissemination of Results														■

Appendix H: Retrospective Data - Hourly Glucose Measurements Prior to Education

GLUCOSE MEASUREMENT (mg/dL)

HOUR

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Patient 10	Patient 11
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Appendix I: Retrospective Data: Demographics and Glycemic Management Before Education

	Age	Gender	Average Glucose between Hour 0 to Hour 12	Average Glucose Hour 0 to hour 24	Was patient treated with Sub Q insulin? Yes/No	Previous diagnosis of diabetes? Yes/ No	Was patient treated with continuous insulin infusion? Yes/No	Time to reach glucose level <180 mg/dL	Use of corticosteroids Yes/ No	Vasopressors used; i.e. Levophed, Phenylephrine, Epinephrine, Vasopressin	Use of medications mixed in Dextrose Yes/No
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Appendix J: Prospective Data - Hourly Glucose Measurements After Education

GLUCOSE MEASUREMENT (mg/dL)

HOUR

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Patient 10	Patient 11
1.											
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Appendix K: Prospective Data: Demographics and Glycemic Management After Education

	Age	Gender	Average Glucose between Hour 0 to Hour 12	Average Glucose Hour 0 to hour 24	Was patient treated with Sub Q insulin? Yes/No	Previous diagnosis of diabetes? Yes/ No	Was patient treated with continuous insulin infusion? Yes/No	Time to reach glucose level <180 mg/dL	Use of corticosteroids Yes/ No	Vasopressors used; i.e. Levophed, Phenylephrine, Epinephrine, Vasopressin	Use of medications mixed in Dextrose Yes/No
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