Simulating Targeted Temperature Management (TTM)
In Post Resuscitative Care for Cardiac Arrest Patients: A Pilot Study

Rosalie Caroline Bennett
Charlottesville, Virginia

Bachelor of Science in Nursing, Texas Christian University, 2002
Master of Science in Nursing, University of Virginia, 2015

A Capstone Presented to the Graduate Faculty of the
University of Virginia in Candidacy for the Degree of
Doctor of Nursing Practice

School of Nursing

University of Virginia
May, 2016

Kathryn B. Reid, PhD, RN, FNP-BC, CNL, committee chair

Valentina Brashers, MD, FACP, FNAP, member

Darla Topley, DNP, APRN, CCNS member

David Burt, MD member

Acknowledgements

This capstone project owes all its success to Mark Adams, CCU Nurse Manager and TTM Coordinator and Jon Howard of the Life Support Learning Center. Mark works tirelessly to make the TTM program and the health system successful and was the inspiration surrounding this entire project. I would not have been able to do the simulations without the work of Jon Howard, who took time out of his very busy schedule to make these experiences as realistic as possible. I would also like to thank all of the many people at the health system who took time to help me in countless different ways. I would like to thank Dr. Katheryn Reid and my committee members, who believed in the purpose and success of this project. When many felt like this was too complicated could not be done, each of you found the future merit for what this could bring to clinicians and to enhance training within the institution. Thank you for cheering me on in the effort. I of course need to thank my wonderful family, who dealt with my grumpiness on snow days, and supported me on this journey. I love you all! Finally, to God my Savior who is my foundation, my rock: "Praise be to the Lord, to God our Savior, who daily bears our burdens" (NIV Bible, Psalm 68:19).

Abstract

Background: Sudden cardiac arrest accounts for 15% of mortality in industrialized nations. Once circulation has been restored through successful CPR and defibrillation, post rescuciation care with TTM is important to prevent further damage to the brain tissue and other organ systems. Full interprofessional collaboration with proper communication and leadership are crucial facilitators to effective team function and improved patient outcomes. Medical simulations are an effective teaching tool for healthcare teams, allowing for education on practices while improving interprofessional teamwork behaviors.

Objectives: The goal of this project was to develop and implement a pilot simulation to improve knowledge of the Targeted Temperature Management (TTM) guideline and improve how interprofessional teams collaborate after participation in a simulation.

Methods: This was a pilot study in a 650 bed academic institution in central Virginia, with a 56 bed ED, and two out of five adult ICUs. Six simulations were conducted with four-to-six clinicians in a mix of nurses and physicians. Participants completed a pretest, short class with a handout on TTM, a simulation with scenario tailored to clinical area with debriefing and a completed posttest.

Results: Originally 29 participants were confirmed; a total of 20 completed the entire simulation experience. Significance was obtained for all questions related to knowledge of TTM competence between pre and post-test scores ($p = \leq 0.001$). The difference on feelings of working in an interprofessional team and how the simulation affected that, achieved significance ($p=0.003$). There was a perfect correlation for clinical experience of four-to-ten years in knowledge score of TTM and feelings of working in interprofessional teams.

Conclusions: The majority of participants felt the simulation helped them to understand TTM and how to use it in the clinical setting. The results show improvement in significance of knowledge gaps. The location of the simulation in the hospital and overall fidelity had little to no impact on the overall results. The staffing constraints affected participants' ability to volunteer and/or follow through with commitment to the simulation. The teams wanted to focus on TTM during the debriefing and not on teamwork aspects. A structured and validated tool based on interprofessional literature should be used in the future to define different aspects of teamwork and allow more reflection and discussion for participants to collaborate better in the clinical setting. The simulation needed a format of multiple days, one for TTM focus with more challenging scenarios, and the other for interprofessional team focus. The role of an APRN prepared as a DNP can use simulations to engage in the process improvement activities and challenge the status quo of individual clinicians because of their experience in system level leadership.

Keywords: Cardiac Arrest, Continuity of Care, Teamwork, Hypothermia, Targeted Temperature Management, Post Cardiac Arrest Syndrome, Simulation, Interprofessional Education

Table of Contents

Simulating Therapeutic Temperature Management (TTM)

In Post-Resuscitative Care for Cardiac Arrest Patients: A Pilot Study

Introduction

Background and Overview of the Problem

Sudden cardiac arrest (SCA) occurs when the heart suddenly stops beating. It accounts for 15% of total mortality in industrialized nations and over 450, 000 deaths per year in the United States (Podrid, 2015). Generally, SCA occurs when there is an electrical problem within the heart and the ventricles suddenly develop a rapid and irregular rhythm or arrhythmia. The quivering ventricles are unable to pump blood to the rest of the body and the heart will eventually quit. Without immediate treatment, the person almost always dies.

There are certain conditions that lead patients to be pre-disposed to a SCA. Family history, heart failure, coronary artery disease, previous myocardial infarction (MI), and previous SCA are all risk factors. A previous MI raises the one-year risk of SCA by 5% (Sudden Cardiac Arrest Leadership Association, 2008). Cardiovascular health affects survival after an SCA event as well. Clinical predictors have shown that patients who had an arrest but no direct cardiovascular cause, and were under the age of 60 had a much better prognosis and long-term survival than others. Research also found that ischemic events rather than primary arrhythmic events had better outcomes, and those with congestive heart failure had the best prognosis overall (Eisenberg, Bergner, & Hallstrom, 1984). Resuscitation-related morbidities also play a factor in long-term survival. Emphasis has been placed in recent years on early CPR and defibrillation, which has been found to increase survival when time to CPR is short. However, after complete ischemia to the entire body, the return of spontaneous circulation (ROSC) following successful CPR results in an unnatural pathophysiological state that can impact long-term survival. Delayed ROSC causes a dangerous cascade of events in the body called Post Cardiac Arrest Syndrome or Secondary Injury, which is the key co-morbidity in an arrest victim. Evidence has shown that if ROSC is achieved rapidly after onset of cardiac arrest, Secondary Injury will likely not occur (Neumar et al., 2008).

The definition of Secondary Injury is a prolonged, whole-body ischemia that causes global tissue and organ injury initially, with damage continueing to occur during and after reperfusion. The post-arrest pathophysiology often overlaps with the disease or injury that caused the arrest and compounds underlying comorbidities. Therapies that target individual organs may compromise other injured organ systems. Secondary Injury consists of four key components: (A) post-cardiac arrest brain-injury, (B) post-cardiac arrest myocardial dysfunction, (C) systemic ischemia/reperfusion response, (D) persistent precipitating pathophysiology. The injury to the brain tissue impairs cerebrovascular autoregulation, causeing cerebral edema and post-ischemic neurodegeneration among other processes. The first intervention that has been proven to be clinically effective at saving brain tissue and combating Secondary Injury is therapeutic hypothermia, or Targeted Temperature Management (Neumar et al., 2008).

Targeted Temperature Management (TTM) is a state of bringing the body temperature below normal in a homoeothermic organism, limiting the effects of the different stages of this damaging cascade (Holzer & Behringer, 2008). The concept of cooling the body was first tested in the 1950s on comatose patients after a cardiac arrest, but medical staff was not able to properly manage some of the harmful side effects such as shivering. Animal trials started in the 1980s, and true clinical trials to understand the benefits of hypothermia started in 1997 and have continued over the last 20 years (Polderman, 2008). Consistently the evidence has exhibited better neurological recovery, as well as better long term survival, than control groups who did not receive hypothermia (Holzer & Behringer, 2008). It is well recognized that post ischemic hypothermia reduces the amount of cell death in certain brain regions, and evidence has shown that it is more effective if applied immediately after injury. However, the optimal timing for induction is still uncertain and continues to be studied (Kim et al., 2014). TTM requires a "buy-in" to an institutional guideline set in place by the full interprofessional team, in order for it to lead to the result of better outcomes (Brooks & Morrison, 2008). Due to the time-sensitive and complex nature of post-arrest care, "it is optimal to have a multi-disciplinary team develop and execute a comprehensive clinical pathway tailored to available resources" (Neumar et al., 2008).

The process of team building is of particular importance for the assembled caregivers early on during the initial phase of resuscitation, which is the most vulnerable phase. At the point the entire team arrives, a coordinated rapid, and efficient exchange of information is vital to successful survival for the patient, accompanied by CPR and defibrillation. "The process by which a team forms materially influences the quality of its performance" (Hunziker et al., 2011). This team-building success will then be carried through to the post resuscitation phase, in which comprehensive care must be established and executed consistently in a well-thought-out and interprofessional approach (Neumar et al., 2008).

Purpose

There are difficulties related to working in teams that are inherent in practice. This project was designed to address some of these difficulties. One area of difficulty is in relation to the theme of team dynamic. There is a perceived demand to act as a team member in all situations, and a disconnect between what the team decides and an individual or professional group's ideas or decisions. Certain individuals relinquish their autonomy for the good of the team. This could be considered a positive in relation to the teamwork concept, but could cause a loss of worthwhile knowledge. The unequal division of responsibilities is also apparent, based on how many team members of a professional role are available; and role boundary conflicts, in which team members overstep the boundaries of another individual's professional territory also occur. Simultaneously, knowledge contribution of the individual's own profession is not always valued equally or put to use by the team. These difficulties can cause members to disengage and as a result the team may not adopt a holistic view of the patient. Furthermore, lack of consensus is often a difficulty when a new or unknown skill is added to a team or if there is an uneven distribution of current knowledge (Kvarnstrom, 2008). For example, if only one or two team members know about using therapeutic hypothermia post arrest while the rest of the team does not share this expertise, this knowledge gap among the team members could cause dissention and lead the team to not collaborate effectively. A final potential difficulty is in relation to the influence of the surrounding organization. The hierarchical value the organization may place on certain professions, may make it difficult for individuals to feel like valued members of the team (Kvarnström, 2008). When team members are able to visualize and experience the roles of others within the group, a change in knowledge occurs in which the assignment of responsibilities are designated in a different way, which is a true reflection of collaborative practice (Owen JA et al., 2014).

Managing these difficulties is important, as collaboration as an interprofessional team has been linked to patient safety. Education in interprofessional collaboration is being heavily researched on appropriate and best outcomes for the team. Simulation is one such medium for health care professionals, and is becoming more popular, as it provides “a safe environment for participants to practice skills in realistic settings and to observe the consequences of their actions” (Freeth D et al., 2009). Not only does the simulation experience affect teamwork, but it provides a direct impact on physicians’ and nurses’ clinical behavior and can change patient and practice outcomes. Rather than a didactic, one-way reaction, education in simulation is learner-centered and real-time feedback can be given (Nicksa GA, Anderson C, Fidler R, & Stewart L, 2015).

The purposes of this project were to: (A) implement a TTM simulation education program, (B) evaluate the effect of participating in the simulation on knowledge of the TTM protocol, and (C) identify how perceptions of interprofessional collaboration change after participation in the simulation. Evidence has shown that lack of protocol clarity, difficulty assembling the equipment, and precise monitoring requirements may contribute to poor efficacy of post resuscitation care (Brooks & Morrison, 2008). Better knowledge of the key concepts in the guideline will hopefully provide better adherence and improvement in perceptions of interprofessional collaboration. The simulation environment is an ideal place for clinicians to gain knowledge in the guideline and to practice using it as a team, rather than seeing it for the first time at the bedside.

Theoretical Framework

The theoretical framework of Expectation States Theory helps to explain the group dynamic of sudden cardiac arrest (SCA), post-arrest teams, and how simulation might be an effective training tool. This sociological theory focuses on how members of the group decide how competent the other members are compared to themselves (Hunziker et al., 2011). It attempts to explain, when task-oriented groups are assembled, how observable power and order is differentiated and obtained. Originally, Expectation States Theory's purpose was to identify how and which subject would influence another in an induced situation based on status. Its original purpose was looking at the experiences of race or gender, but it has evolved to studying how status influences participation, which fits perfectly into the dynamics of healthcare teams (Skvoretz, 1981). The theory is based on assumptions about the behavioral effects of the team related to the comparative status of team members, and how people act accordingly. The four propositions of this theory directly correlate to healthcare teams and to how people view their role compared to whom else is in the room (Skvoretz, 1981). The comparative status that individuals in groups naturally assume when assembled, called performance expectations, lead to hierarchies. If members of the group (whether purposefully or subconsciously) decide there is one person most competent to do a task, the other team members will defer and volunteer less information in completing the task. In resuscitations, these hierarchies can create barriers for a full exchange and interaction, and lead to formal or informal rules. An example of this is when an arrest occurs in an ICU, and a code is called. As the team begins to arrive, that bedside nurse will usually direct the other nurses to specific tasks (chest compressions, defibrillator, medications, etc.), as well as directing the respiratory/anesthesia providers and others to their specific roles. When the medical resident arrives, the bedside ICU nurse, who has been the team leader, will immediately defer to the resident, despite the fact that the nurse may have more experience and clinical knowledge. When this happens, often this seasoned ICU nurse will no longer contribute and will not provide valuable information, as they may believe they no longer have the right to volunteer information as a person of higher status is now present. In emergencies at the early stages, it is important that all team members contribute. If a hierarchy is established early on, it may prevent an open flow of communication amongst all team members

(Hunziker et al., 2011). The Expectation States Theory helps to explain the group dynamics in an arrest team, and how they should focus as a group carrying through the continuity of care to the post resuscitative phase.

Project Question

The team dynamics are of major importance to the success of cardiac arrest resuscitation as well as through the post resuscitation phase. The TTM guideline requires not only a full understanding of its purpose and content, but also the full collaboration of the interprofessional healthcare team. The research question related to this project is: does participation in targeted temperature management simulation training improve both knowledge of the TTM protocol and team member perceptions' of interprofessional collaboration?

Review of the Literature

Nationally, nine out of ten people who arrest will die. Yet with immediate intervention of cardiopulmonary resuscitation (CPR), defibrillation and advanced cardiac life support (ACLS), followed by post resuscitation care using targeted temperature management, the chance of survival is much higher. If CPR and defibrillation are done immediately, four out of ten victims will survive (Sudden Cardiac Arrest Foundation, 2015). Yet for every minute that CPR is delayed, the likelihood of survival decreases by as much as 10% (Hunziker et al., 2011). This requires those who respond to arrest victims immediately to form a highly skilled and functional team. TTM is different than other sections of the American Heart Association (AHA) arrest guidelines, as it is a "relatively long-lasting intervention which requires significant interprofessional collaboration over this period of time" (Brooks & Morrison, 2008). Interprofessional simulations are an ideal method for education and team training in regards to cardiac arrest and post-resuscitative care using TTM. A literature review was conducted to examine team dynamics in cardiac arrest care as well as how the use of simulations can affect the overall impact of education and training in technical and interprofessional skills.

There were two notable attributes the literature focused on and discussed: leadership and communication. As stated earlier, establishing the team roles as it forms during an arrest influences the outcome and quality of its performance, and leadership is a key aspect (Hunziker et al., 2011).

Leadership

Taylor, et al., (2014) examined the communication that affects the leader's decisions and interactions with the team. This key point directly correlates with the outcomes from many of the other studies. Leadership has to be adaptive and flexible with situational changes, as noted by Shetty, et al., (2009) and Marsch, et al., (2004). These three studies found that even when leaders were empowered to give orders and had a commanding presence; strict adherence to a guideline did not correlate to positive outcomes. In fact, it was found to be the opposite. With flexibility comes an open door for other members to participate. In the study by Marsch, et al., (2004), two out of the six successful teams did not have a structured leader, which shows that with proper team dynamics, the team can carry the weight and have a positive outcome. Another key aspect of leadership was who the leader was. Anderson, et al., (2010) found that assigning the role of team leader simply on the basis of professional status rather than the extent of experience did not match the requirements for optimal treatment. The more inexperienced medical doctors (MD), such as interns and residents, were usually the leaders and became the authority figure on the team, which often brought confusion. For some of these residents, their first participation in an arrest situation was as the team leader without any introduction into this leadership role (Andersen PO et al., 2010). This gives rise to a concept that is rarely seen: to have well-trained first-responding nurses, be successful leaders on ACLS teams (Hunziker et al., 2011). The reason this probably has not happened often; could potentially be due to Expectation States Theory as described earlier. Hunziker, et al., (2011) gave a solution to this issue in their paper, “Teamwork and Leadership in Resuscitation” stating, “Incoming professionals of higher status should not, by default, take over leadership of the resuscitation” (p. 2384). Hunziker, et al., (2011) also found that when senior physicians entered into a resuscitation late, they served the team better in an advisory role and by supporting the group performance rather than taking over as the team leader.

Communication

Communication was another major attribute of cardiac arrest teams found in the literature. The most effective study dealing with this is from Taylor, et al., (2014), in which the authors examined the different loops of communication during a patient arrest. They found that team leaders used a form of closed loop communication in which he/she asked a question and received a response back. The majority of the time, the team leader was giving orders and asserting a level of authority, clarifying the delivery of treatment, updating on patient’s current condition, and advising the team of further treatment. Yet, two out of three times that the team (not the team leader) communicated, it was not to the leader. The information was frequent and very relevant to the situation, including resource allocation, patient status, team safety, preparation of equipment, medications, and documentation. The important information was passing simultaneously but exclusively within the rest of the team, while there was a very different and focused communication with the team leader. The ultimate suggestion that the researchers gave was that a balance had to be met between both extremes within the group dynamic (Taylor KL et al., 2014). A limitation to this study was that it was not videotaped, and therefore the nonverbal aspects of communication were not seen; thus it is unknown if they played a role in the teamwork. The research from Walker, et al., (2013), Shetty, et al., (2009), and Marsch, et al., (2004) all spoke to the fact that effective team communication could drastically affect arrest outcomes. When all members are contributing and team members are giving feedback to leadership, there are always better results. Anderson, et al., (2010) speaks to communication as well, pointing out that there was information overload from the team leader to the team members without anything going back to the leader. On one occasion, the team leader stopped resuscitation efforts despite protests from the team members. There should have been a discussion of strategies and re-evaluation from all members of the team, with the team leader weighing the options given (Andersen PO et al., 2010).

Simulation

The Joint Commission has identified that failures in communication, human factors and leadership are what most often lead to sentinel events. The simulation environment can provide high risk scenarios, skills and tasks in a low-risk setting and train to these failures. (Nicksa GA et al., 2015).

Much of the current literature on the use of simulations in healthcare has been for medical residents in practicing procedures, technical and non-technical skills. Although the focus has been generally on the residents themselves, the simulations have required an interprofessional team with nurses and para-professionals in order to make the experience truly realistic and educational. Generally, the literature focused on two aspects of simulation: 1) how it impacted clinical expertise and 2) how it impacted interprofessional relationships.

Clinical Expertise

There is little debate on the effect of simulations in improving clinical skills. The concept of practice-makes-perfect allows the participants in the simulated patient environment to hone skills that are either new or ones that are high-risk and rarely used. When surgeons used simulations to practice technical and non-technical skills, the impact was highly favored. Eighty-nine percent of surgical residents found that simulations were extremely helpful, with 51% focused on diagnostic abilities and 75% recommending future simulations emphasizing procedures ((Nicksa GA et al., 2015). The effect of bringing ad hoc trauma teams together in a simulation environment allowed for 58% of residents to use trained skills in a trauma setting that is more controlled and quieter, which aided the overall effectiveness of the simulation (Roberts NK et al., 2014). Another study on obstetric (OB) residents found that in a simulated environment, technical and behavioral skills could be taught during an OB crisis, and the new skills could be directly transferred to the real clinical environment. Nearly 82 percent of these residents rated the experience as a five for “excellent” and the realism of doing these high risk procedures as extremely valuable (Daniels K, Lipman S, Harney K, Arafeh J, & Druzin M, 2008).

Interprofessional Relationships

The effects of the simulation environment on the overall relationship of the entire healthcare team was by far the biggest impact discussed within the literature. For example, in a simulated OB environment:

> [This exercise] was viewed as a positive interprofessional learning opportunity that facilitated relationship building and the development of new perspectives. Participants were able to check out assumptions and expectations of others, and develop respect for different roles within the team (Freeth D et al., 2009).

Surgical residents appreciated the opportunity for different members of the team to practice in a safe environment. Eighty-seven percent felt that working with an interdisciplinary team was not only helpful, but provided a realistic atmosphere to the scenarios. This style of education provided a more collaborative and patient-centered approach, as the simulation was designed for all participants to be viewed as one team rather than individual disciplines respectively consulted. Seventy-five percent of the residents felt that the difference between a good and excellent resident was in their communication skills; this was addressed in the simulation, which gave the team the opportunity to manage the problem (Nicksa GA et al., 2015).

Amongst emergency trauma residents, the simulation training improved patient safety and care efficacy through team functioning, clarity in team leadership, communication, situational awareness and mutual support (Roberts NK et al., 2014).

Recommendation for Clinical Practice

Cardiac Arrest Teams and Simulations

Despite limitations, the research conducted on teamwork and continuity of care in cardiac arrest is extremely applicable to the healthcare setting at all levels. Team interaction and the way teams communicate have been found to play a crucial role in the occurrence of medical errors and patient outcomes (Hunziker et al., 2011). Besides the theoretical knowledge and skills taught during cardiac life support courses and continuing education, it is paramount that proper leadership and communication techniques are taught. Walker, et al., (2013) found that using simulations and bringing the simulation to the clinical area in real time gave a sense of realism and provided great training in team collaboration and continuity from one element of care to the next (Walker ST et al., 2013). This article’s findings, as well as the concepts found in the other literature, can easily be generalized and reproduced in any practice setting. Simulations provide the opportunity to practice different scenarios. For example, a well-trained and experienced ICU nurse serving as team leader with a resident in an advisory role, or vice versa, can give that MD more experience both leading and deferring to the greater knowledge of a person in a lower role. Huntziker, et al., (2011) states, “an important advantage of simulation methodology is that, unlike in actual emergency situations, a controlled, standardized experimental situation can be created, to which multiple interventions can be applied and directly compared” (p. 2382). Simulations provide the entire team with the opportunity to identify key elements that went well or went adversely, and to learn from those mistakes without the high cost of a real patient.

Targeted Temperature Management

TTM is standard therapy post arrest once circulation has been restored, and thus should be considered as part of the resuscitation team’s efforts. The American Heart Association (AHA) states that a comprehensive and interprofessional system of care should be implemented post resuscitation (Peberdy, M.A., et al., 2010) The current practice is for cooling to be initiated in the ICU; although the evidence suggests that initiating cooling either during CPR or just after in the pre-hospital and emergency department settings can be done safely and effectively with positive results. The evidence is lacking related to pre-hospital TTM outcomes, and it is not completely understood how soon cooling should be started, but has been suggested that starting earlier may have better long-term effects. Simple cooling, such as with ice-cold saline through a peripheral intravenous catheter, is safe and effective; therefore there is no reason to not start it sooner in the course of a patient’s resuscitation, as long as the therapy can be maintained without an increase in temperature. The variety of places and ways treatment is begun for patients post-arrest is why interprofessional collaboration starting at the initial time of the arrest and carrying through post resuscitation, is vital to ensuring positive patient outcomes. There are ongoing debates, and further research needs to be conducted on a standardized way in which to induce TTM, but it is agreed that a guideline must be set in place to consider hypothermia for the long-term survival of a cardiac arrest patient.

Implications for Practice

The difference between the guideline for TTM and a cardiac arrest algorithm is that TTM is a long-lasting intervention that requires significant interprofessional collaboration (Brooks & Morrison, 2008). TTM demands the entire healthcare team to have communication and a “buy-in” to the guideline, or the results will not be successful and therefore the guideline is pointless. As was stated in the literature, simulation training for cardiac arrest resuscitation is a valuable practice to train for a chaotic occasion in a controlled learning environment. Simulations are just as valuable for post resuscitation care with TTM guidelines, in which local interprofessional champions facilitate the process, provide key objectives to meet, and demonstrate real-world examples of success to enhance overall learning for improved outcomes of the patients (Brooks & Morrison, 2008).

Rationale for the Project

Targeted Temperature Management requires all players to communicate and coordinate for effectiveness in overall patient outcomes. To meet that ultimate objective, the first key piece is knowledge of the institutional guideline, followed by implementation in practice. However, at present there is a general concern across the country that TTM guidelines are not being followed. Data from multiple surveys suggested that self-reported rates of guideline adherence among physicians may be as low as 30-40% (Brooks & Morrison, 2008). Therefore, it is important that there is much better awareness of the institutional guidelines and their appropriate implementation by a healthcare teams, and not just by individual clinicians.

Project Question

Based on the research on teamwork regarding cardiac arrest, the need for that collaboration within TTM, and the effectiveness of protocol adherence, simulation appears to be an effective training tool to enhance both these objectives. The research question for this project is: does participation in targeted temperature management simulation training improve knowledge of the TTM protocol and perceptions of interprofessional collaboration?

Methods

Sudden cardiac arrest (SCA) is a problem in industrialized nations, with death occurring in nine out of ten instances. With early intervention of Basic Life Support (BLS)/Advanced Cardiac Life Support (ACLS), followed by post resuscitation care with targeted temperature management, the chance of survival is much higher (Sudden Cardiac Arrest Foundation, 2015). Following a guideline for Targeted Temperature Management is important to the functionality of the interprofessional team and ultimately improves outcomes for SCA patients.

Purpose

The purposes of this project are: (A) to implement a TTM simulation education program, (B) to evaluate the effect of participating in the simulation on knowledge of the TTM protocol, and (C) to identify changes in perceptions of interprofessional collaboration after participation in the simulation.

Definition of Terms

Target Temperature Management (aka-TTM, hypothermia, therapeutic hypothermia, cooling): a patient's core body temperature is cooled to 32º-34º C within 4 hours of the arrest and slowly rewarmed. The entire process takes about 4 days (University of Virginia Health System, 2015).

Sudden Cardiac Arrest (SCA): heart function ceases abruptly without warning, usually caused by an arrhythmia that prevents the heart from pumping blood to the vital organs (Sudden Cardiac Arrest Association, 2015).

Sudden Cardiac Death (SCD): an unexpected death due to a cardiac cause usually occurs within one hour of symptom onset (Sudden Cardiac Arrest Association, 2015).

Basic Life Support/Advanced Life Support (BLS/ACLS): refers to using CPR, defibrillation, such as an AED, and medications to attempt to return circulation to a person in sudden cardiac arrest.

Post Resuscitation Disease (aka-Secondary Injury): prolonged whole-body ischemia causing global tissue and organ injury that becomes a cascade of events during and after reperfusion (Neumar et al., 2008).

Interprofessional Collaboration: a partnership between a team of health providers and a client participating in a collaborative and coordinated decision-making process that includes communication, accountability, responsibility and a blend of professional cultures (Bridges, Davidson, Odegard, Maki, & Tomkowiak, 2011).

Bedside Shivering Scale (BSAS): a tool used to assess shivering at the bedside. It assigns a score of 0 with no shivering to 5 being severe, and denotes type of shivering and the location on the body it is occurring (University of Virginia Health System, 2015).

Preparation and Planning

The TTM simulation plan began out of a quality improvement project. The original TTM guideline at the health center was old and not relevant to current evidence or to the standard of other academic institutions. With the help of Mark Adams, the Coronary Care Unit (CCU)

Nurse Manager and TTM Program Coordinator, and EB Enfield,the former CCU Clinical Nurse Specialist, a new guideline was written into the proper institutional format, with the focus on re-warming rates and proper shivering management. After a careful review of current evidence, the rewarming rate was changed, and a shivering algorithm was designed using the Bedside Shivering Assessment Scale (BSAS). This tool can aid clinicians in proper care to reduce shivering which is detrimental to the cooling process. This new guideline is currently being reviewed and voted on by the Critical Care Subcommittee

The new plan also requires robust and specific educational goals to ensure that awareness is brought to the clinical team about what TTM is, how it is used, and more specifically, what is in the health center's guideline. Contact was made with Sarah Oh, in the office of Graduate Medical Education (GME), who aided in planning and recording two TTM podcasts that are now available on the GME website to all health center staff. After meeting with Mark Adams, as well as Jenny Hamby, the former nurse educator in the Emergency Department, it became apparent that clinicians had little knowledge of the important aspects of either the past or present TTM guideline. Physicians, nurses and patient care technicians in all areas of the hospital had difficulty in implementing TTM when receiving a patient, and communication amongst staff was poor in how to properly manage the patient, especially related to timing of events and shivering assessment.

The process of deciding on a simulation as an educational tool required much stakeholder buy-in and investigation into how willing and available interprofessional clinicians could be. Multiple meetings were set up with Jon Howard in the Life Support Learning Center to discuss his availability to help, as well as his expertise in the area of simulations. Along with Jon, discussions were held with Dr. David Burt, Emergency Department (ED) attending, and faculty in proper uses and realistic needs in conducting a simulation for busy clinicians. Informal discussions were made with: (A) Cheri Blevins, Clinical Nurse Specialist in the Medical Intensive Care Unit (MICU); (B) Darla Topley, Clinical Nurse Specialist in the 4 West ICU; (C) EB Enfield, former Clinical Nurse Specialist in Coronary Care Unit (CCU); and (D) Dr. Scott Syverud, ED attending and faculty. Advice was given on how to get clinicians involved and which ICUs were applicable for a TTM simulation. All were extremely supportive in the project and were willing to help make it successful.

Written approval for the simulation project was sought through proposal meetings with all necessary unit leaders: (A) MICU: Dr Kyle Enfield, Medical Director; Rick Carpenter, Nurse Manager; Sharon Bragg, Assistant Nurse Manager; Cheri Blevins, Clinical Nurse Specialist; Paul Merrel, Clinical Nurse Specialist; Sarah Kaplan, senior clinician and Unit TTM Nurse Champion; (B) CCU: Dr Jamie Kennedy, Medical Director; Mark Adams, Nurse Manager; (C) ED: Dr John Riordan, Medical Director; Megan Hinger, Nurse Manager (Figure 1).

Once written approval was obtained from the unit leaders from both ICUs and ED, there was a coordinated effort to recruit clinicians to participate in the simulations. Meetings, emails and phone calls were conducted with the unit managers, medical directors, medical faculty, chief medical residents, chief cardiology and medical fellows, and nursing schedule coordinators for help in finding appropriate clinicians who would be interested and benefit from the simulation and to coordinate dates and times in October for the simulation to be conducted. Multiple recruiting flyers were sent around to fellows, residents and nursing staff, with much desire for participation (Figures 10-12). All leaders were extremely accommodating in working out a schedule in order to ensure participation of all those who were interested.

A meeting was set up with Darla Topley, who gave a tour of the designated simulation room and a reconnaissance was done of all equipment in the room, identifying what could not be/or was not appropriate for the TTM scenarios. With the help of Mrs. Topley, as well as Epic (electronic medical record) administrators, information was obtained on how to realistically chart on a fake patient during the simulation in order to make the experience more effective. A username and password were obtained by Epic for use in the Epic Playground mode. Scenarios were written with Mark Adams, one specifically for the ICU and one for the ED, with the help of Jon Howard and with input from Dr. David Burt.

Multiple meetings were held with Jon Howard, the simulation expert from Life Support Learning Center, who would be conducting the simulations with the facilitator/researcher. With much coordination, equipment needs were identified and delegated. Scenarios were reviewed, as was the debriefing observation tool. Contact was made with Bob Dailey, the Respiratory Therapy Supervisor, for use of a ventilator during the simulation to make the experience more realistic. It was later determined that the use was not appropriate as there were no RTs involved in the scenario. A schedule was arranged with the Neuro ICU for use of their Thermoguard (cooling) machine during the dates that the simulations would be occurring, and help was received from unit clerks on all the units within the fourth floor on obtaining and returning necessary equipment through the teletracking system. Especially helpful was the unit clerk, Mary, from the CCU, who went above and beyond her daily duties to make sure everything that was needed was ordered and delivered appropriately. Reminder emails were sent to all participants one week prior to their simulation and then again two days prior. There were no negative responses.

Jon Howard and the facilitator/researcher both arrived approximately 30-45 minutes prior to each simulation. All equipment was staged in a designated “Pixis” (electronic storage, staged as a shelf for the simulation) and the mannequin was turned on and ensured running appropriately with the monitors. A simulated patient was pulled up in Epic Playground for use in documentation and copies of the new guideline, order sets, ED cardiac arrest packets, education handouts, consent handouts, and pretests were organized and available.

During the simulation dates, contact was made daily with the 4 West ICU staff to ensure they were aware of what we were doing and why multiple non-4 West staff members would be on the unit. Every effort was made to ensure that the simulation did not interfere with patient care in that area. Signs were placed to help participants know where to go, and a sign-up sheet was made for each individual simulation.

Once all simulations were conducted, all equipment was returned appropriately and hand-written thank-you notes were given out across the health system to those who aided in preparation and planning. New meetings were set up with the new ED Nurse Educator, Sharon Hardigree, and Mark Adams for follow up with some of the suggestions and comments that came out of the simulations.

Every effort was made to contact all participants to follow up with the posttest survey. Most were able to complete within 5 days following their simulation, but repeated reminder emails were sent to all clinicians on a weekly basis until most surveys were completed. At this time, a raffle for ice cream gift cards for each simulation team was conducted and the cards were distributed to the winners.

Project Design

This project was a pilot study. The sample for each simulation was groups of four to six clinicians made up of an interprofessional group of: (A) internal medicine and emergency medicine doctors, and (B) emergency and ICU nurses. The setting was a 600-bed academic institution in central Virginia with a 56 bed emergency department. Two of the five adult ICUs were used: the Medical Intensive Care Unit (MICU) and the Coronary Care Unit (CCU). The intervention consisted of designing and implementing a simulation for training on the TTM guideline in order for interprofessionals to improve their teamwork while learning and adhering to the guideline. The location was a designated simulation room on the 4 West ICU, room number 4194.

Procedures

The simulation was conducted over multiple days in middle to late October, consisting of a total of six simulations, two devoted to the emergency department and two per ICU. The participants signed up for a designated time prior to the simulation (Figure 7). Each simulation was ideally supposed to be comprised of two physicians and three nurses. All nursing staff, fellows and attendings were volunteers; most residents were volunteers and some were designated by their medical director, depending on which unit they were on. At the start of each simulation, the group was given a short pre-test (Figure 4) on the knowledge of targeted temperature management, the medical center's guideline, and interprofessional collaboration in relation to this intervention for cardiac arrest patients. There was a short class in regards to what TTM is and how interprofessional collaboration fits into the understanding and adherence to the organizational guideline. The team then conducted the simulation starting at the point in which a patient has circulation after an arrest and continuing through the next steps to post resuscitation care. The simulations varied slightly in background story as the staff members changed from an ICU to an ED team (Figure 8 and Figure 9). A major difference in the classes and simulation was that the ED was not taught about the rewarming rate, due to TTM patients rarely staying in the ED long enough to rewarm.

There were five major objectives that each team needed to perform that related to the TTM guideline. The objectives for the ED were: (A) timing of when arrest began, when ROSC occurred and when cooling initiated and how to document; (B) how to start cooling in the ED; (C) medications to initiate; (D) shivering management-BSAS, medications; and (E) targeted temperature. The objectives for the ICU were: (A) timing of arrest, when ROSC occurred, when cooling was initiated and how to document; (B) transition to invasive cooling line; (C) shivering management-BSAS, medications; (D) targeted temperature to cool; and (E) rewarming rate. During the simulation each team was observed using a debriefing tool (Figure 6), designed by the researcher, which evaluated how well the team met the key objectives. Once the simulation was finished, short five-to-ten-minute debriefings occurred using the debriefing tool as the framework for the discussion. The participants were emailed a link with the post-test (Figure 5) with instructions to complete it within five calendar days. This time frame allowed for participants to reflect on their knowledge gained and experiences in the simulation and provided them more time to fully answer the questions.

Measures and Data Analysis

The pre- and post-test survey instrument, which was developed by clinical experts, was designed around the five major objectives of the simulation that were important to the TTM guideline (figures 4 & 5). The survey evaluated how familiar the participants were with these key concepts. The survey instrument was designed by the researcher with feedback from the TTM coordinator. Questions 1-6 are basic demographic information, question 7 is to identify individual familiarity of the guideline, questions 8-11 are knowledge questions related to the five key objectives, ascertaining how much the individual knows and understands of the guideline. Questions 12 and 13, about perceptions of working in an interprofessional team, were designed to determine how different clinicians feel about this concept. Question 14 on the pre-test seeks to know opinions about making the guideline more useable as they currently know it, with the purpose of getting honest feedback from clinicians in possible improvements. On the post-test, questions 13-14 are related to how the simulation changed participants knowledge of the guideline and how the simulation changed participants' perspectives on working with an interprofessional team. The purpose of these two questions is to see if doing a hypothermia simulation regularly is perceived to be beneficial by clinicians. Question 15 is about individual perceptions of working in teams in the healthcare setting and if the simulation affected those perceptions. The last two questions are about changes to the guideline itself based on information after the simulation and the experience of the simulation itself. The overall purpose for these survey tools was to get an understanding if changes need to be made and to have a finalized guideline and simulation that can be used regularly to enhance the interprofessional team as they perform therapeutic hypothermia on patients at this institution.

The survey implementation format selected is SelectSurvey.NET, which is an ASP.NET, web-based survey tool fully hosted by the School of Nursing hardware. The survey instrument is installed on a Microsoft IIS Webserver with full encryption for all data transactions and therefore protected by a Cisco ASA firewall and is backed up regularly. Each question was scored using a Likert Scale from 1-5, with open free text questions in regards to feelings of teams concepts and simulation experiences. Six questions were identified as specific knowledge-based questions and the total sum of these questions is 18 possible. The results of the pre- and post-tests were matched and all other tests that didn't have both pre-and post-test scores were discarded.

Descriptive statistics, paired sample t-test and Pearson Correlation were conducted on the results of these scores to identify significance. The statistical package used was IBM SPSS version 22 and Microsoft Excel.

Protection of Human Subjects

Approval of Institutional Review Board for Social and Behavioral Sciences (IRB-SBS) was obtained prior to beginning this study (Figure 3). All participants received information of the study regarding purpose, time, risks, benefits, and confidentiality at the time of their simulation (Figure 2). A participant's name, UVA email address, professional role (MD, RN, etc.) and work environment within the institution were obtained when they signed up for their simulation. This allowed for an email reminder to attend the simulation as well as a reminder to fill out the posttest survey. Pre- and post-test questions include basic demographics, but no names were connected with the answers. Once assigned to a simulation team, each participant was linked by the identifier of their profession and simulation team assigned; for example, nurse 1 on Medical ICU (MICU) team A or MD 2 on Coronary Care Unit (CCU) team B. No identifiable information and data left the health system in order to protect the participants. After the completion of the posttest, one person from each simulation team, a total of six participants, had their names drawn randomly to receive an ice cream gift card paid for by the researcher.

Products of the Capstone

The products of this capstone project on a TTM simulation include: (A) the newly revised TTM protocol for the academic medical center in central Virginia; (B) other current educational programs to include podcast slide shows for residents; (C) intervention program of the simulation; (D) the Capstone Project Report; (E) abstracts and manuscript to be submitted to the Critical Care Nurse journal (author guidelines found in Appendix A).

Results

Twenty participants completed both the pretest and posttest. Results were analyzed for frequencies and significance. Of the participants, 14 (70%) were female and 6 (30%) were male with an average age of 35. While experience levels range from less than 3 years to over 15 years, the mean experience level of participants was less than 3 years in their specific specialty (Table 1).

Participants were asked how familiar they were with the TTM guideline in the ICUs or Cardiac Arrest Alert Packet in the ED (Table 2). Although the posttest showed an improvement, with no one choosing "slightly," no significant difference was noted between pre- and post-tests. When asked to rate what they considered was the importance of timing of TTM (when arrest occurred, when return of circulation occurred and when cooling initiated) (Table 3), 2 (10%) answered "somewhat important" and 18 (90%) answered "very important" on pretest. On posttest 19 (95%) answered "very important", with one participant not answering the question; however, this also did not achieve statistical significance.

Participants were asked how they perceived their competency regarding initiating and maintaining TTM therapy (Table 4). There was a significant improvement ($p < 0.03$) in perceived competency after the simulation. In the pretest group, 5 (25%) answered "very competent" in comparison to the posttest group in which 9 (45%) chose "very competent". No one chose "vaguely competent" on the posttest, although 2 (10%) had selected that in the pretest. Participants were also asked about their knowledge of the Bedside Shivering Scale (BSAS) (Table 5). In the pretest group, 1 (5%) stated they had never heard of it, 12 (60%) "used occasionally" and 3 (15%) "used often." In the posttest group, no one stated they had never heard of it and the "used often" category increased to 4 (20%); however, this did not achieve significance.

One question assessed participants' basic knowledge of the targeted temperature goal for treatment and another focused on the rewarming rate (Tables 6 &7). While 15 (75%) of participants answered the targeted temperature goal accurately on the pretest, on the posttest 18 (90%) answered the targeted temperature goal accurately; however, this did not reach significance. In contrast, there was highly significant improvement ($p<.0.001$) in knowledge of rewarming rate. No participants answered the rewarming rate item correctly on the pretest. In comparison, 14 (70%) answered this question correctly on the posttest.

Of the knowledge questions on the pre- and post-tests, the total score of 18 points was possible. The mean score on the pretest was 11.8 versus 15.048 on the posttest, indicating a highly significant ($p<0.001$) improvement in their basic knowledge of TTM from the pretest to posttest (Table 8, Figure 13). Further analysis was done using Pearson Correlation for participants' different experience levels and their results on the pre-and post-test (Table 11). A perfect correlation was noted for those with the clinical experience level of 4-10 years and a strong relationship was noted for those with over 15 years' experience.

Comparison was made between MDs and nurses identifying how they felt the simulation changed their TTM knowledge level (Table 10). Although no significant difference between the groups was noted, 4 (57.1%) of MDs felt the simulation made "somewhat of a change" and 2 (28.6%) had a "complete change" of their knowledge level. Of the nurses, 5 (41.7%) felt the simulation made a "slight change", and 6 (50%) felt it made "somewhat of a change".

Participants rated their perceived competency working in interprofessional (IP) teams (Table 9). On the pretest, the majority, 15 (75%), felt "very comfortable" working interprofessionally, and 1 participant (5%) “did not feel comfortable”. On the posttest, the question was changed slightly in order to better assess how the simulation affected the participants’ self-perceived level of comfort working in an IP team. Two (10%) did not feel there was a change in competency, 10 (52.6%) had “somewhat of a change” and 2 (15.8%) had a complete change. These data represent a highly significant improvement ($p=0.003$) in participants’ comfort working in an IP team between the pre- and post-tests. This IP comfortability was also analyzed by clinical role (Figure 14). There was no significant difference between the MDs and nurses, but there was significance with how the nurses answered this question from pre- and post-test ($p<0.01$). Experience level was also examined in participants’ feelings on working in an IP team (Table 12). Using the Pearson Correlation test, a perfect correlation was noted with those with 4-10 years’ experience and a weak, negative relationship noted for those with less than 3 years’ experience.

Discussion

The ultimate purpose of this pilot study was to determine best practices to be used to teach clinicians the institutional guideline for TTM as well as how to implement these practices appropriately in healthcare teams. Using interprofessional simulation for TTM, the objectives are to increase knowledge, increase guideline adherence and increase IP collaboration in the clinical setting. Ultimately the purpose is to improve outcomes for those having just undergone cardiac arrest (Figure 15). Based on both the qualitative and quantitative data, themes were identified in the study itself, and provided feedback to improve future training simulations on TTM and ultimately to improve clinical practice.

Knowledge and Competency in Practice

Knowledge Questions

Increasing familiarity with the TTM guideline was one goal of this study, in order that clinicians would gain a better understanding of what TTM is, what it requires of the healthcare team in doing the therapy, and how to find specific information they might need within the guideline. When asked in the posttest how familiar they were with the TTM guideline, no participants chose “slightly.” This suggests that the simulation was a factor in helping clinicians become familiar with the guideline despite the lack of statistical significance in results. Changes in understanding of timing in relation to certain aspects of TTM were not statistically significant either. Yet, with all participants choosing “very important” on the timing question on the posttest, suggests that people still learned from the education and simulation experience.

Related to familiarity is how competent the clinicians felt at either initiating or maintaining TTM. The fact that there was significance from the pre- and post-tests and that the posttest scores of “very competent” increased while no one chose “vaguely” demonstrates that the simulation has the potential to increase the ability of participants to learn and use the TTM guideline.

The Bedside Shivering Scale (BSAS) is a major tool that guides therapy and aids in maintaining the overall cooling effects on the patient. On the posttest, no clinicians answered they hadn’t heard of BSAS and the p-value that approaches significance may suggest that this was a knowledge gap that the simulation experience met for participants (Table 5).

The most noteworthy changes came in response to the main knowledge questions regarding the targeted temperature to obtain during TTM therapy and the rewarming rate. Although most answered correctly regarding knowing the targeted temperature on the pretest, there was still a knowledge gap across all experience levels. The increase of correct answers on the posttest also suggested the positive increase the simulation had in teaching the correct information. The p-value approached significance, suggesting that with a larger group of participants in this study, significance may have been achieved. The biggest impact of the simulation experience on participants' knowledge was shown by knowledge of the rate of rewarming, which increased with significance. All participants who answered incorrectly on the posttest were from the ED. The rewarming rate was not a specific objective that those in the ED simulations were taught about and it was mentioned as an afterthought during the simulation. Rarely do TTM patients stay in the ED long enough to rewarm, and therefore this result is not surprising and actually expected.

Overall Knowledge Scores

The overall summation scores of the knowledge questions showed significance, and the p-value approached significance between doctors and nurses. This identifies how the simulation affected and increased TTM knowledge. The majority of participants felt there was at least a slight change in their TTM knowledge due to the simulation, and two doctors had a complete change, which shows a trend of the effects of the simulation that was better than just a classroom treatment of the subject.

The 4-to-10 years of experience group had a perfect relationship and the greater than 15 years group had a strong relationship when comparing experience to the knowledge summation scores. This suggests that these participants already had some understanding of TTM but the simulation aided in solidifying the information in more permanent way. The perfect correlation of the 4-to-10 years group was a surprising result; a conclusion might be that these clinicians have a strong knowledge base coupled with some experience, but are still fairly young in their careers and able to grasp new concepts and increase their knowledge actively.

Interprofessional Competency

As noted during the literature review, TTM therapy requires a group of clinicians with different skills and roles to be comfortable and competent functioning as a team in order for it to be truly carried out appropriately (Neumar et al., 2008). From the initial answers on the pretest on how the participants felt working interprofessionally, to how the simulation affected these feelings, the results were significant. There was a noticeable trend amongst both MDs and nurses that signified a positive impact of simulations on their comfort working in these mixed teams. The significant impact was seen with the nurses, in which the majority had a change due to the simulation.

Once again, the experience level of 4-to-10 years had a perfect relationship with comfort in IP teams and suggests they are at a place in their careers in which they have molded themselves and defined their role within the interprofessional team. As the hospital environment is becoming less segregated amongst clinicians, those at this experience level understand their clinical role and how that fits within the team. They are also young enough in their careers that they are able to adapt to the different members of the team they encounter.

Interprofessional Themes

In open-ended questions participants were asked to write what they felt were important aspects of a team. These answers were compared to the themes noted in the literature: communication, leadership, and collaboration amongst members. Participants' answers fit into these categories, with communication being the most frequent theme on the pretest and collaboration being the most frequent on posttest. It should be noted that communication and leadership make up a full collaborative experience, and therefore it was no surprise that leadership was the second most important theme noted on the posttest. This reflects that clinicians want to better understand each other, work together and communicate better but often do not know how to do this in the clinical setting. Therefore it is important to reflect how the simulation really affected this experience and if it would be worthwhile for the future.

The effect of the simulation on intraprofessional competency and comfortability is debatable. Although the answers reflected on the pre- and post-tests suggest that there was some change and it was a worthwhile experience, the changes were small. On the other hand, the results point to an increase in TTM knowledge level as noted by the significance level on the t-test comparing the pre- and post-test data. In nearly all aspects the simulation met this goal in the research question with much success.

Using IPE Simulation to Advance Knowledge and Teamwork

Using Simulation to Increase Knowledge

The goal of this pilot study was to increase knowledge of TTM and to increase interprofessional collaboration through the use of simulations. On the posttest, participants were asked how they felt the simulation affected their knowledge of TTM, with 10% choosing "completely." Both of these respondents were MDs from the ICU with less than 3 years' experience. Fifty-seven percent of participants chose "somewhat," and this group was a mix of nurses and MDs. The majority felt that the simulation helped them better understand TTM and how to use it in the clinical setting, and the answers to individual questions reflected this. On the specific knowledge questions alone, there was a significant difference from the pre-and post-tests in how well participants learned the important objectives of the guideline. This was also reflected in what participants stated during the debriefings. Overall, they asked questions and clarified their current knowledge with the new guideline both during the education session and throughout the entire simulation through the debriefing. As a group, participants were discussing with their team members about the guideline and using the tools in the guideline such as BSAS scoring, shivering management algorithm and time line, during the scenario. Participants stated on their posttest that they felt the simulation increased understanding in what needed to be done to be efficient in TTM therapy and that they learned a lot. One participant stated, “I thought I knew this material well but found that I had some significant gaps”. These answers, along with the data noted in the previous section, reflect that the simulation for TTM did what it needed to in order to increase their knowledge.

Fidelity of Simulation Experience

It is important to examine the difference in simulation experience from high fidelity versus low fidelity in regards to mannequin and supplies. This simulation used a moderately technical mannequin in which some basic physiological pieces were changed to meet the needs of the scenario so that it gave a basic impression of a live patient. There were IVs, breath and heart sounds, as well as a Foley catheter and readings on the monitor. The patient was not able to be properly hooked to a ventilator due to constraints of the hospital, but still had an endotracheal tube in place. The majority of the equipment needed for the simulation was present, including pumps for medication drips, Thermoguard and ICY Cath indwelling catheter. The cooling blanket was obtained for the ED scenario but the incorrect cooling machine was brought to the simulation room and therefore participants had to pretend the machine was turned on. Therefore, the simulation was not completely realistic due to the supply constraints. However, there were no complaints regarding this aspect in the debriefings, nor in the comments. By observation, participants felt that the simulation met their needs and the effect of the supplies, equipment and mannequin made little to no difference on the entire simulation experience.

The simulation was located in a vacant room on one of the ICUs that was not participating in this study. Although it was an ICU, only the supplies that would be available for the situation at hand were in the room. Therefore, for the ED simulation there was a stretcher and only the specific supplies usually available in the ED. That simulation would have been more realistic in one of their ED trauma bays, but that was not possible due to the clinical constraints of a 24-hour area. Having the simulation in this particular ICU gave easy access for busy clinicians to come and participate in the simulation for an hour, and yet be accessible the entire time if needed. If it had been in the actual simulation center, a less convenient location, it would have been harder for participants to get there, which could possibly have reflected the overall participation. Except potentially for the ED experience, the location had little to no impact on the overall results.

Scenarios Affect Simulation Experience

The two scenarios were a collaboration of the researcher, the TTM Coordinator at the health center and the simulation facilitator. Other clinical experts reviewed the scenarios prior to their use in the simulation. As one goal of this study was for participants to learn and understand the TTM guideline, the scenarios were very simple and straightforward, which permitted observation of the participants. One participant felt that they would have preferred a scenario with more complications that required more thought, since no patient is completely textbook in nature. This is good feedback, but also would require more time, which this study did not allow. Part of the promise to recruit participants was that it would be only an hour, and one person did note that they felt rushed.

Participants in IP Simulation

The participants were all volunteer clinicians with varied experience levels. In the majority of the simulations, this mix worked very well: when an MD did not have as much knowledge with TTM, there was a nurse who did and who took up the leadership role instead, and vice versa. Yet, involving busy clinicians also proved a challenge. Some committed participants did not attend the simulation. Whether that was due to unavailability due to staffing and/or clinical emergencies, or for other reasons it is not known, but it was a challenge to overcome for two simulations. In one ICU simulation, only one MD attended but was paged and had to leave prior to starting the actual simulation scenario itself. A more senior nurse did not attend this same simulation, which left two fairly inexperienced nurses. Their simulation was drastically different without that interprofessional team and it became more of a walkthrough teaching session instead of a realistic scenario.

Using IP Simulation to Increase Collaboration

Team Observations during Simulation

Two of the teams were models of collaboration, one for the ICU (MICU) and one for the ED. The team for the ICU was excited to get their hands dirty on the simulation and seemed to love working together as a team. For this team, and the other for the ED, there was constant communication and collaboration amongst all members, with the leaders consistently welcoming the input of other team members. Other simulations were much quieter, but still worked effectively. One ICU team segregated into the members' specific roles, but still communicated with one another and was effective in its objectives. Occasionally, in some of the scenarios, the nurse was more dominant and became the leader, but deferred to the MD often and there was always respect and collaboration there. As these important aspects of interprofessionalism were related to participants during the debriefing, the teams consistently turned the discussion to the TTM aspects rather than focusing on their teamwork.

Observation Tool vs Literature Based Tool

The end of the simulation, a time in which the entire team is able to reflect on the entire experience, is known as a debriefing or debrief. The researcher had created an observation tool (Figure 6) based on the five key objectives and had taken notes during the scenarios. This tool guided the debrief as each objective was discussed and made it possible to include aspects of teamwork. The researcher explained observations noted and reflected on changes the team could have made. She then gave time for the team to discuss what they felt needed improvement and what went well as a team. Overall, the teams wanted to discuss particular aspects of TTM with clarifications or changes that could be made to the guideline and for the institution, but very little reflection related to their work as a team. Perhaps this could have been reflected on more if there was more time available, but as only ten minutes were allotted for the debriefs, not everything that needed to be discussed could be included.

Although the observation tool used for the simulation was based on the objectives the teams were supposed to meet, it was more of a checklist in which the researcher added some brief observations throughout. A more thorough and structured tool, developed using the literature as a base, perhaps would have made the debrief more effective. It would have been more ideal to properly define the different aspects of teamwork and therefore allow for more clarity for the participants as they heard about and reflected on their experiences. Along with an improved tool, more time needed to be allowed for reflection and discussion on these vital aspects of the team experience in order for each individual to understand how to collaborate better interprofessionally once back in their clinical settings.

Strengths, Challenges and Limitations

Strengths of Design

The key strength of this study on TTM guideline adherence in a simulation amongst interprofessional teams is that it showed that TTM simulations can aid the healthcare organization. The simulation provides hands-on experience for team members so that they really understand what the TTM guideline says and how to implement it into practice. The simulation also educates participants on key points to ensure clinicians provide better outcomes to cardiac arrest patients. Finally, the simulation provides an opportunity for professionals from different disciplines who care for cardiac arrest patients in post resuscitation care to work together, make mistakes, and understand each other's roles within the guideline framework without jeopardizing real patients.

Challenges of Design

There are identified challenges to this study design as well. The difficulty in validating what clinicians do within resuscitation/post resuscitations is great due to logistics within the emergency department and intensive care units. Doing direct observations requires intensive planning, leadership and technology involvement, all of which were difficult to obtain in the timeframe allowed for this project. This was further complicated because the researcher was not an employee of the health system. A major limitation is getting management to assist with providing people for the simulation with little to no compensation. Additional problems that prevented fully adequate execution included: (A) clinical areas needing their staff members to be on the units, (B) nurses being unwilling to volunteer their off time, and (C) difficulty convincing residents and/or attendings to participate.

Limitations of the Project

There were some obvious limitations to this study. The first is the small sample size of 20 participants who filled out a pretest, went through the simulation experience and completed the posttest. Although significance was found, the results were limited by the sample size and perhaps do not reflect the results of the clinicians at large within the institution. The generalizability of the study is a limitation as well. This study was specifically looking at two ICUs and the ED at one academic institution. A more thorough study of an interprofessional simulation for TTM would need to look at multiple institutions and perhaps multiple units and clinicians within each institution. Further study on this subject would require exploration of objectively measured changes in the clinical setting after the study was complete, rather than knowledge and perceptions immediately following the simulation. Finally, and the largest limitation, was finding participants who are active in the clinical setting who could take time to invest in such a simulation experience. This study found that even though 30 people initially volunteered, there are too many constraints for clinicians to realistically participate. One MD was handed the code pager as he was walking over to the simulation, a variable that could not be accounted for initially and may not be avoidable. The time aspect is of major importance, as it was a struggle to many participants to commit one hour to this study; to allow for more time and/or multiple days would require logistical buy-in from leadership and management far up the chain beyond specific units.

Implications for the Interprofessional Team

Practice Delivery of the Healthcare Team

This simulation experience can have significant impact on direct patient care from the entire interprofessional team in terms of how the TTM guideline is implemented and how communication amongst team members is conducted. Currently, ICU nurses are struggling to completely understand the TTM guideline themselves and then must walk residents and other team members through the order sets, timeline, shivering management, and other aspects of TTM care at the same time. ED resuscitation teams seem to implement segments of the guideline, but do not completely understand the importance of completing the many key details. By implementing a simulation regularly into training, the entire interprofessional team has a chance to learn the guideline while also working together to accomplish a common goal; the successful resuscitation and neurologic functioning of a post-cardiac arrest patient. The simulation allows for mistakes to be made, for medical doctors, nurses and patient technicians to learn to work together better and to understand their own role and the functions of the different team members within the TTM guideline. They are then able to guide other clinicians in the future.

Role of an APRN in Simulation

Simulations play a pivotal role in practicing high risk scenarios, skills and tasks in a low risk setting (Nicksa GA et al., 2015). The use of simulations is a perfect medium for an advanced practice nurse (APRN), who is able to engage an interprofessional team to look beyond knowledge deficits. With experience in system level leadership, APRNs can use simulations to engage in process improvement activities and can challenge the status quo of individual clinicians and institutions. Through their leadership, APRNs are able to use simulations to “uncover defects in the current processes and establish more effective strategies to provide care” (Topley, 2015). During a simulation, the APRN guides and facilitates the team through real-life scenarios; is able to provide immediate feedback of the current condition, including identifying areas where improvement is needed; and can clarify roles and responsibilities of participants’ as needed (Topley, 2015). Simulations have become an important aspect of clinical education and the APRN stands at the forefront in making them effective for the entire interprofessional team and the institution itself.

Future of Interprofessional Simulation with TTM

This study has shown that a simulation to help medical personnel learn and understand TTM as an interprofessional team has great merit. One participant stated, “I thought it went great”, others said, “It was great”, “Awesome simulation” and “It was a great experience”. One participant stated that they felt that this simulation would be a vital thing to incorporate into the nurse residency program. Another participant stated that there needed to be more awareness about TTM on the medical side, and this simulation was one way to do that.

Despite the results and feedback, there are some notable changes that need to be made in order to make a TTM simulation more effective for the institution.

First, the simulation, to truly be effective in its dual-sided goal of knowledge and collaboration, requires two distinct simulations separating the knowledge and collaboration aspects. The first simulation would be focused specifically on TTM knowledge and understanding. One way to accomplish this might be by handing out the guideline prior to the day of the simulation and then allowing time for questions and clarifications during the education portion, which would enhance the learning level and increase competence. Although teamwork aspects would be discussed during the debrief, the main focus would be on how the team understood and followed the guideline. The second simulation would use the team’s new TTM knowledge, but would focus on the interprofessional components and working to improving those throughout the simulation. This simulation would be about being more effective in their communication, leadership and collaborative skills as a team, and with a goal of incorporating those components in everyday practice.

Another change would be didactic modifications to the education components. The ED objectives of initiating the cooling process and knowing, ordering and giving medications for cooling, would be combined into one objective. Based on observations during the simulation and comments made, the ED participants need more of challenge with difficult situations while continuing to follow the guideline. For both scenario settings, bringing more of a focus to shivering management and when to move from first round to second round medications would allow for more critical thinking as well as team collaboration. Another area that this simulation did not discuss was the physiologic changes caused by TTM and how they affect lab results and therefore treatment options. This would be another component for the teams to work through. All of these changes would require more time in the simulation and debrief, which the two-simulation experience would allow for.

Summary and Conclusions

Using simulation with TTM has an abundant purpose and future. The simulation would be a great facilitator in learning for quarterly or yearly education amongst staff members in specific units. A TTM simulation could be used by bringing together the nurse residents with MD fellows to aid in collaboration interprofessionally, as well as in meeting their knowledge deficits. A TTM simulation has countless other uses that this study only has begun to explore, and will provide the academic institution a platform to increase its interprofessional collaboration in the setting of TTM for the future.

References

Bridges, D. R., Davidson, R. A., Odegard, P. S., Maki, I. V., & Tomkowiak, J. (2011). IInterprofessional collaboration: Three best practice models of interprofessional education. *Medical Education Online, 16*(6035) doi:dx.doi.org/10.3402%2Fmeo.v16i0.6035

Brooks, S. C., & Morrison, L. J. (2008). Implementation of therapeutic hypothermia guidelines for post-cardiac arrest syndrome at a glacial pace: Seeking guidance from the knowledge translation literature. *Resuscitation, 77*, 286.

Daniels K, Lipman S, Harney K, Arafeh J, & Druzin M. (2008). Use of simulation based team training for obstetric crises in resident education. *Simulation in Healthcare: The Journal of the Society for Medical Simulation, 3*(3), 154-160. doi:http://dx.doi.org/10.1097/SIH.0b013e31818187d9

Eisenberg, M. S., Bergner, L., & Hallstrom, A. (1984). Survivors of out-of-hospital cardiac arrest: Morbidity and long-term survival. *American Journal of Emergency Medicine*, *2*(3), 189.

Freeth D, Ayida G, Berridge EJ, Mackintosh N, Norris B, Sadler C, & Strachan A. (2009). Multidisciplinary obstetric simulated emergency scenarios (MOSES): Promoting patient safety in obstetrics with teamwork-focused interprofessional simulations. *Journal of Continuing Education in the Health Professions*, *29*(2), 98-104. doi:http://dx.doi.org/10.1002/chp.20018

Holzer, M., & Behringer, W. (2008). Therapeutic hypothermia after cardiac arrest and myocardial infarction. *Best Practice & Research Clinical Anaesthesiology*, *22*(4), 711-728. doi:http://dx.doi.org/10.1016/j.bpa.2008.02.001

Hunziker, S., Johansson, A. C., Tschan, F., Semmer, N. K., Rock, L., Howell, M. D., & Marsch, S. (2011). Teamwork and leadership in cardiopulmonary resuscitation. *Journal of the American College of Cardiology, 57*(24), 2381-2388. doi:10.1016/j.jacc2011.03.017

Kim, F., Nichol, G., Maynard, C., Hallstrom, A., Kudenchuk, P. J., Rea, T., . . . Cobb, L. A. (2014). Effect of prehospital induction of mild hypothermia on survival and neurological status among adults with cardiac arrest: A randomized clinical trial. *JAMA*, *311*(1), 45-52. doi:http://dx.doi.org/10.1001/jama.2013.282173

Kvarnstrom, S. (2008). Difficulties in collaboration: A critical incident study of interprofessional healthcare teamwork. *Journal of Interprofessional Care*, *22*(2), 191-203. doi:http://dx.doi.org/10.1080/13561820701760600

Neumar, R. W., Nolan, J. P., Adrie, C., Aibiki, M., Berg, R. A., Bottiger, B. W., . . . Vanden Hoek, T. L. (2008). Post cardiac arrest syndrome: Epidemiology, pathophysiology, treatment and prognostication: American heart association, international liason committee on resuscitation consesnsus statement. *Circulation, 118*, 2452.

Nicksa GA, Anderson C, Fidler R, & Stewart L. (2015). Innovative approach using interprofessional simulation to educate surgical residents in technical and nontechnical skills in high-risk clinical scenarios. *JAMA Surgery, 150*(3), 201-207. doi:http://dx.doi.org/10.1001/jamasurg.2014.2235

Owen JA, Brashers VL, Littlewood KE, Wright E, Childress RM, & Thomas S. (2014). Designing and evaluating an effective theory-based continuing interprofessional education program to improve sepsis care by enhancing healthcare team collaboration. *Journal of Interprofessional Care, 28*(3), 212-217. doi:http://dx.doi.org/10.3109/13561820.2014.890581

Polderman, K. H. (2008). Induced hypothermia and fever control for prevention and treatment of neurological injuries. *Lancet, 371*, 1955.

Roberts NK, Williams RG, Schwind CJ, Sutyak JA, McDowell C, Griffen D, . . . Wetter N. (2014). The impact of brief team communication, leadership and team behavior training on ad hoc team performance in trauma care settings. *American Journal of Surgery, 207*(2), 170-178. doi:http://dx.doi.org/10.1016/j.amjsurg.2013.06.016

Skvoretz, J. (1981). Extending expectation states theory: Comparative status models of participation in N person groups. *Social Forces, 59*(3), 752-770. Retrieved from http://search.proquest.com/docview/60073760?accountid=14678

Sudden Cardiac Arrest Association. (2015). SCA fact sheet. Retrieved from http://www.suddencardiacarrest.org/aws/SCAA/pt/sp/edmaterials

Sudden Cardiac Arrest Foundation. (2015). About sudden cardiac arrest. Retrieved from http://www.sca-aware.org/about-sca

Topley, D. K. (2015). A team approach: Active engagement through open chest simulations [Abstract]. *NACNS Cardio-Thoracic Symposium,*

University of Virginia Health System. (2015). *Practice guideline for targeted temperature managment*

Figures

To Unit/Department Leaders:

The targeted temperature management (therapeutic hypothermia) guideline for return of circulation after cardiac arrest was old and outdated. There is one that is new and updated to current evidence related to shivering and rewarming, and should be going to the critical care subcommittee in the coming months. The plan outlines education goals to ensure awareness is brought to the clinical team about what it is, how it is used, and what the guideline says. National evidence shows that 30-40% of physicians does not adhere or follow a guideline when using TTM, and clinically at UVA we've found that many residents do not even know what it is. To combat this we've recorded podcasts that will be available on the GME website within the next week.

-my project is to help with the education plan by designing an interprofessional targeted temperature management simulation to train on the 5 key objectives for ED and ICU team members.

My plan is to conduct an hour long simulation consisting of a pre-test, short education on key objectives of guideline, conducting a simulation and a short de-brief. At the end of the simulation each individual will be given a web address to conduct a post-test/survey and their name will then be in the running for 1 of 6 ice cream gift certificates to be drawn a week later once surveys are due.

-There are a total of 6 simulations: 1-2 for ED, 2 for MICU team and 2 for CCU team.

-conducted in the 4 West ICU designated simulation room, # 4194

Although this is a feasibility study in order to provide the UVA health system with training aid that can be used regularly, this is my project for my DNP capstone. IRB approval will be sought; all participants will sign an informed consent prior to beginning the simulation.

I am requesting your participation in this simulation by allowing your staff to participate and aid in promoting the event. Please sign in the appropriate line for your agreement and I am happy to entertain any questions you may have.

Thank you,

Rosie Bennett
RN, MSN, CEN

Figure 1. Letter to Leaders

ED Nurse Manager ______________________

ED Medical Director ______________________

MICU Nurse Manager ______________________

MICU Medical Director ______________________

Information of Pilot Study

Purpose of the research study: This capstone project is to help with the education plan of the new updated TTM guideline. It is a pilot feasibility study and has three purposes: (1) to implement a Targeted Temperature Management (TTM) simulation education program, (2) to evaluate the effect of participating in the simulation on knowledge of the TTM protocol, and (3) to identify perceptions of interprofessional collaboration in the context of post resuscitation care.

What you will do in the study: You are involved in one of six simulations regarding TTM. The simulation team consists of two medical doctors (either an attending or fellow and a resident), and three nurses. At the start of the simulation each participant will sign consent, and then will take a pre-test on their knowledge of the TTM guideline and how effective their interprofessional team is. The team will then be given a short class and a one-page handout regarding the key objectives related to their specialty area. Following the class, the team will conduct a simulation on a TTM patient and a short de-brief will be conducted. At the end of the session, each participant will be given the web address to complete a post-test and survey in five calendar days.
While taking the pre/post test surveys, you may skip any question that makes you uncomfortable and you may stop the surveys at any time.

Time required: The study will require about 1 hour of your time.

Risks: There are no risks in this pilot study. A loss of confidentiality will not put any participant at risk, as this is for an educational purpose, to improve the way a TTM simulation might be run and used in the future.

Benefits: There are no direct benefits to you for participating in this research study. We hope the results of this study will provide a well-constructed simulation education program for TTM for the Life Support Learning Center, ED, ICUs and TTM champions to train their clinical staff in the future.

Confidentiality: Because of the nature of the study, it may not be possible to guarantee complete confidentiality and it may be possible that others will know what you have reported. However effort is being made to keep all data confidential. All surveys are conducted via a secure server owned by the UVA School of Nursing and will not be linked to your name. All data will be secured in a locked office in the Coronary Care Unit. Once on a team, you will be designated only as job title on that team (ie-nurse on MICU team A). Your supervisor will know you have participated in the simulation, but will not know your specific results.

Voluntary participation: Your participation in the study is completely voluntary and you have the right to withdraw at any time without penalty.

Payment: You will receive no payment for participating in the study. After completing the post-test survey you will be in a raffle for a $5 ice cream gift card.

If you have questions about the study, contact:

Rosie Bennett, MSN, CEN, DNPc
School of Nursing
University of Virginia, Charlottesville, VA 22903.
Telephone: 575-496-2088
rcb9kx@virginia.edu

Kathryn Reid, PhD, RN, FNP-BC, CNL
Acute and Specialty Care, School of Nursing, Box 800826
University of Virginia, Charlottesville, VA 22903.
Telephone: (443)924-0115
kjb@virginia.edu

Figure 2. Information Form Regarding Project Participation

September 21, 2015

Rosalie Bennett and Kathryn Reid
Academic Divisions
1159 River Oaks Lane
Charlottesville, VA 22901

Dear Rosalie Bennett and Kathryn Reid:

Thank you for submitting your project entitled: "Simulating Targeted Temperature Management (TTM) in Post Resuscitative Care for Cardiac Arrest Patients: A Simulation Feasibility Study" for review by the Institutional Review Board for the Social & Behavioral Sciences. The Board reviewed your Protocol on September 21, 2015.

The first action that the Board takes with a new project is to decide whether the project is exempt from a more detailed review by the Board because the project may fall into one of the categories of research described as "exempt" in the Code of Federal Regulations. Since the Board, and not individual researchers, is authorized to classify a project as exempt, we requested that you submit the materials describing your project so that we could make this initial decision.

As a result of this request, we have reviewed your project and classified it as exempt from further review by the Board for a period of four years. This means that you may conduct the study as planned and you are not required to submit requests for continuation until the end of the fourth year.

This project # 2015-0359-00 has been exempted for the period September 21, 2015 to September 20, 2016. If the study continues beyond the approval period, you will need to submit a continuation request to the Board. If you make changes in the study, you will need to notify the Board of the changes.

Sincerely,

Tonya R. Moon, Ph.D.
Chair, Institutional Review Board for the Social and Behavioral Sciences

Figure 3. IRB Approval Letter

1) Gender: Male/Female
2) Age:
3) Years of experience in clinical role: a) Less than 3 years b) 4-10 years c) 10-15 years d) Over 15 years
4) Race a) African American b) Caucasian c) Native American d) Asian/Pacific Islander e) other
5) In what clinical area do you primarily work in: a) Emergency Medicine b) Intensive Care Unit
6) What is your primary position: a)MD b)nurse c) paramedic/patient care tech
7) How familiar are you with the Therapeutic Hypothermia Guideline/Cardiac Arrest Alert packet:

a) I am not familiar with Therapeutic Hypothermia
b) Slightly familiar-I have heard of it, not sure what to do or how to find it
c) Somewhat familiar-I know basic concepts and know where to find guideline, rarely use it
d) Very familiar-use it all the time

8) How important do you feel the issue of timing (ie: time of arrest, time of return of circulation, initiated cooing) is related to the Therapeutic Hypothermia Guideline/Cardiac Arrest Alert packet
a) I do not consider timing to be important
b) It is important on a case by case basis
c) It is somewhat important
d) I consider timing very important

9) How competent are you with how to initiate and/or maintain cooling (if initiated in the prior level of care)?
a) I am not familiar
b) Vaguely familiar-I have seen others do it
c) Somewhat familiar-I have done it occasionally
d) Very familiar-I do it all the time

10) Do you know what the Bedside Shivering Scale (BSAS) is?
a) No-I have never heard of it
b) Yes-I have heard of it, I have never used it
c) Yes-I have used it occasionally
d) Yes-use it all the time

11) When using the Therapeutic Hypothermia Guideline/Cardiac Arrest Alert Packet:
a) What is the target temperature? ___________ (drop down of #s)

b) What is the rewarming rate?____________ (drop down of #s)
12) How competent do you feel in working within an interprofessional team? a) I do not know what an interprofessional team is? b) I do not feel comfortable c) Somewhat comfortable d) Very comfortable
13) What do you consider as the most important aspects that make up a team in healthcare?
14) If there are changes that could be made to the hypothermia guideline/packet in your specialty area, what would they be?

Figure 4. Pre Test. An example of what participants filled out using online survey tool

1) Gender: Male/Female
2) Age:
3) Years of experience in clinical role: e) Less than 3 years f) 4-10 years g) 10-15 years h) Over 15 years
4) Race f) African American g) Caucasian h) Native American i) Asian/Pacific Islander j) other
5) In what clinical area do you primarily work in: c) Emergency Medicine d) Intensive Care Unit
6) What is your primary position: a)MD b)nurse c) paramedic/patient care tech
7) How familiar are you with the Therapeutic Hypothermia Guideline/Cardiac Arrest Alert packet:

e) I am not familiar with Therapeutic Hypothermia f) Slightly familiar-I have heard of it, not sure what to do or how to find it g) Somewhat familiar-I know basic concepts and know where to find guideline, rarely use it h) Very familiar-use it all the time
8) How important do you feel the issue of timing (ie: time of arrest, time of return of circulation, initiated cooing) is related to the Therapeutic Hypothermia Guideline/Cardiac Arrest Alert packet e) I do not consider timing to be important f) It is important on a case by case basis g) It is somewhat important h) I consider timing very important
9) How competent are you with how to initiate and/or maintain cooling (if initiated in the prior level of care? e) I am not familiar f) Vaguely familiar-I have seen others do it g) Somewhat familiar-I have done it occasionally h) Very familiar-I do it all the time
10) Do you know what the Bedside Shivering Scale (BSAS) is? e) No-I have never heard of it f) Yes-I have heard of it, I have never used it g) Yes-I have used it occasionally h) Yes-use it all the time
11) When using the Therapeutic Hypothermia Guideline/Cardiac Arrest Alert Packet:

c) What is the target temperature? ____________ (drop down of #s) d) What is the rewarming rate?_____________ (drop down of #s)
12) How competent do you feel in working within an interprofessional team? e) I do not know what an interprofessional team is? f) I do not feel comfortable g) Somewhat comfortable h) Very comfortable
13) The simulation increased by knowledge and abilities regarding the Therapeutic Hypothermia Guideline/Cardiac Arrest Alert Packet: a) It did not change my knowledge and abilities b) Slightly changed my knowledge and abilities c) Somewhat changed my knowledge and abilities d) Completely changed my knowledge and abilities
14) The simulation increased my sense of competency working on an interprofessional team using the Therapeutic Hypothermia Guideline/Cardiac Arrest Alert Packet: a) No change b) Slight change c) Somewhat of a change d) Complete change in competency
15) What do you consider as the most important aspects that make up a team in healthcare?
16) If there are changes that could be made to the Hypothermia Guideline/Cardiac Arrest Alert

packet in your specialty area, what would they be?
17) Provide Feedback about your experience in the simulation.

Figure 5. Post Test. An example of what participants filled out online using survey tool after simulation

ED Objectives	
1) Identify timing: a) when arrest began b) when ROSC occurred c) when cooling initiated d) documented on Cardiac Arrest Alert Packet	
2) Initiate and go through process of cooling based off of Cardiac Arrest Alert packet checklist and Epic Order Set	
3) Know, order and give appropriate medications for cooling	
4) Manage shivering appropriately using BSAS and ordering/giving appropriate medications	
5) Know goal temperature, monitoring temp and record when have reached that goal	
ICU Objectives	
1) Identify timing: a) When arrest began b) When ROSC occurred c) When cooling initiated (and where)	

d) Documented appropriately in Epic	
2) Appropriately transition from external cooling to an invasive cooling (to include appropriate equipment for line placement; setting up Thermoguard, have temperature sources ready and available)	
3) Manage shivering appropriately using BSAS and ordering/giving appropriate medications	
4) Know goal temperature, monitor temperature, identify using Thermoguard when goal temperature is reached	
5) Identify what the rewarming rate is, how to operate/read Thermoguard to begin rewarming and appropriate time frame	

Figure 6. Team Observation Tool. An example of how teams were observed during the simulation and facilitated the debrief discussion

Please sign up below on a designated slot for your profession. By signing your name you agree to be at the simulation room, #4194 in the TCV ICU West on the 4th floor at the designated time. Each simulation experience will take a total of an hour and there will be a short online survey to conduct in the week following. By filling out that final survey, you will be in a raffle with your simulation team members for an ice cream card.

Simulation 1: ED A <u>date and time here</u>

MD 1:

Name______________________________ Email____________________________________

MD 2:

Name______________________________ Email____________________________________

Nurse 1:

Name______________________________ Email____________________________________

Nurse 2:

Name______________________________ Email____________________________________

Nurse 3/Paramedic/PCT:

Name______________________________ Email____________________________________

Simulation 2: ED B <u>date and time here</u>

MD 1:

Name______________________________ Email____________________________________

MD 2:

Name______________________________ Email____________________________________

Nurse 1:

Name______________________________ Email____________________________________

Nurse 2:

Name______________________________ Email____________________________________

Nurse 3/Paramedic/PCT:

Name______________________________ Email____________________________________

Simulation 3: MICU A <u>date and time here</u>

MD 1:

Name______________________________ Email____________________________________

MD 2:

Name______________________________ Email____________________________________

Nurse 1:

Name______________________________ Email____________________________________

Nurse 2:

Name______________________________ Email____________________________________

Nurse 3/Paramedic/PCT:

Name______________________________ Email____________________________________

Simulation 4: MICU B <u>date and time here</u>

MD 1:

Name________________________________ Email_______________________________________

MD 2:

Name________________________________ Email_______________________________________

Nurse 1:

Name________________________________ Email_______________________________________

Nurse 2:

Name________________________________ Email_______________________________________

Nurse 3/Paramedic/PCT:

Name________________________________ Email_______________________________________

Simulation 5: CCU A <u>date and time here</u>

MD 1:

Name________________________________ Email_______________________________________

MD 2:

Name________________________________ Email_______________________________________

Nurse 1:

Name________________________________ Email_______________________________________

Nurse 2:

Name________________________________ Email_______________________________________

Nurse 3/Paramedic/PCT:

Name________________________________ Email_______________________________________

Simulation 6: CCU B date and time here

MD 1:

Name_______________________________ Email_____________________________________

MD 2:

Name_______________________________ Email_____________________________________

Nurse 1:

Name_______________________________ Email_____________________________________

Nurse 2:

Name_______________________________ Email_____________________________________

Nurse 3/Paramedic/PCT:

Name_______________________________ Email_____________________________________

Figure 7. Sign up Form for Simulation. This is the form to keep track of participants and discarded once simulation/post-test was complete.

TH Scenario 1 (ED)

Case Information:

Designed for: Interprofessional team in ED

Estimated time:

Simulation Setting: ED

A. Pre-performance

1. Scenario Narrative Overview (one paragraph for participants, one paragraph for coordinator only):
   Charge nurse report: EMS is bringing in a 45 YOF resuscitated code.
   If team asks/listens to EMS report: Found by husband in bed pulseless and apneic at 0245, 911 called, VF, defib x2, epi x2, ROSC, intubated, cold NS 2L infusing by IO and PIV. It is now 0315 and the patient is expected in a few minutes.
   [Patient is exactly as described above.]

2. Simulation Objectives (what do you want the participants to do?):
   Before arrival: preparation for resuscitated code
   On arrival: rapid assessment of pulse, VS, hemodynamic status, candidate for TH
   Teamwork on interventions: Monitoring, cooling, sedation, labs, shivering

3. Setup and Equipment:

   Environment: ED trauma bay (actual location: TCV-ICU 94)

   Manikin Set Up: In street clothes, rigged 18g L AC PIV, rigged R proximal tibia IO, intubated correctly, NS 1L x2 infusing

   Equipment: Manikin with controller; iSimulate as patient monitor; NG/OG tube; cooling blankets and machine; temperature-sensing Foley; esophageal temp probe; NSR EKG; STach EKG; pictures of goosebumps; warming blanket

   Medications needed: NS 2L cold; fentanyl and midazolam boluses and CADD pumps for sedation; Demerol; Buspar; Propofol; paralytic(?)

4. Participant Roles:
   RNs: Primary, charge nurse, additional support
   MDs: Primary, additional support
   PCTs
   EMS crew (confederates)

TH Scenario 1 (ED)

5. Patient and Medical Information:

Demographics:

Name:	Lupita Nyong'o	Gender: F	
Age:	45 years old	DOB: 09/02/1970	
Ethnicity:	Height:		Weight: 59 kg

Chief Complaint: Resuscitated code

HPI: Found by husband about 30 minutes ago in cardiac arrest; EMS a few minutes out with resuscitated code

PMH: AFib; ablation x2; hypertrophic cardiomyopathy

Medications: Lasix 40 mg PO; Potassium

Allergies: NKDA

Latest Lab Data: None available

Specific exceptions to WNL in review of systems:
Unresponsive, apneic, intubated

Current VS per EMS report:

HR: 116 ST BP: 96/58 RR: 16 BVM Sat: 96% BVM Temp: Unknown Pain: Unknown

TH Scenario 1 (ED)

B. Performance

6. State Transitions (Visualize the flow of the patient's condition here when correct and incorrect actions are performed):

Value / States	Start 0315	Time Jump 1 0445	Time Jump 2 0650	Admit 0715
HR Rhythm	108 STach	94 NSR	92 NSR	90 NSR
RR	16 BVM @ 100% O2	16 vent @ FiO2 0.4	16 vent @ FiO2 0.3	16 vent @ FiO2 0.3
BP	96/58	92/52	98/60	94/56
Heart sounds	Regular	Regular	Regular	Regular
Lung sounds	Mild crackles in bases	Clear	Clear	Clear
Pupils	Unresponsive	Unresponsive	Unresponsive	Unresponsive
SpO2	96% BVM	97% vent	98% vent	98% vent
Voice	Unresponsive	Unresponsive	Unresponsive	Unresponsive
Other	EtCO2 48	EtCO2 42	EtCO2 38	EtCO2 39
Time Range				
Expected Actions / Triggers **What is required to move to another state?** **Action or inaction** **How long for change?**	**Prepare equipment prior to EMS arrival.** Receive report. Confirm pulse. Obtain VS, 12-lead EKG, labs. Transfer to ventilator. Can patient be cooled? (Yes.) Start cooling process including temperature monitoring. Initiate ongoing sedation. Consider vasopressor. Go to Time Jump 1.	As facilitator reads lab results, Jon puts pictures of goosebumps on arms, makes manikin "shiver"(?). Document BSAS score, consider medications, warming blanket. Once interventions occur, go to Time Jump 2.	Tension in jaw, make manikin "shiver"(?). Document BSAS score, consider medications. Medications won't work, team to consider paralytic. Go to Admit.	CCU bed opened at 0700. How to get patient to CCU without allowing rewarming to start?
Teaching Points				

Figure 8. ED Simulation Scenario (format developed by Jon Howard)

TH Scenario 2 (ICU)

Case Information:

Designed for: Interprofessional team in ICU

Estimated time:

Simulation Setting: ICU

A. Pre-performance

1. Scenario Narrative Overview (one paragraph for participants, one paragraph for coordinator only):
   Patient en route from ED: 45 YOF resuscitated code, found by husband in bed pulseless and apneic at 0245, 911 called, VF, defib x2, epi x2, ROSC, intubated, cold NS 2L infusing by IO and PIV. Patient has been in ED, no STEMI seen, cooling started with chilled NS and cooling blankets, currently at 34.4C. It is now 0500.
   [Patient is exactly as described above.]

2. Simulation Objectives (what do you want the participants to do?):
   Before arrival: preparation for resuscitated code, especially in prepping Icy Cath
   On arrival: rapid assessment of hemodynamic status, VS, temperature
   Teamwork on interventions: Monitoring, cooling, sedation, labs, shivering

3. Setup and Equipment:

   Environment: ICU room (actual location: TCV-ICU 94)

   Manikin Set Up: In gown, rigged 18g L AC PIV, rigged R proximal tibia IO, intubated correctly, OG tube placed

   Equipment: Manikin with controller; iSimulate as patient monitor; NG/OG tube; temperature-sensing Foley; esophageal temp probe; NSR EKG; STach EKG; pictures of goosebumps; warming blanket

   Medications needed: fentanyl and midazolam CADD pumps for sedation; Demerol; Buspar; Propofol; paralytic(?)

4. Participant Roles:
   RNs: Primary, additional support
   MDs: Primary, additional support
   PCAs/PCTs

TH Scenario 2 (ICU)

5. Patient and Medical Information:

Demographics:

Name: Lupita Nyong'o Gender: F
Age: 45 years old DOB: 09/02/1970
Ethnicity: Height: Weight: 59 kg

Chief Complaint: Resuscitated code

HPI: Found by husband about 0245 in cardiac arrest

PMH: AFib; ablation x2; hypertrophic cardiomyopathy

Medications: HOME: Lasix 40 mg PO; Potassium

Allergies: NKDA

Latest Lab Data: None available

Specific exceptions to WNL in review of systems:
Unresponsive, apneic, intubated

Current VS per ED report:

HR: 90 NSR BP: 94/56 RR: 16 vent Sat: 98% at FiO2 0.3 Temp: 34.4C Foley, 34.5C esophageal Pain: Unknown

TH Scenario 2 (ICU)

B. Performance

6. State Transitions (Visualize the flow of the patient's condition here when correct and incorrect actions are performed):

Value / States	Start 0500	Time Jump 1 0600	Time Jump 2 0620	Rewarming 0300 next day
HR Rhythm	90 NSR	94 NSR	96 NSR	90 NSR
RR	16 vent @ FiO2 0.3	16 vent @ FiO2 0.3	16 vent @ FiO2 0.3	16 vent @ FiO2 0.3
BP	94/56	90/52	98/60	102/66
Heart sounds	Regular	Regular	Regular	Regular
Lung sounds	Clear	Clear	Clear	Clear
Pupils	Unresponsive	Unresponsive	Unresponsive	Unresponsive
SpO2	98% vent	98% vent	98% vent	98% vent
Voice	Unresponsive	Unresponsive	Unresponsive	Unresponsive
Other	EtCO2 39; Temp 34.4C	EtCO2 40; Temp 33.1C	EtCO2 38; Temp 32.9C	EtCO2 39; Temp 33.2C
Time Range				
Expected Actions / Triggers **What is required to move to another state?** **Action or inaction** **How long for change?**	**Prepare equipment prior to patient arrival.** Receive report. Confirm pulse. Obtain VS, 12-lead EKG, other diagnostics as needed. Place Icy Cath. Continue cooling process. Continue ongoing sedation. Consult Neurology. Go to Time Jump 1.	As facilitator reads lab results, Jon puts pictures of goosebumps on arms, makes manikin "shiver"(?). Document BSAS score, consider medications, warming blanket. Once interventions occur, go to Time Jump 2.	Tension in jaw, make manikin "shiver"(?). Document BSAS score, consider medications. Medications won't work, team to consider paralytic. Go to Rewarming.	Rewarming should begin now (how fast? To what temp?).
Teaching Points				

C. Debriefing

Debriefing Questions and Overview:

In one sentence, what happened to the patient?
What went well?
What would you do differently?
What are your thoughts about Therapeutic Hypothermia?
How was your teamwork?

3

Figure 9. ICU Simulation Scenario (format developed by Jon Howard)

Hypothermia Simulation Pilot Program

The Problem: UVA's Targeted Temperature Management (therapeutic hypothermia) guideline after cardiac arrest was old and outdated. There is one that is new and updated to current evidence and is under review by the Critical Care Subcommittee. The new plan outlines education goals to ensure awareness is brought to the clinical team about what it is, how it is used, and what the guideline says. Podcasts have already been recorded here at UVA about hypothermia and will be available on the GME website any day.

> -my project is to help with the education plan by designing an interprofessional targeted temperature management simulation to train on the 5 key objectives for ED and ICU team members.

Request from ED staff:

Who-volunteers of nurses and techs.

What-an hour long simulation in which a pre-test will be taken, simulation conducted related to therapeutic hypothermia in the Emergency Department and a take-home post-test to be done within 5 calendar days. The ED will have 2 simulation sessions, volunteers only sign up for 1 session

When -in mid-late October (dates and times to be decided once have volunteers).

Where-designated simulation room in 4 West ICU, #4194

Why-1) to help improve education related to hypothermia

2) have a say in how future hypothermia education is conducted

3) work with residents/attendings in a simulated environment, without the stress of a live patient

4) learn what is important for ED staff to know and remember about hypothermia

4) raffle for ice cream gift card conducted after post-test surveys

Figure 10. ED Volunteer Request

Hypothermia Simulation Pilot Program

The Problem: UVA's Targeted Temperature Management (therapeutic hypothermia) guideline after cardiac arrest was old and outdated. There is one that is new and updated to current evidence and is under review by the Critical Care Subcommittee. The new plan outlines education goals to ensure awareness is brought to the clinical team about what it is, how it is used, and what the guideline says. Podcasts have already been recorded here at UVA about hypothermia and will be available on the GME website any day.

> -my project is to help with the education plan by designing an interprofessional targeted temperature management simulation to train on the 5 key objectives for ED and ICU team members.

Request from MICU/CCU staff:

Who-volunteers of nurses

What-an hour long simulation in which a pre-test will be taken, simulation conducted related to therapeutic hypothermia in the ICU setting and a take-home post-test to be done within 5 calendar days. The MICU and CCU will each have 2 simulation sessions, volunteers only sign up for 1 session

When -in mid-late October (dates and times to be decided once have volunteers).

Where-designated simulation room in 4 West ICU, #4194

Why-1) to help improve education related to hypothermia

2) have a say in how future hypothermia education is conducted

3) work with residents/attendings in a simulated environment, without the stress of a live patient

4) learn what is important for ICU staff to know and remember about hypothermia

4) raffle for ice cream gift card conducted after post-test surveys

Figure 11. ICU Volunteer Request

Hypothermia Simulation Pilot Program

The Problem: UVA's Targeted Temperature Management (therapeutic hypothermia) guideline after cardiac arrest was old and outdated. There is one that is new and updated to current evidence and is under review by the Critical Care Subcommittee. The new plan outlines education goals to ensure awareness is brought to the clinical team about what it is, how it is used, and what the guideline says. Podcasts have already been recorded here at UVA about hypothermia and will be available on the GME website any day.

-my project is to help with the education plan by designing an interprofessional targeted temperature management simulation to train on the 5 key objectives for ED and ICU team members.

Request from Medical Residents:

Who-volunteers of residents who will be paired with a cardiology/medical fellow or an ED attending .

What-an hour long simulation in which a pre-test will be taken, simulation conducted related to therapeutic hypothermia in the ICU and a take-home post-test to be done within 5 calendar days. The CCU will have 2 simulation sessions (potentially 3), volunteers only sign up for 1 session

When - October 14 (time to be announced, probably around 1130 and 3:00p).

Where-designated simulation room in 4 West ICU, #4194

Why-1) to help improve education related to hypothermia

2) have a say in how future hypothermia education is conducted

3) work with nurses in a simulated environment, without the stress of a live patient

4) learn what is important for the CCU to know and remember about hypothermia

4) raffle for ice cream gift card conducted after post-test surveys

Figure 12. Medical Resident Volunteer Request

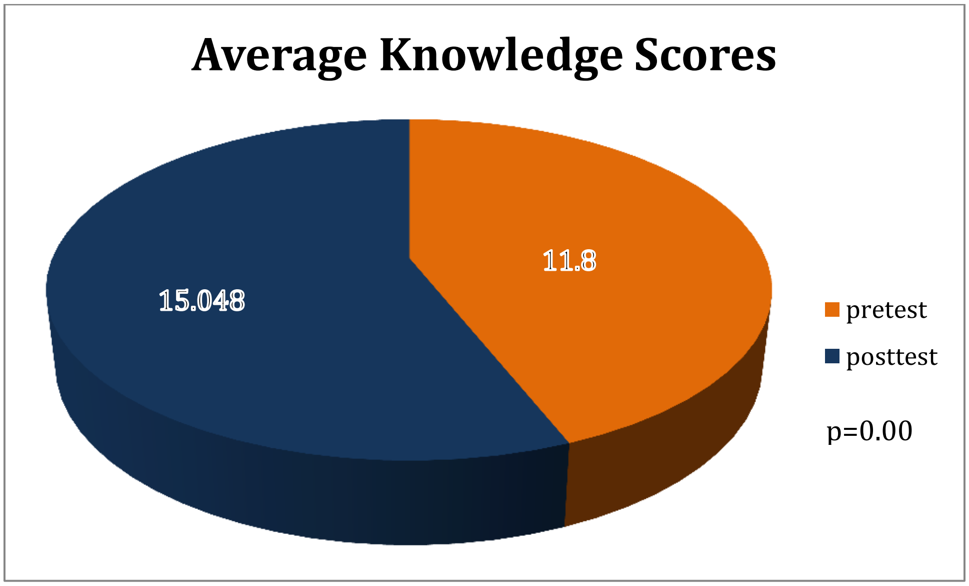

Figure 13: The Sum of Knowledge Items on Pretest Compared to the Posttest

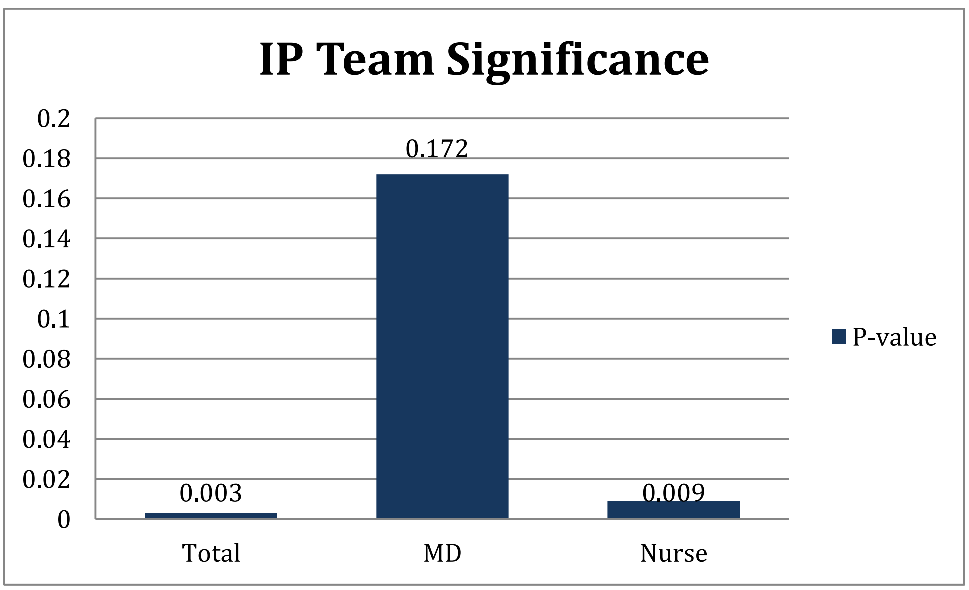

Figure 14: The Significance of Participants' Feelings of Working in IP Teams

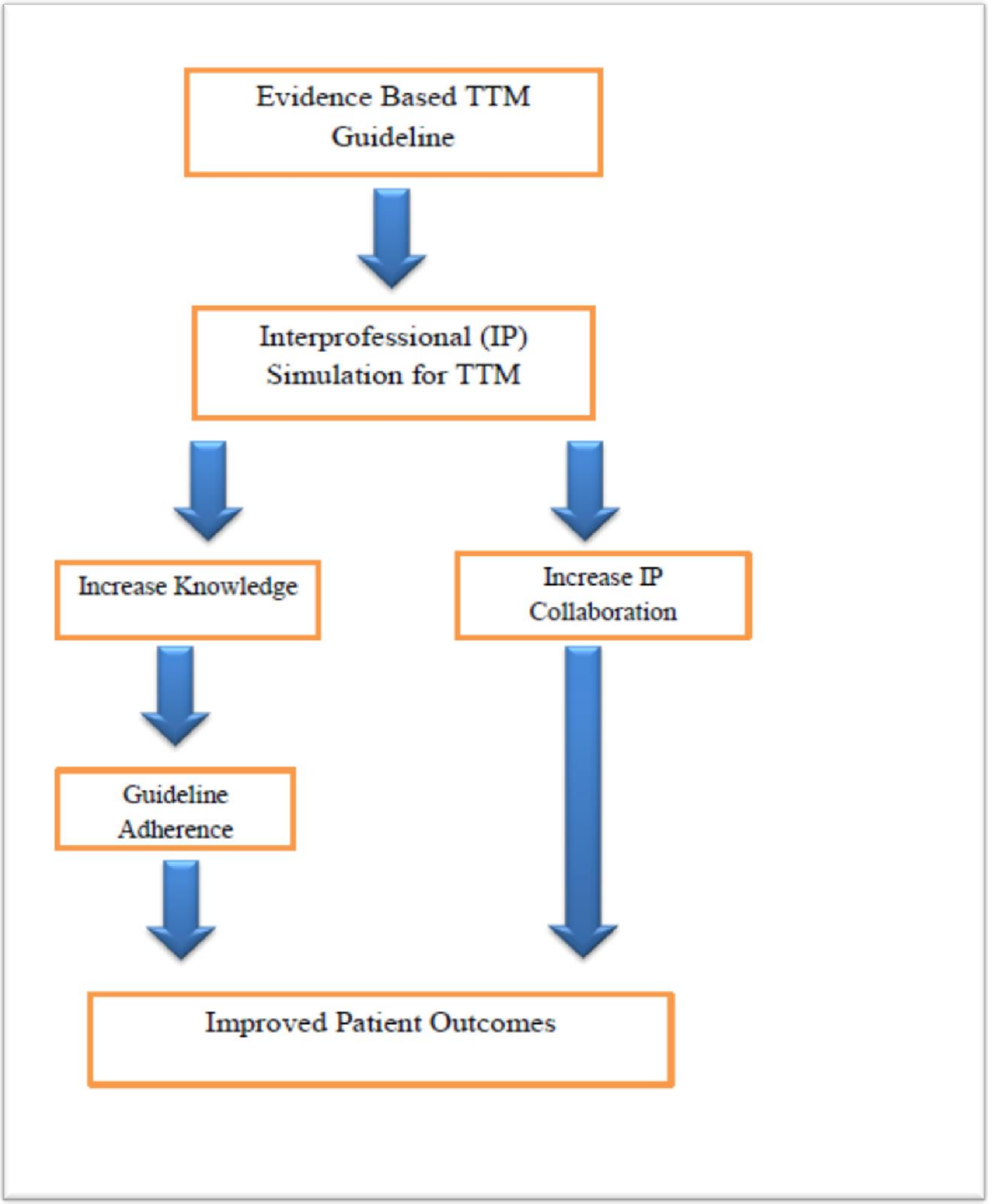

Figure 15: Project Goal and Objectives Using Simulation

Tables

Table 1
*Demographics of the Participants**

Characteristic	Number	Percent
Sex		
Female	14	70%
Male	6	30%
Average Age	35 years	
Clinical Experience		
Mean	<3 years	
<3 years	12	60%
4 to 10 Years	2	10%
10 to 15 years	1	5%
>15 years	5	25%
Primary Clinical Area		
ICU	14	70%
ED	6	30%
Role		
MD	7	35%
Nurse	13	65%

*n=20

Table 1: Demographics of participants in simulations

Table 2
Familiarity with TTM Guideline/Cardiac Arrest Alert Packet

	Pretest			Posttest			p-value
Number of Participants*	Slightly Familiar	Somewhat Familiar	Very Familiar	Slightly Familiar	Somewhat Familiar	Very Familiar	
20	1 (5%)	13 (65%)	5 (25%)	0	13 (65%)	6 (30%)	.666

*One person did not respond to this question.

Table 2: How familiar were participants with TTM Guideline and/or Cardiac Arrest Alert Packet

Table 3
*Importance of Timing in TTM**

	Pretest			Posttest			p-value
Number of Participants	Occasionally Important	Somewhat Important	Very Important	Occasionally Important	Somewhat Important	Very Important	
20	0	2 (10%)	18 (90%)	0	0	19** (95%)	.649

*Time of arrest, time of ROSC, and time cooling was initiated
**One person did not respond to this question.

Table 3: Participants' beliefs about importance of timing in TTM

Table 4
Competence in Initiating and Maintaining TTM

	Pretest			Posttest			
Number of Participants	Vaguely Competent	Somewhat Competent	Very Competent	Vaguely Competent	Somewhat Competent	Very Competent	p-value
20	2 (10%)	13 (65%)	5 (25%)	0	11 (55%)	9 (45%)	.030

Table 4: Participants' feelings of competence in initiating and maintaining TTM

Table 5
Bedside Shivering Scale (BSAS)

	Pretest				Posttest				
Number of Partici-pants	Never Heard of It	Heard of It, Never Used It	Used It Occasion-ally	Use It Often	Never Heard of It	Heard of It, Never Used It	Used It Occasion-ally	Use It Often	p-value
20	1 (5%)	4 (20%)	12 (60%)	3 (15%)	0	4 (20%)	12 (60%)	4 (20%)	.267

Table 5: Participants' knowledge of the Bedside Shivering Scale

Table 6
Targeted Temperature

Number of Participants	Pretest		Posttest		p-value
	Incorrect	Correct	Incorrect	Correct	
20	5 (25%)	15 (75%)	2 (10%)	18 (90%)	.186

Table 6: Participants' knowledge of targeted temperature for therapy

Table 7
Rewarming Rate for TTM

Number of Participants	Pretest		Posttest		p-value
	Incorrect	Correct	Incorrect	Correct	
20	20 (100%)	0	6 (30%)	14 (70%)	.000

Table 7: Participants' knowledge of the rewarming rate for TTM

Table 8
*Knowledge Score**

	Pretest	Posttest	p-value
Mean	11.8	15.048	
Sample t-test			.000

*Number of participants = 20

Table 8: Sum of knowledge items on pretest comparted to posttest

Table 9
Working with IP Teams

	Pretest				Posttest*				
	Not Comfort-able	Somewhat Comfort-able	Very Comfort-able	p-value	No Change	Slight Change	Some Change	Complete Change	p-value
Total	1 (5%)	4 (20%)	15 (75%)		2 (10.5%)	4 (21%)	10 (52.6%)	3 (15.8%)	.003
MD	0	2 (28.6%)	5 (38.5%)		0	1 (14.3%)	4 (57.1%)	2 (28.6%)	.172
Nurse	1 (7.7%)	2 (15.4%)	10 (76.9%)		2 (16.7%)	3 (25%)	6 (50%)	1 (8.3%)	.009
MD-Nurse				.172					.172

*1 participant did not answer

Table 9: Participants' Feelings about Working with IP Teams

Table 10
Simulation Changed Knowledge of TTM

Number	No Change	Slight Change	Some Change	Complete Change	p-value
Total (MD-Nurse)	1 (5.3%)	6 (31.6%)	10 (52.6%)	2 (10.5%)	.289
MD	0	1 (14.3%)	4 (57.1%)	2 (28.6%)	
Nurse	1 (8.3%)	5 (41.7%)	6 (50%)	0	

Table 10: How participants felt the simulation changed their knowledge of TTM

Table 11

Correlation of Experience Level with Knowledge Score

Years of Experience	Pearson Correlation
<3 years	.136
4-10 years	1.00
10-15 years	NA
>15 years	.721

Table 11: The correlation of specific experience level with the sum score of knowledge questions

Table 12

Correlation of IP Team to Experience

Years of Experience	Pearson Correlation
<3 years	-.406
4-10 years	1.00
10-15 years	NA
>15 years	NA

Table 12: The correlation of participants' feelings of working on an IP team to specific experience level

Appendix

Appendix A. Instructions for Publications

The full, downloadable version of Critical Care Nurse publication instructions can be found online at: http://ccn.aacnjournals.org/site/misc/ifora.xhtml

CRITICAL CARE NURSE is an official publication of the American Association of Critical-Care Nurses (AACN). Authors are invited to submit manuscripts for consideration and peer review. Clinical topics must apply directly to the care of critically and acutely ill patients and/or progressive care, telemetry, and stepdown unit patients and their families, with case presentations and clinical tips especially welcome.

Manuscripts should be submitted online via the *CCN* online manuscript submission and review system at www.editorialmanager.com/ccn. At the time of submission, complete contact information (postal/mail address, e-mail address, telephone and fax numbers) for the corresponding author is required. First and last names, e-mail addresses, and institutional affiliations of all coauthors also are required. (Print copies of the journal will be sent only to coauthors who provide their physical address.) Manuscripts submitted through the online system should not be submitted by mail or e-mail.

Authors who desire OnlineNOW publication can make that choice during the online submission process. The full-text of OnlineNOW articles appears exclusively on the journal's Web site at www.ccnonline.org, with only the key points of the article appearing in the print and digital editions of the journal. OnlineNOW articles enjoy a faster turnaround time from acceptance to publication than do full-text articles in print. OnlineNOW articles are peer reviewed, copyedited, formatted, indexed, and citable just like *CCN*'s print offerings.

Quality improvement studies help maximize the integrity and safety of critical care. *CCN* welcomes such articles. However, because of their necessarily subjective relationships to context and social processes, such articles are difficult to evaluate using traditional empirical standards. For this reason, *CCN* asks that quality improvement studies adhere to the Standards for Quality Improvement Reporting Excellence (SQUIRE) Guidelines. For more information, please go to http://qshc.bmj.com/content/vol17/Suppl_1 or doi: 10.1136/qshc.2008.029058.

For medical case reports, authors should follow the CARE guidelines to organize and present content effectively. The CARE guidelines are available at http://www.care-statement.org/case-report-writing-template.html.

Editorial Office Contact Information

Peer Review Coordinator: telephone, (949) 448-7341 or (800) 394-5995, ext 241; fax, (949) 448-5542; e-mail, ccn.editorialoffice@aacn.org

For help submitting your manuscript online, visit www.editorialmanager.com/ccn and click "Author Tutorial." For technical help or questions not addressed by the Author Tutorial document, e-mail ccnhelp@aacn.org

Checklist for Authors

Manuscripts should be submitted online via the *CCN* online manuscript submission and review system at http://www.editorialmanager.com/ccn. Editorial Manager will combine your submission into a single PDF file for purposes of review. Your online manuscript submission should contain the following components:

☐ Cover letter (include name, home and work addresses, home and work telephone numbers, fax number, and e-mail address of corresponding author)

- ☐ Authorship, Financial Disclosure, Copyright Transfer, and Acknowledgment Form—each author signs a separate form
- ☐ Title page (include title of manuscript; name(s), professional credential(s), affiliation(s), addresses of all authors in the order intended for publication; brief [1 to 2 sentences] biography of each author; funding and financial disclosure; acknowledgments; and 3 to 5 key words for indexing)
- ☐ Text of manuscript
- ☐ Abstract (include as numbered page; double-spaced on separate page)
- ☐ References (include as numbered pages; double-spaced on separate page; follow reference style described in these guidelines)
- ☐ Tables (double-spaced, 1 per page; numbered consecutively; include title for each)
- ☐ Figure legends (separate page; double-spaced)
- ☐ Illustrations (1 per page; number and label on back)
- ☐ Permissions to publish identifiable persons in photographs and names of people in the Acknowledgments, copyrighted materials, and any material not belonging to author

Appendix B: Draft for Publication

Simulating Therapeutic Temperature Management (TTM)
In Post-Resuscitative Care for Cardiac Arrest Patients: A Pilot Study

Background and Purpose

Sudden cardiac arrest accounts for over 450,000 deaths per year in the United States (Podrid, 2015). Emphasis has been placed in recent years on early CPR and defibrillation, which have been found to increase survival by rapid return of circulation. The return of spontaneous circulation after complete ischemia to the entire body is an unnatural pathophysiological state that can cause Post Cardiac Arrest Syndrome or Secondary Injury, which is a key co-morbidity of an arrest victim (Neumar et al., 2008).

The definition of Secondary Injury is a prolonged, whole-body ischemia that causes global tissue and organ injury initially, and continued cascade of damage during and after reperfusion. Post-arrest pathophysiology often overlaps with the disease or injury that originally caused the arrest and underlying comorbidities. There are four key components of secondary injury: (A) post-cardiac arrest brain-injury, (B) post-cardiac arrest myocardial dysfunction, (C) systemic ischemia/reperfusion response, and (D) persistent precipitating pathophysiology, which may compromise other organ systems. The first intervention that has been proven to be clinically effective in reducing Secondary Injury is therapeutic hypothermia or Targeted Temperature Management (TTM) (Neumar et al., 2008).

TTM is an induced state of body temperature below normal in a homoeothermic organism (32-34 degrees Celsius) that impacts multiple stages of Secondary Injury simultaneously (Holzer & Behringer, 2008). It has been shown to reduce the number of cell death in certain brain regions and is most effective if applied immediately after injury. With every hour delay, the chance of a favorable recovery is reduced by 31% and with every 30 minute delay in reaching the target temperature, there is a 17% greater chance in poor versus good neurological survival (Hunziker et al., 2011).

Review of Literature

The effective use of TTM for cardiac arrest patients requires coordination and optimization of care delivery by members of an interprofessional team. However, there remain significant barriers to working in teams that are inherent to all clinical professions from all backgrounds (Neumar, et al, 2008). Current literature about teamwork in cardiac arrest suggests that leadership and communication are key components of effective collaborative care delivery. Leaders must be adaptive and flexible. A commanding and domineering presence does not reflect a positive outcome, rather it closed the door for other members to contribute and participate. A study by Anderson, et al found the grade of leadership authority and the extent of the experience did not match the requirements for optimal treatment. The more inexperienced physicians usually were the leaders and authority figure, which brought confusion to the team. For some residents, their first participation in an arrest was as a team leader. It has been found that teams will give control over to the physician regardless if the team includes an ICU nurse with over 20-years' experience. Communication was another aspect that affects code team effectiveness. Team leaders used a form of closed loop communication in which he/she asked a question and received a response back. The majority of the time, the team leader was giving orders and asserting a level of authority, clarifying the delivery of treatment, updating on patient's current condition, and advising team of further treatment. Yet, two out of three times that the team communicated, it was not to the leader. A balance has to be met in how the leaders and team communicate in order to be successful. In all studies it was found that when all members contribute and are giving feedback, there are always better results (Taylor, KL et al., 2014).

The Joint Commission identifies that failures in communication, leadership and human factors are what most lead to sentinel events. The simulation environment can provide high risk scenarios, skills and tasks in a low risk setting and train professionals in skills that reduce the these failures. (Nicksa, GA et al., 2015). Team communication has been found to play a crucial role in reducing medical errors and improving patient outcomes. According to Hunziker, et al "an important advantage of simulation methodology is that, unlike in actual emergency situations, a controlled, standardized experimental situation can be created, to which multiple interventions can be applied and directly compared" (Hunziker, et al., 2011, 2382). A review of the literature found that evidence generally focused on two aspects of simulation: 1) how it impacted clinical expertise and 2) how it impacted interprofessional relationships.

With regard to enhancing clinical expertise, there is little debate on the effect of simulation of improving clinical skills. For example, residents who participated in simulation for training surgical technique, trauma, or OB high risk procedures provided positive evaluations of the simulation experience (Roberts, NK, et al., 2014; Daniels, K et al., 2008).

For teamwork training, Freeth et al state that the simulation environment "was viewed as a positive interprofessional learning opportunity that facilitated relationship building and the development of new perspectives. Participants were able to check out assumptions and expectations of others, and develop respect for the different roles within the team" (Freeth, D et al., 2009). Among surgical residents, 87% felt that working with an interdisciplinary team was not only helpful, but made for a more realistic scenario (Nicksa, GA et al., 2015).

TTM is not only more effective when begun early after cardiac arrest, but there is also evidence that once cooling has been initiated, the therapy must be maintained without an increase in temperature for optimal outcomes. This is why interprofessional collaboration from the time of the initial arrest all the way through post resuscitative care with TTM is so vital to ensuring there is a positive outcome for the patient. The team needs to have a shared understanding of the procedure and how to prioritize care delivery. One approach to achieving that understanding is through implementing guidelines in practice. This is particularly important since guideline adherence among physicians may be as low as 30-40% (Brooks & Morrison, 2008).

The purpose of this study was to determine if participation in targeted temperature management simulation training improves clinician knowledge of the TTM protocol and interprofessional collaboration. Best practices for training clinicians to use an institutional guideline for TTM are also discussed (figure 1). The ultimate goal is to increase guideline adherence and interprofessional collaboration in the clinical setting in an effort to improve outcomes for those patients having just undergone cardiac arrest.

Study Design/Procedure

Approval for this simulation was obtained from the Social and Behavioral Sciences Internal Review Board, with no loss of confidentiality. The simulation was conducted over multiple days in middle to late October, consisting of a total of six simulations, two devoted to the emergency department and two per ICU. The participants signed up for a designated time prior to the simulation. All nursing staff, fellows and attendings were volunteers; most residents were volunteers and some were designated by their medical director.

At the start of each simulation, the group was given a short pre-test on the knowledge of targeted temperature management, the medical center's guideline, and interprofessional collaboration in relation to this intervention for cardiac arrest patients. There was a short, ten minute class in regards to what TTM is and how interprofessional collaboration fits into the understanding and adherence to the organizational guideline. The team then participated in the simulation starting at the point in which a patient has circulation after an arrest and continuing through the next steps to post resuscitation care. The simulations varied slightly for staff members from an Intensive Care Unit (ICU) versus an Emergency Department (ED) team in order to retain consistency with practice processes in those areas. For example, a major difference was that the ED team was not taught about the rewarming rate, due to the fact that TTM patients rarely stay in the ED long enough to rewarm.

There were five major objectives that each team needed to perform that related to the TTM guideline. The objectives for the ED team were to be able to identify the following key goals: (A) documentation of the timing of when arrest began, when Return of Spontaneous Circulation (ROSC) occurred and was when cooling initiated; (B) utilization of the proper procedure for starting the cooling process in the ED; (C) choosing which medications to administer; (D) implementation of the shivering management-Bedside Shivering Assessment Scale (BSAS) and appropriate management; and (E) targeting of the appropriate body temperature. The objectives for the ICU were: (A) documentation of the timing of when arrest began, when return of spontaneous circulation (ROSC) occurred and when was cooling initiated; (B) utilization of the proper procedure for transitioning to invasive cooling line; (C) implementation of the shivering management-BSAS and appropriate management; (D) targeting of the appropriate body temperature; and (E) rewarming rate. During the simulation each team was observed using a debriefing tool designed by the researcher, which evaluated how well the team met the key objectives. Once the simulation was finished, short five-to-ten-minute debriefings occurred using the debriefing tool as the framework for the discussion. The participants were emailed a link with the post-test with instructions to complete it within five calendar days. This time frame allowed for participants to reflect on their knowledge gained and experiences in the simulation and provided them more time to fully answer the questions.

The pre- and post-test survey instrument, which was developed by clinical experts, was designed around the five major objectives of the simulation that were important to the TTM guideline (figures 4 & 5). The survey evaluated how familiar the participants were with these key concepts. The survey instrument was designed by the researcher with feedback from the TTM coordinator. Questions 1-6 are basic demographic information, question 7 is to identify individual familiarity of the guideline, questions 8-11 are knowledge questions related to the five key objectives, ascertaining how much the individual knows and understands of the guideline. Questions 12 and 13, about perceptions of working in an interprofessional team, were designed to determine how different clinicians feel about this concept. Question 14 on the pre-test seeks to know opinions about making the guideline more useable as they currently know it, with the purpose of getting honest feedback from clinicians in possible improvements. On the post-test, questions 13-14 are related to how the simulation changed participant's knowledge of the guideline and how the simulation changed participants' perspectives on working with an interprofessional team. The purpose of these two questions is to see if doing a hypothermia simulation regularly is perceived to be beneficial by clinicians. Question 15 is about individual perceptions of working in teams in the healthcare setting and if the simulation affected those perceptions. The last two questions are about changes to the guideline itself based on information after the simulation and the experience of the simulation itself. The overall purpose for these survey tools was to get an understanding if changes need to be made and to have a finalized guideline and simulation that can be used regularly to enhance the interprofessional team as they perform therapeutic hypothermia on patients at this institution.

Each question in the survey was scored using a Likert Scale from 1-5, with open free text questions in regards to feelings of teams concepts and simulation experiences. Six questions were identified as specific knowledge-based questions and the total sum of these questions is 18 possible. The results of the pre- and post-tests were matched and all other tests that didn't have both pre-and post-test scores were discarded. Descriptive statistics, paired sample t-test and Pearson Correlation were conducted on the results of these scores to identify significance. The statistical package used was IBM SPSS version 22 and Microsoft Excel.

Results

Twenty participants completed both the pretest and posttest. Results were analyzed for frequencies and significance. Of the participants, 14 (70%) were female and 6 (30%) were male with an average age of 35. While experience levels range from less than 3 years to over 15 years, the mean experience level of participants was less than 3 years in their specific specialty (Table 1).

Participants were asked how familiar they were with the TTM guideline in the ICUs or Cardiac Arrest Alert Packet in the ED. Although the posttest showed an improvement, with no one choosing "slightly," no significant difference was noted between pre- and post-tests. When asked to rate what they considered was the importance of timing of TTM (when arrest occurred, when return of circulation occurred and when cooling initiated), 2 (10%) answered "somewhat important" and 18 (90%) answered "very important" on pretest. On posttest 19 (95%) answered “very important”, with one participant not answering the question; however, this also did not achieve statistical significance.

Participants were asked how they perceived their competency regarding initiating and maintaining TTM therapy (Table 2). There was a significant improvement ($p< 0.03$) in perceived competency after the simulation. In the pretest group, 5 (25%) answered “very competent” in comparison to the posttest group in which 9 (45%) chose “very competent”. No one chose “vaguely competent” on the posttest, although 2 (10%) had selected that in the pretest. Participants were also asked about their knowledge of the Bedside Shivering Scale (BSAS). In the pretest group, 1 (5%) stated they had never heard of it, 12 (60%) “used occasionally” and 3 (15%) “used often.” In the posttest group, no one stated they had never heard of it and the “used often” category increased to 4 (20%); however, this did not achieve significance.

One question assessed participants’ basic knowledge of the targeted temperature goal for treatment and another focused on the rewarming rate (Tables 3 &4). While 15 (75%) of participants answered the targeted temperature goal accurately on the pretest, on the posttest 18 (90%) answered the targeted temperature goal accurately; however, this did not reach significance. In contrast, there was highly significant improvement ($p<.0.001$) in knowledge of rewarming rate. No participants answered the rewarming rate item correctly on the pretest. In comparison, 14 (70%) answered this question correctly on the posttest.

Of the knowledge questions on the pre- and post-tests, the total score of 18 points was possible. The mean score on the pretest was 11.8 versus 15.048 on the posttest, indicating a highly significant ($p<0.001$) improvement in their basic knowledge of TTM from the pretest to posttest (Table 5). Further analysis was done using Pearson Correlation for participants’ different experience levels and their results on the pre-and post-test (Table 6). A perfect correlation was noted for those with the clinical experience level of 4-10 years and a strong relationship was noted for those with over 15 years' experience.

Comparison was made between MDs and nurses identifying how they felt the simulation changed their TTM knowledge level. Although no significant difference between the groups was noted, 4 (57.1%) of MDs felt the simulation made "somewhat of a change" and 2 (28.6%) had a "complete change" of their knowledge level. Of the nurses, 5 (41.7%) felt the simulation made a "slight change", and 6 (50%) felt it made "somewhat of a change".

Participants rated their perceived competency working in interprofessional (IP) teams (Table 7). On the pretest, the majority, 15 (75%), felt "very comfortable" working interprofessionally, and 1 participant (5%) "did not feel comfortable". On the posttest, the question was changed slightly in order to better assess how the simulation affected the participants' self-perceived level of comfort working in an IP team. Two (10%) did not feel there was a change in competency, 10 (52.6%) had "somewhat of a change" and 2 (15.8%) had a complete change. These data represent a highly significant improvement ($p=0.003$) in participants' comfort working in an IP team between the pre- and post-tests. This IP comfortability was also analyzed by clinical role (Figure 14). There was no significant difference between the MDs and nurses, but there was significance with how the nurses answered this question from pre- and post-test ($p<0.01$). Experience level was also examined in participants' feelings on working in an IP team. Using the Pearson Correlation test, a perfect correlation was noted with those with 4-10 years' experience and a weak, negative relationship noted for those with less than 3 years' experience.

Discussion

Using interprofessional simulation for TTM, the objectives were to increase knowledge, increase guideline adherence and increase IP collaboration in the clinical setting. Based on both the qualitative and quantitative data, themes were identified in the study itself, and provided feedback to improve future training simulations on TTM and ultimately to improve clinical practice.

Using Simulation to Increase Knowledge

The majority of participants felt that the simulation helped them understand TTM and how to use it in the clinical setting, and the significance in those specific questions reflected this. There were significant differences from the pre and post-tests in how well participants learned the important objectives of the guideline. This was also reflected in responses from participants during the debriefing session. The biggest impact of the simulation experience on participants' knowledge was shown by knowledge of the rate of rewarming, which increased with significance. All participants who answered incorrectly on the posttest were from the ED. Rarely do TTM patients stay in the ED long enough to rewarm, and therefore this result is not surprising and actually expected.

Participants asked questions and clarified their current knowledge with the new guideline during the education sessions, throughout the entire simulation, and during the debriefings. On the posttest participants stated: "I thought I knew this material well but found that I had some significant gaps". This further suggests that the simulation increased their knowledge.

Fidelity of Simulation Experience

This simulation used a moderately technical mannequin which had basic physiological components that met the needs of the scenario. There were intravenous catheters, breath sounds, and urinary catheter and monitor readings including temperature from the endotracheal tube in place. Other equipment needed for the simulation included a Thermoguard and ICY Cath indwelling catheter used for cooling. The location of the simulation was in a vacant ICU room. There were only supplies available in the room those that were consistent with the clinical area in which an actual TTM procedure would have occurred – i.e. the emergency department of the ICU. Having the simulation located in the hospital rather than a simulation center allowed easy access for busy clinicians to participate but still be accessible. Although there were some unrealistic supply constraints, there were no complaints regarding this in the debriefing or in the posttest comments.

Scenarios and Participants in Simulation

The scenarios were developed through a collaborative effort of the TTM coordinator at the health center, the simulation facilitator, and other selected clinical experts. Although one participant would have "preferred a more complicated scenario since no patient is exactly like a textbook", the scenarios were designed to be simple and straightforward to allow the educational goals to be achieved without unnecessary complexity and confusion. This also permitted easier observation of team behaviors. Participants were volunteers with varied experience levels. In the majority of simulations this mix worked well, as when an MD did not have as much experience with TTM, there was a nurse who took on the leadership role and vice versa. Involving busy clinicians proved to be a challenge. Some committed participants did not attend or had their participation interrupted due to staffing and/or clinical emergencies.

Team Observation during Simulation

Notes were taken throughout the simulations based on the teamwork objectives. Two of the teams, one for the ICU and another for the ED were models of collaboration. These teams actively participated in the simulation and engaged in constant communication and collaboration amongst all members, with the leaders consistently welcoming the input of other team members. Other simulations were quieter, but still worked effectively. Teams were given feedback from these observations during the debriefing sessions. Time was then given for the participants to discuss what they felt needed improvement and what went well. Most teams chose to discuss clarifications of TTM or suggestions that could be made to the guideline, but few reflected on their work as a team. Perhaps a more thorough and structured tool developed with literature as a base would have made the debriefing sessions more effective. More time would likely be needed in order for each individual to better understand how to collaborate once back in their clinical settings.

Strengths, Challenges, Limitations

The key strength of this study on TTM guideline adherence in a simulation amongst interprofessional teams is that it showed that TTM simulations can aid the healthcare organization. It provided hands-on experience so that clinicians know what it says and can implement it into practice. The study provided an opportunity for professionals from different disciplines who care for cardiac arrest patients in post resuscitation to work together, make mistakes and understand each other's roles within the guideline as a framework.

The challenges were: 1) validating what clinicians do with resuscitation/post resuscitations by observation proved difficult and would require intensive planning, leadership and technological involvement which was not feasible for this pilot project, 2) obtaining volunteers to participate in the simulation without compensation, 3) staffing demands that prevented clinicians from taking the time needed to participate.

The primary limitation of this pilot was the small sample size of just 20 clinicians which limits generalizability to other clinicians. Other limitations include the use of non-validated tools for both the pre and posttest survey instruments and the observation checklists. The largest limitation was finding participants in a very busy institution. It was a struggle for participants to commit one hour and to have a simulation with more time or multiple days would require buy-in from leadership and management beyond individual units.

Conclusions

This pilot study demonstrates that a simulation experience can have a significant impact on knowledge of an interprofessional team. It is anticipated that by implementing simulations regularly into training, interprofessional teams will better implement the TTM guideline while also learning to work together toward the successful resuscitation and neurologic functioning of a post-cardiac arrest patient.

References

Bridges, D. R., Davidson, R. A., Odegard, P. S., Maki, I. V., & Tomkowiak, J. (2011). Interprofessional collaboration: Three best practice models of interprofessional education. *Medical Education Online, 16*(6035) doi:dx.doi.org/10.3402%2Fmeo.v16i0.6035

Brooks, S. C., & Morrison, L. J. (2008). Implementation of therapeutic hypothermia guidelines for post-cardiac arrest syndrome at a glacial pace: Seeking guidance from the knowledge translation literature. *Resuscitation, 77,* 286.

Daniels K, Lipman S, Harney K, Arafeh J, & Druzin M. (2008). Use of simulation based team training for obstetric crises in resident education. *Simulation in Healthcare: The Journal of the Society for Medical Simulation, 3*(3), 154-160. doi:http://dx.doi.org/10.1097/SIH.0b013e31818187d9

Eisenberg, M. S., Bergner, L., & Hallstrom, A. (1984). Survivors of out-of-hospital cardiac arrest: Morbidity and long-term survival. *American Journal of Emergency Medicine, 2*(3), 189.

Freeth D, Ayida G, Berridge EJ, Mackintosh N, Norris B, Sadler C, & Strachan A. (2009). Multidisciplinary obstetric simulated emergency scenarios (MOSES): Promoting patient safety in obstetrics with teamwork-focused interprofessional simulations. *Journal of Continuing Education in the Health Professions, 29*(2), 98-104. doi:http://dx.doi.org/10.1002/chp.20018

Holzer, M., & Behringer, W. (2008). Therapeutic hypothermia after cardiac arrest and myocardial infarction. *Best Practice & Research Clinical Anaesthesiology*, *22*(4), 711-728. doi:http://dx.doi.org/10.1016/j.bpa.2008.02.001

Hunziker, S., Johansson, A. C., Tschan, F., Semmer, N. K., Rock, L., Howell, M. D., & Marsch, S. (2011). Teamwork and leadership in cardiopulmonary resuscitation. *Journal of the American College of Cardiology, 57*(24), 2381-2388. doi:10.1016/j.jacc2011.03.017

Kim, F., Nichol, G., Maynard, C., Hallstrom, A., Kudenchuk, P. J., Rea, T., . . . Cobb, L. A. (2014). Effect of prehospital induction of mild hypothermia on survival and neurological status among adults with cardiac arrest: A randomized clinical trial. *JAMA*, *311*(1), 45-52. doi:http://dx.doi.org/10.1001/jama.2013.282173

Kvarnstrom, S. (2008). Difficulties in collaboration: A critical incident study of interprofessional healthcare teamwork. *Journal of Interprofessional Care*, *22*(2), 191-203. doi:http://dx.doi.org/10.1080/13561820701760600

Neumar, R. W., Nolan, J. P., Adrie, C., Aibiki, M., Berg, R. A., Bottiger, B. W., . . . Vanden Hoek, T. L. (2008). Post cardiac arrest syndrome: Epidemiology, pathophysiology, treatment and prognostication: American heart association, international liaison committee on resuscitation consensus statement. *Circulation, 118*, 2452.

Nicksa GA, Anderson C, Fidler R, & Stewart L. (2015). Innovative approach using interprofessional simulation to educate surgical residents in technical and nontechnical skills in high-risk clinical scenarios. *JAMA Surgery, 150*(3), 201-207. doi:http://dx.doi.org/10.1001/jamasurg.2014.2235

Owen JA, Brashers VL, Littlewood KE, Wright E, Childress RM, & Thomas S. (2014). Designing and evaluating an effective theory-based continuing interprofessional education program to improve sepsis care by enhancing healthcare team collaboration. *Journal of Interprofessional Care, 28*(3), 212-217. doi:http://dx.doi.org/10.3109/13561820.2014.890581

Polderman, K. H. (2008). Induced hypothermia and fever control for prevention and treatment of neurological injuries. *Lancet, 371*, 1955.

Roberts NK, Williams RG, Schwind CJ, Sutyak JA, McDowell C, Griffen D, . . . Wetter N. (2014). The impact of brief team communication, leadership and team behavior training on ad hoc team performance in trauma care settings. *American Journal of Surgery, 207*(2), 170-178. doi:http://dx.doi.org/10.1016/j.amjsurg.2013.06.016

Skvoretz, J. (1981). Extending expectation states theory: Comparative status models of participation in N person groups. *Social Forces, 59*(3), 752-770. Retrieved from http://search.proquest.com/docview/60073760?accountid=14678

Sudden Cardiac Arrest Association. (2015). SCA fact sheet. Retrieved from http://www.suddencardiacarrest.org/aws/SCAA/pt/sp/edmaterials

Sudden Cardiac Arrest Foundation. (2015). About sudden cardiac arrest. Retrieved from http://www.sca-aware.org/about-sca

Topley, D. K. (2015). A team approach: Active engagement through open chest simulations [Abstract]. *NACNS Cardio-Thoracic Symposium,*

University of Virginia Health System. (2015). *Practice guideline for targeted temperature managment*

Figures and Tables

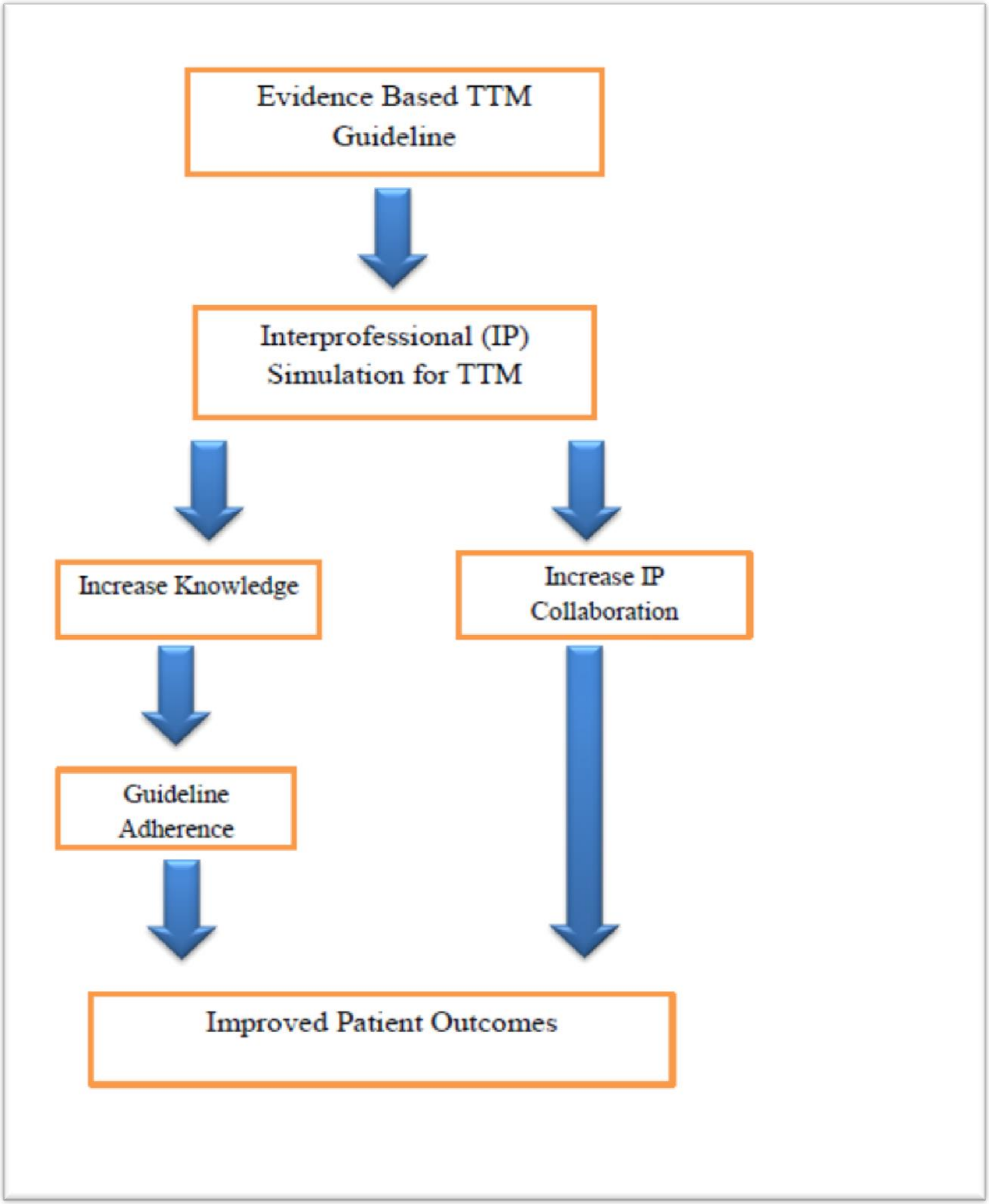

Figure 1: Project Goal and Objectives Using Simulation

Table 1

*Demographics of the Participants**

Characteristic	Number	Percent
Sex		
Female	14	70%
Male	6	30%
Average Age	35 years	
Clinical Experience		
Mean	<3 years	
<3 years	12	60%
4 to 10 Years	2	10%
10 to 15 years	1	5%
>15 years	5	25%
Primary Clinical Area		
ICU	14	70%
ED	6	30%
Role		
MD	7	35%
Nurse	13	65%

*n=20

Table 1: Demographics of participants in simulations

Table 2

Competence in Initiating and Maintaining TTM

	Pretest			Posttest			
Number of Participants	Vaguely Competent	Somewhat Competent	Very Competent	Vaguely Competent	Somewhat Competent	Very Competent	p-value
20	2 (10%)	13 (65%)	5 (25%)	0	11 (55%)	9 (45%)	.030

Table 2: Participants' feelings of competence in initiating and maintaining TTM

Table 3

Targeted Temperature

Number of	Pretest	Posttest	p-value

Participants	Incorrect	Correct	Incorrect	Correct	
20	5 (25%)	15 (75%)	2 (10%)	18 (90%)	.186

Table 3: Participants' knowledge of targeted temperature for therapy

Table 4

Rewarming Rate for TTM

Number of Participants	Pretest		Posttest		p-value
	Incorrect	Correct	Incorrect	Correct	
20	20 (100%)	0	6 (30%)	14 (70%)	.000

Table 4: Participants' knowledge of the rewarming rate for TTM

Table 5

*Knowledge Score**

	Pretest	Posttest	p-value
Mean	11.8	15.048	
Sample t-test			.000

*Number of participants = 20

Table 5: Sum of knowledge items on pretest comparted to posttest

Table 6

Correlation of Experience Level with Knowledge Score

Years of Experience	Pearson Correlation
<3 years	.136
4-10 years	1.00
10-15 years	NA
>15 years	.721

Table 6: The correlation of specific experience level with the sum score of knowledge questions

Table 7

Working with IP Teams

Pretest				Posttest*				
Not	Somewhat	Very	p-	No	Slight	Some	Complete	p-

	Comfort-able	Comfort-able	Comfort-able	value	Change	Change	Change	Change	value
Total	1 (5%)	4 (20%)	15 (75%)		2 (10.5%)	4 (21%)	10 (52.6%)	3 (15.8%)	.003
MD	0	2 (28.6%)	5 (38.5%)		0	1 (14.3%)	4 (57.1%)	2 (28.6%)	.172
Nurse	1 (7.7%)	2 (15.4%)	10 (76.9%)		2 (16.7%)	3 (25%)	6 (50%)	1 (8.3%)	.009
MD-Nurse				.172					.172

*1 participant did not answer

Table 7: Participants’ Feelings about Working with IP Teams

Appendix C: UVA New Targeted Temperature Management Guideline

TITLE:
Therapeutic Hypothermia after Cardiac Arrest

PURPOSE:
Reducing brain temperature during the first 24 hours after resuscitation from cardiac arrest and closely managing temperature for 48 or more hours has a significant effect on survival and neurological recovery. The use of targeted temperature management (TTM) by inducing mild therapeutic hypothermia (TH) early after ischemic insult has been shown to decrease the severity of ischemic brain damage and improve neurological outcomes. The patients that qualify for TH have suffered from a cardiac arrest, have had a return of spontaneous circulation (ROSC), and are minimally responsive or unresponsive post arrest.

PATIENT POPULATION:
Define the patient population for whom the guideline or protocol is intended. Check appropriate box(s): Adult Acute Care **x** Adult Critical Care Pediatrics Ambulatory Care **x** Emergency Department

TABLE OF CONTENTS:
For guidelines that are lengthy or have multiple appendices, it is helpful to include a table of contents with hyperlinks to the appropriate place in the document. ▪ Definitions ▪ Patient Assessment /Documentation ▪ Treatment/Documentation ▪ Discharge/Follow-Up/Patient Education and Hand-Off of Care ▪ Outcome Measures ▪ Education Plan ▪ References

DEFINITIONS:
TH: Therapeutic hypothermia to maintain core body temperature between 32°-34° Celsius (inducing hypothermia) for designated period of time (outlined in protocol below). **TTM:** Therapeutic Temperature Management- collective term for several therapies, including TH **Post-Cardiac Arrest:** absence of pulses requiring chest compressions, regardless of presenting rhythm with subsequent ROSC. **ROSC:** Return of Spontaneous Circulation (ROSC)-return of pulses with non-lethal rhythm and maintaining a blood pressure. **RASS:** Richmond Agitation Sedation Scale-used to evaluate level of delirium and sedation level in ICU patients. Score of +4 is combative and ranges to -5 unarousable. **EMR:** Electronic Medical Record **BSAS:** Bedside Shivering Assessment Scale-used for hypothermic patients to assess shivering level (Appendix C).

CPC Scale: Cerebral Performance Category Scale-a scale in neurological medicine that grades a patient's response to CPR on a scale of 1-5, 1 being a return to normal cerebral function and 5 is brain death.

PATIENT ASSESSMENT/DOCUMENTATION:

Inclusion Criteria:

1. ROSC from cardiac arrest with therapy initiated within 6 hours
2. No purposeful movements after return of ROSC
3. Age >18 years (older teens with a pediatric consult approval)
4. Mechanically ventilated
5. Blood pressure can be maintained at ≥90 mm Hg systolic spontaneously or with fluid and/or a maximum of two vasoactive agents upon initiation of cooling therapy

Exclusion Criteria:

1. Alternative clinical conditions causing the patient to be comatose (i.e.; drugs, sepsis, head trauma, stroke, overt status epilepticus)
2. Major trauma or <72 hours after major surgery
3. Pregnancy in third trimester
4. Temperature of <30° C following arrest
5. Unstable blood pressure (MAP<60mm Hg for >30 minutes on vasopressor therapy) or ventricular rhythm unresponsive to therapy
6. Known or preexisting coagulopathy (PTT >1.5 times ULN) or active bleeding
7. Cryoglobulinemia

Order Set: See Generic Hypothermia Focused Order Set (Appendix A)

TREATMENT/DOCUMENTATION:

Preparation:

1. Ensure appropriate orders are in EMR for use of the Epic hypothermia order set

2. Obtain baseline labs (see Epic order set): BMP, Mg, Phos, CBC, PT/PTT, lactate

3. Determine availability of intravascular temperature management system (console and appropriate catheter; located in NNICU, CCU, MICU)
   -determine presence of IVC filter-if no, MD to insert intravascular cooling catheter via femoral approach
   -if IVC filter present, consider use of a shorter intravascular cooling catheter via internal jugular or subclavian approach. Adjunctive cooling methods will be necessary during initiation of cooling

4. If an intravascular temperature management system is not available, obtain equipment for surface cooling (one console and two hose sets should be ordered from the Equipment Room)

5. Document post resuscitation neurologic exam by MD in the medical record prior to patient cooling. A neurology consult should be considered, but should not delay the initiation of cooling

Procedure: (refer to Appendix B-UVAHS Therapeutic Hypothermia Clinical Timeline)

Phase I-Cooling:

A. Initiate Cooling
   1. Initiate cooling as early as possible after ROSC
   2. Core temperature goal of 32°-34° C. The goal temperature should be reached as rapidly as possible (less than 4 hours).
   3.

Internal Cooling Catheter (Preferred)	**External Surface Cooling System**
▪ Initiate cooling process using 2 liters of 4◦ C NS administered rapidly (pressure bag) through either a femoral catheter or peripheral venous catheter. Not indicated if the patient has documented pulmonary edema. ▪ If an intravascular temperature management system is available, follow steps in Temperature Control Using an Intravascular Cooling System (PNSO Critical Care Procedure Manual, procedure 95A).	▪ Pack patient in ice (groin, chest, axillae, sides/beneath neck). ▪ Follow Procedure for Induced Hypothermia after Cardiac Arrest Using Surface Cooling (PNSO Critical Care Procedure Manual, procedure 95B).

   4. Warm humidification on the ventilator during the cooling period is not recommended
   5. Patients should **NOT** have an interruption of sedation ("sedation holiday") for TTM duration
   6. Cooling should continue for 24 hours from the **initiation of therapy**. This is a guideline, and can therefore be adjusted depending on patient circumstances. "Resetting the clock" requires a team decision and attending approval.

B. Medication: Sedation and Anesthesia (refer to Appendix C)
   1. Initiate sedation with fentanyl and midazolam as follows per MD order:
      a. Fentanyl: 50 mcg IV bolus followed by a maintenance infusion of 25-100 mcg/hr
      b. Midazolam: 2 mg IV bolus followed by a maintenance infusion of 2 to 8 mg/hr

C. Shivering Management : (refer to Appendix C)

Phase II-Rewarming/Maintenance: (Appendix B- UVAHS Therapeutic Hypothermia Clinical Timeline)

A. Begin rewarming once 24 total hours of cooling has occurred
   1. Use a slow rewarming approach of **0.25◦ C/hour**
   2. Maintain patient at 36.5◦ C with the intravascular temperature management system for at least the next 24 hours
   3. Discontinue active temperature maintenance (place intravascular temperature management system in "standby") but **avoid** removing cooling catheter as it might be needed again.

B. Continue monitoring temperature until removal of the intravascular cooling catheter. The ICY and Quattro catheters have an FDA-approved 4 day dwell time.

C. Medication management: (Appendix C-Shivering Management)
   1. Discontinue neuromuscular blocking agents (if used)
   2. Pharmacologic intervention may be necessary for shivering during the rewarming phase of therapy to prevent rapid rewarming and its sequelae (see Appendix C).
   3. Titrate analgesics and sedatives for patient comfort until patient is rewarmed to 36.5◦ C

Monitoring/Documentation:

- Continuous temperature monitoring from two sources is required. Both temperature shall be displayed on the bedside monitor (via the hospital monitor interface accessory) for any patient receiving therapy with an intravascular temperature management system
- Neurology consultation and EEG monitoring should be considered for cases of neuromuscular blockade.
- Labs should be obtained q4 h during active cooling and rewarming (see Epic Order Set) :
  BMP, Magnesium, Phosphorous, Lactic Acid (x4)

Therapy Considerations:

- Therapeutic hypothermia needs to be treated as an urgent priority
- The benefits of any off-unit procedure or tests should be carefully weighed against the interruption of cooling
- Electrolyte and acid-base management:
  *the management of electrolyte and acid base disturbances is essential
  *serum potassium levels are monitored closely as the serum level will decrease during the cooling phase of management and increase during the rewarming period
  *a mild increase in lactic acid should also be expected
- Glucose management: hypothermia can lead to increased insulin resistance, leading to elevated glucose levels. Follow ICU glucose management protocols.
- Dysrhythmias possible:
  -PR, QRS and QT interval prolongation
  -Tachycardia (expected upon initiation)
  -Bradycardia (expected as cooling progresses)
  -Atrial fibrillation
  -Very low risk of VT/VF with mild hypothermia (avoid overcooling)

DISCHARGE/FOLLOW-UP/PATIENT EDUCATION AND HAND-OFF OF CARE:
▪ Patients will be transferred out of the ICU or discharged home dictated by symptom progression and overall health status as appropriate by clinical team ▪ Key information must be recorded in Epic on the TTM Flow sheet ▪ Family education is located in the UVA Repository PE 01094

OUTCOME MEASURES:
The goal of TTM is to discharge patients with a CPC score of 1 or 2.

EDUCATION PLAN:
*Nursing Education: TTM trainers for institution with a mandatory class new staff must attend. TTM nurse champions will be chosen and trained for each ICU. Those champions will then regularly be the unit experts and provide updates to staff as new information is made available. *Fellows-Cardiology/Pulmonary-Critical Care/Surgical/Neurosciences Education: TTM coordinator and/or TTM trainer to offer annual classes incorporating current evidence for hypothermia, clinical practice guideline and order set in order to appropriately use them in patient population. *Resident Education: Podcast available; in services done upon request.

REFERENCES:

Kimberger, O., & Kurz, A. (2008). Thermoregulatory management for mild therapeutic hypothermia. *Best Practice & Research Clinical Anaesthesiology, 22*(4), 729-744. doi:http://dx.doi.org/10.1016/j.bpa.2007.11.002

Olson, D., Grissom, J. L., & Dombrowski, K. (2011). The evidence base for nursing care and monitoring of patients during therapeutic temperature management. *Therapeutic Hypothermia & Temperature Management, 1*(4), 209-217. doi:http://dx.doi.org/10.1089/ther.2011.0014

Polderman, K. H., & Herold, I. (2009). Therapeutic hypothermia and controlled normothermia in the intensive care unit: Practical considerations, side effects, and cooling methods. *Critical Care Medicine, 37*(3), 1101-1120. doi:http://dx.doi.org/10.1097/CCM.0b013e3181962ad5

Presciutti, M., Bader, M. K., & Hepburn, M. (2012). Shivering management during therapeutic temperature modulation: Nurses' perspective. *Critical Care Nurse, 32*(1), 33-42. doi:http://dx.doi.org/10.4037/ccn2012189

Seder, D. B., & Van der Kloot, T. E. (2009). Methods of cooling: Practical aspects of therapeutic temperature management. *Critical Care Medicine, 37*(7 Suppl), S211-22. doi:http://dx.doi.org/10.1097/CCM.0b013e3181aa5bad

Medical dictionary. (2014). Retrieved from http://medical-dictionary.thefreedictionary.com

The ohio state university, wexner medical center, induced hypothermia protocol. (2014). Unpublished manuscript.

University of pennsylvania post cardiac arrest Care/Therapeutic temperature management order set, nursing orders and clinical practice guideline. (2013). Unpublished manuscript.

Holzer, M., & Behringer, W. (2008). Therapeutic hypothermia after cardiac arrest and myocardial infarction. *Best Practice & Research Clinical Anaesthesiology, 22*(4), 711-728.

Nielsen, N., Wetterslev, J., al-Subaie, N., Andersson, B., Bro-Jeppesen, J., Bishop, G., . . . Friberg, H. (2012). Target temperature management after out-of-hospital cardiac arrest--a randomized, parallel-group, assessor-blinded clinical trial--rationale and design. *American Heart Journal, 163*(4), 541-548. doi:http://dx.doi.org/10.1016/j.ahj.2012.01.013

Oddo, M., Schaller, M., Feihl, F., Ribordy, V., & Liaudet, L. (2008). From evidence to clinical practice: effective implementation of therapeutic hypothermia to improve patient outcome after cardiac arrest. *Critical Care Medicine, 34*(7), 1865.

Polderman, K. H. (2008). Induced hypothermia and fever control for prevention and treatment of neurological injuries. *Lancet, 371*, 1955-1969.

Nielsen, N., Wetterslev, J., al-Subaie, N., Andersson, B., Bro-Jeppesen, J., Bishop, G., . . . Friberg, H. (2012). Targeted Temperature Management at 33° C vs 36° C after Cardiac Arrest. *The New England Journal of Medicine*. 369:23.

Boehm, J. (2007). A Chilling Review of Hypothermia. *Code Communications Newsletter, 2:4.* www.zoll.com.

DISCLAIMER:

Guidelines or protocols are general and cannot take into account all of the circumstances of a particular patient. Judgment regarding the propriety of using an specific procedure or guideline with a particular patient remains with the patient's physician, nurse, or other health care professional, taking into account the individual circumstances presented by the patient.

REVISION HISTORY

Date	Version	Description	Owner(s) Name, Credentials, Title	Committee Approval*	Date of Approval

Adults- Patient Care Committee approval is required if the guideline will be used in multiple areas or if the local area does not have a practice committee to approve the guideline. If approval is required through other committees (such as patient safety, infection control, etc), please list those committees and dates of approval as well.

Pediatrics- Children's Hospital Clinical Practice approval is required if the guideline will be used in multiple areas or if the local area does not have a practice committee to approve the guideline. If approval is required through other committees (such as patient safety, infection control, etc), please list those committees and dates of approval as well.

APPENDIX B: Clinical Timeline

Cooling started (by any method)	**Cooling Phase*** Shivering managed Electrolytes monitored q 4hr Lactate monitored q4hr x4 Sedation maintained (no holiday)	**Controlled rewarming phase** Electrolytes monitored q 4hr Sedation maintained (no holiday)	Patient reaches 36.5 **	ThermolGard remains **on** to actively maintain normothermia Stop paralytic; begin sedation wean	ThermoGard placed in '**Standby**' to monitor patient temperature

24 hours from start of cooling*	Approx. 14 hours	**24** hours	12 hours +
0:00	24:00:00	38:00:00	62:00:00

* Cooling phase 'clock' starts with initial attempts to cool (prehospital, ED, ICU) by any method (iced NS infusion, ice bags, etc.), NOT from time the ICY catheter is inserted or goal temperature is reached

** Once patient is rewarmed to 36.5, **DO NOT** change anything with ThermoGard console settings for **24** hours. The patient is actively maintained for **24** hours at this temperature.

APPENDIX C: SHIVERING MANAGEMENT

TABLE 1: Bedside Shivering Assessment Scale (BSAS)

SCORE	***TYPE OF SHIVERING***	***LOCATION***
0	None	No shivering is detected on palpation of the masseter, neck, or chest muscles
1	Mild	Shivering localized to the neck and thorax only
2	Moderate	Shivering involves gross movement of the upper extremities (in addition to neck and thorax)
3	Severe	Shivering involves gross movements of the trunk and upper and lower extremities

Presciutti, M., *et al* (2012). Shivering Management During Therapeutic Temperature Modulation: Nurses' Perspective. *Critical Care Nurse*.32:1.

Appendix D: Cerbral Performance Categories Scale

Cerebral Performance Categories Scale

CPC Scale

Note: If patient is anesthetized, paralyzed, or intubated, use "as is" clinical condition to calculate scores.
CPC 1. Good cerebral performance: conscious, alert, able to work, might have mild neurologic or psychologic deficit.
CPC 2. Moderate cerebral disability: conscious, sufficient cerebral function for independent activities of daily life. Able to work in sheltered environment.
CPC 3. Severe cerebral disability: conscious, dependent on others for daily support because of impaired brain function. Ranges from ambulatory state to severe dementia or paralysis.
CPC 4. Coma or vegetative state: any degree of coma without the presence of all brain death criteria. Unawareness, even if appears awake (vegetative state) without interaction with environment; may have spontaneous eye opening and sleep/awake cycles. Cerebral unresponsiveness.
CPC 5. Brain death: apnea, areflexia, EEG silence, etc.

Safar P. Resuscitation after Brain Ischemia, in Grenvik A and Safar P Eds: Brain Failure and Resuscitation, Churchill Livingstone, New York, 1981; 155-184.

Appendix E: Shivering Prophylaxis / Pharmacological Management of Shivering