A Feasibility Study for Implementing an Induced Hypothermia Protocol for Patients with Return of Spontaneous Circulation after Cardiac Arrest

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Abstract

The problem was that Delray Beach Fire-Rescue (DBFR) did not have an Emergency Medical Services Protocol for induced hypothermia (IH) for patients successfully resuscitated after cardiac arrest events. The purpose of the research was to identify other agencies that are currently using a similar protocol and to investigate what equipment, medications, and training would be required to institute this protocol into existing EMS protocols. A descriptive research methodology was utilized to answer the following research questions: Is there a need for a feasibility study for an induced hypothermia protocol? How would an induced hypothermia protocol be implemented? Is the implementation of an induced hypothermia protocol financially possible? Do local Emergency Departments have protocols in place for the continuity of care in the critical care setting? The literature review and interviews identified the trends of induced hypothermia in the prehospital setting, and the efficacy for improved neurological outcomes for cardiac arrest patients. Recommendations were made to include an IH protocol for DBFR. Further recommendations were made to ensure the continuity of the protocol in hospital-based medicine at local facilities.
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Introduction

Cardiac arrest is defined as the cessation of cardiac mechanical activity, as confirmed by the absence of signs of circulation. Each year, approximately two thirds of cardiac arrest patients are treated by EMS across the United States. (Jacobs, Nadkarni, 2004) Changes in prehospital equipment, medication administration protocols, and education have resulted in greater survival rates for patients who experience cardiac arrest. Although survival rates have improved, research suggests that often these patients have resulting neurological impairment from the hypoxia and cerebral ischemia they experienced during the arrest. The American Heart Association (AHA) began formally recommending induced hypothermia (IH) in the 2005 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care as a means of improving the neurological outcome of cardiac arrest patients. Since 2003, Delray Beach Fire-Rescue (DBFR) has had over three hundred cardiac arrest service calls, averaging fifty nine annually. (Documed Software)

The problem is that DBFR does not have an EMS protocol for induced hypothermia for patients successfully resuscitated after cardiac arrest events. The purpose of this applied research project is to investigate the feasibility of implementing an induced hypothermia protocol.

The author of this applied research paper will utilize the descriptive research method and the following four questions to guide the researcher’s efforts: Is there a need for a feasibility study for an induced hypothermia protocol? How would an induced hypothermia protocol be implemented? Is the implementation of an induced hypothermia
protocol financially possible? Do local Emergency Departments have protocols in place for continuity of care?

**Background and Significance**

The City of Delray Beach is located in Palm Beach County on the east coast of Florida. The population is approximately 65,000 and is demographically and economically diverse. The City is geographically made up of 17 square miles. During the winter months, the population swells to nearly 80,000 with part-time elderly residents who reside primarily in the western corridor of the City. The Delray Beach Fire-Rescue Department (DBFR) provides fire suppression, advanced and basic life support services including transportation, prevention, inspection, education, special operations, and other community-based services. Additionally, DBFR contractually provides its services to two neighboring municipalities: Highland Beach and the Town of Gulf Stream. DBFR has 151 personnel, of which 143 are certified firefighters. (DBFR annual report 2007) The Department has six stations and operates with a daily minimum staffing of 32 personnel.

In 2007, DBFR ran a total of 11,747 service calls, for which 83% or 9,688 were EMS-oriented. Of these, 3,000 were for cardiac-related emergencies, including sudden cardiac arrest. A total of 54 patients experienced cardiac arrest in 2007 in the service areas of Delray Beach. Over the course of the last ten years, significant improvements have occurred in prehospital medicine, particularly in prehospital cardiac medicine. The advent of the Auto Pulse, a machine that provides and coordinates CPR, has led to drastically improved return of spontaneous circulation (ROSC) statistics. At the same time, changes in Advanced Cardiac Life Support (ACLS) protocols have provided the
optimum opportunity for ROSC for cardiac arrest patients. Perhaps one of the most significant initiatives has been the public access to defibrillation (PAD) program, which has put early defibrillation of cardiac dysrhythmias into the hands of the laymen.

Although advancements in prehospital medicine are improving the odds of ROSC, the unfortunate truth of the matter is that the neurological recovery of these patients is typically impaired, sometimes to a great extent. During a cardiac arrest event, oxygen-rich blood is not circulating because the heart has lost the capacity to pump it. In essence, every cell in the body is in a state of hypoxia, or oxygen deprivation. Prolonged hypoxia can lead to ischemia, and certain organs and systems of the body are more sensitive to this oxygen deprivation than others. The brain, for example, starts to become ischemic after only four to six minutes from a lack of oxygen. Permanent cognitive and sensory loss can occur inside of six minutes. The focus of prehospital medicine has been on regaining circulation for these patients, and not necessarily on their long-term prognosis or recovery. One study suggested “that while 17-25% of cardiac arrest patients survived to hospital admission, only 4-9% left the hospital neurologically intact.” (Swinhart, 2005)

The concept for controlled IH actually began in the late 1950’s. Varying degrees of IH have been used for decades in surgical procedures, but a reemergence of the concept occurred in the 1980’s and a number of subsequent studies were done specifically to identify the benefit of mild hypothermia after cardiac arrest. (Safar, Kochanek, 2002) Interest in the prehospital application of IH peaked in the early 2000’s and by 2006, the Wake County EMS System (WCEMS) began the use of IH as part of their protocol for cardiac arrest patients. The program that WCEMS initiated was based largely upon the
recommenda
tions made in the 2005 AHA guidelines. Although not yet considered a
standard of care, IH in the prehospital setting has gained considerable momentum across
the country as more and more agencies move to adopt this protocol.

The problem that exists within Delray Beach Fire-Rescue is that there is currently
not a protocol for IH, the appropriate equipment has not been procured, and none of the
local Emergency Departments possess an inpatient protocol for the continuity of care that
is required for these patients. With proper IH protocol development and incorporation,
the residents and visitors of the City of Delray Beach who have the misfortune of
experiencing sudden cardiac arrest would benefit by having greatly enhanced
neurological recovery and outcome3s. DBFR already works closely with the Chest Pain
Centers within its service area to gather and analyze ROSC data. By adding an IH
component of care, DBFR would enhance its capability of analyzing the outcomes of
these specific patients.

The problem that DBFR is currently facing is related to the United States Fire
Academy’s (USFA) operational objectives in that it aims to assist in appropriately
responding in a timely manner to emergent issues. By incorporating an IH protocol,
cardiac arrest patients within the service area of DBFR would be afforded a statistically
better chance of neurological recovery post resuscitation. The number of cardiac arrests
faced by DBFR has been on a steady incline since 2002 (Table 1) and with 25.9% of the
population over the age of 65, the expectation would be for this trend to continue (U.S.
Census 2000)
All of the studies done to date support the fact that mild to moderate IH for ROSC patients supports improvement in neurological outcome, and it is invariably anticipated that this will become the standard of care within the next few years.

**Literature Review**

Is there a need for a feasibility study for an induced hypothermia protocol? Although the uses of varying degrees of IH were first discovered in the 1950’s and 1960’s, substantial research was not performed until the 1980’s. The American Heart Association (AHA) first recommended IH in its 2005 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. (Suffoletto, Menegazzi, Salcido, 2007)) The notion of incorporating IH into the realm of prehospital emergency medicine was not actually initiated until Wake County Emergency Medical Services (WCEMS) began their program in 2006.

Patients who experience sudden cardiac arrest are found in a situation in which their heart has essentially stopped beating. The heart is responsible for circulating oxygenated blood throughout the body, the cellular structure, and all of the organ systems, including the brain. Different body systems and organs suffer varying degrees of oxygen deprivation. Ischemia is defined by Merriam Webster’s Medical Dictionary as “deficient supply of blood to a body part (as the heart or brain) that is due to obstruction of the inflow of arterial blood (as by the narrowing of arteries by spasm or disease).” Necrosis, on the other hand, is defined as “death of living tissue; specifically: death of a portion of tissue differentially affected by local injury (as loss of blood supply, corrosion, burning, or the local lesion of a disease).” Ischemic changes generally precede necrotic changes, and depending upon the nature of the tissue, the damage may be irreversible.
The brain in particular is very susceptible to oxygen deprivation and can experience permanent damage in as little as 4-6 minutes. (Swinhart, 2005)

Patients who are fortunate enough to survive a cardiac arrest typically have neurological impairment to varying degrees. This can range from memory loss to physical disabilities such as impaired speech ad loss of motor skills. The science of IH and why it works continues to be investigated. By inducing a slower metabolic rate, it is believed that the oxygen demands are lessened. Furthermore, small blood clots can typically form in areas where ischemia or injury has occurred. Inducing hypothermia reduces the rate at which these clots form. (Polderman, 2008)

Studies have been conducted to ascertain better ways of improving neurological recovery for successfully resuscitated patients. Two noteworthy studies were resulted in 2002. The first study took place in Europe at nine centers in five different countries between 1996 and 2001. The study showed that 55% of patients in the trial who received IH had a favorable neurologic outcome at six months compared with 39% of the patients who did not receive this therapy. (Holzer, 2002) The second study is known as the Australian study and involved a total of 77 patients who remained in a coma state after ROSC. Of these 77 patients, 49% who were treated with IH were either discharged home or to a rehabilitation facility. (Safar, 2002) To date, these two studies are the most comprehensive done to determine what role IH can or should have in post resuscitative care.

As a result of the above studies, the Advanced Life Support Task Force of the International Liaison Committee on Resuscitation (ILCOR) formally made recommendations regarding IH in 2002. Citing that mild hypothermia may also be
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beneficial for in-hospital cardiac arrest, the recommendation was made that “unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32-34 degrees Celsius for 12-24 hours when the initial rhythm was ventricular fibrillation.” (Bernard 2004) This marked the first time that IH was formally recommended for ROSC patients. It was not until 2005 that the AHA changed its guidelines.

Despite the AHA and ILCOR recommendations, the use of IH in the prehospital setting remains rare. In an abstract done by the AHA in 2007, only 6.2% of Medical Directors queried stated that the EMS agencies they were affiliated with had IH. Of those that did have an IH protocol, the average age of the protocol was 12 months. Per the abstract, common perceived barriers of the protocol included: providers being overburdened with other tasks (62.1%), short transport times (60.7%), lack of refrigeration equipment (60.0%), and receiving hospitals’ failure to continue therapeutic hypothermia (56.6%). (Suffoletto, 2007)

Dr. Kees Polderman of the University Medical Center Utrecht in the Netherlands opines that IH is a major breakthrough in medicine. He asserts that the protocol “remains widely underused in many countries, especially the USA and, to a lesser extent, the UK and Germany. Therefore, applying the existing evidence and working on implementation strategies should be priority.” (Polderman, 2008)

Dr. Randall Wolff is the Medical Director for DBFR and is an Emergency Department physician, as well. He is responsible for establishing the EMS protocols that DBFR follows and for the direction the department uses in its approach to prehospital medicine. When asked his views about IH and the possibility of including them into the
protocols he said, “Induced Hypothermia is likely to become the standard of care within the next few years. There is no doubt that IH will give patients a better chance of full neurological recovery than the treatments we currently provide. Unlike many of the protocols we use, this one will have to be a joint effort between the hospitals and the EMS providers from a continuation of care perspective.” (Dr. R. Wolff, personal communications, July 10, 2008)

Dr. Bryan Bledsoe is an ED physician, speaker, author, and recent addition to the faculty at the University of Nevada at Las Vegas. Dr. Bledsoe believes in the science behind IH and feels that EMS should begin using this protocol sooner rather than later. He views this as a relatively inexpensive and progressive treatment option for ROSC patients and that the future applicability for use with trauma and stroke patients is worth the investment. He is confident the AHA will adopt IH as a standard of care in the 2010 guidelines. (Dr. B. Bledsoe, personal communications, July 28, 2008)

DBFR transports 98% of its patients to one of two facilities: Delray Medical Center (DMC) or Bethesda Memorial Hospital (BMH). Personal interviews were conducted with the Directors of the Emergency Department at each of these facilities to gauge their familiarity with IH and to determine their plans for introducing it into their treatment modalities. Dr. Santosh Mathen of DMC stated that although his facility did not currently have an IH protocol, he was very familiar with the concept but could not give a timetable for its inclusion. (Dr. S. Mathen, personal communications, June 9, 2008) Dr. Angel Feliciano of BMH similarly responded that he was familiar with IH but that BMH had no immediate plans to submit the protocol to the medical committee. (Dr. A Feliciano, personal communications, June 12, 2008) In the summer of 2008, the two
major counties to the south of Palm Beach began incorporating IH into both prehospital and in-hospital treatment modalities.

How would an induced hypothermia protocol be implemented? DBFR is currently faced with the predicament that although the data suggests IH is a beneficial protocol to initiate in the field, neither a prehospital nor in-hospital based protocol exists within its immediate geographical area.

An article titled “Induced Cooling by EMS (ICE): Year One in Raleigh/Wake County” details the collaborative effort between hospitals and EMS providers that is necessary to institute the protocol. As proactive as an EMS provider may be, IH cannot be initiated in the field without continuation of care in the hospital because more harmful side effects may be inflicted on the patient. The authors emphasize the importance of a collaborative effort between EMS and their local Emergency Departments, stating that, “The patient’s best opportunity for benefit is realized with a well-coordinated program with seamless transition from the hospital environment through the ED, potentially through the cardiac catheterization lab, and finally to the ICU.” (Myers, Lewis, 2008)

An effort to incorporate an IH protocol into DBFR’s existing protocols would have to occur on four levels: creation of an EMS protocol by the Medical Director, creation of a hospital-based protocol by the local hospitals, procurement of the necessary equipment, and finally, extensive training for DBFR personnel on not only the protocol, but the science behind it.

The practice of induced hypothermia in the prehospital setting is gaining momentum, including areas of South Florida, as mentioned above. The Wake County EMS System, by all accounts, was the first to initiate the prehospital protocol. Articles
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on their program are readily available that detail the creation of their protocol, and take
periodic looks at the progression of it, including statistical analysis. Dr. Brent Myers, the
WCEMS Medical Director, has written and spoken extensively about their program. A
copy of their EMS protocol is available and is used as a starting point for many
departments. (Appendix C)

Is the implementation of an induced hypothermia protocol financially possible?
The prehospital protocol for IH calls for the initiation of cooling of the ROSC patient.
Primarily, this is done by placing cold packs in the groin and axilla of the patient and
administering cold saline boluses in two different intravenous sites. Additionally,
medication is given to reduce patient shivering and to keep the patient sedated.

The main financial obstacle faced by DBFR is procuring refrigerator/freezers for
each unit to store the saline solutions. These solutions must be maintained at near-
freezing temperatures and must be maintained consistently. An additional consideration
was the space availability of the department’s Rescue vehicles, as any unit purchased
would have to be retrofitted. A variety of units were researched and it was found that a
marine-based refrigerator/freezer would best fit the needs for DBFR. At a cost of $650
each, the Isotherm unit can readily freeze to 32 degrees Celsius, has 1.3 cubic square feet
and has a 12/24 volt set up that can be wired to the shore line of the units. Maintaining
power to the unit is of the utmost importance, thus the need to have continuous power
must be taken into consideration. The department has six front line rescue units, with
two in reserve, thus bringing the total cost to $5200.00.

Ice packs are already kept in inventory, so no additional cost would be incurred.
Finally, a variety of medications are used with this protocol, notably Versed and
Vecuronium for patient paralysis. Dopamine is also used to maintain the blood pressure of the ROSC patient. Again, the department already has both Versed and Dopamine in stock, so no additional funding would be required. Vecuronium, on the other hand, would have to be purchased, and this could be done through the department’s current vendor at a cost of $9.10 per vial.

Training and continuing education are vital to the implementation of this protocol. The department has an EMS Training Lieutenant who would be responsible for a portion of the training. Additional training would be secured at a cost of $500.00 daily for each shift. To train all three shifts, with two make up days, would cost $2500.00.

Do local Emergency Departments have protocols in place for continuity of care? As previously discussed, none of the Emergency Departments in the catchment area for DBFR currently has an IH protocol or capabilities. The use of IH protocol is initiated by the providers in the field, but must be carefully and systematically carried out in the hospital setting for the best result and patient safety.

EMS involvement in initiating IH is crucial. However, perhaps more crucial is the totality of a hospital’s involvement. Patients who experience cardiac arrest and have successful resuscitation are transported to ED’s. Once stabilized, the patient is moved to either a catheterization lab, an operating room, or an intensive care unit (ICU). Thus, the need for a hospital-wide protocol is seen. An inter-disciplinary effort is paramount and can involve ED physicians, ED nurses, neurologists, cardiologists, intensive care physicians, cardiac surgeons, and ICU nurses and staff. In addition, ancillary staff such as radiology and the pharmacy must be keen to the intricacies of the protocol.
Barriers to having this protocol in the facility, as discussed with Dr. Mathen of DMC, include protocol development, equipment procurement, training, and “buy-in” by disciplines such as cardiology and neurology. Whereas EMS is responsible solely for initiating the protocol, the hospitals will have to coordinate their efforts over a 24 hour period, which is the maximum duration of the protocol. Dr. Feliciano of BMH echoed the sentiments of Dr. Mathen. His interest in instituting an IH protocol for his facility is high, but as of the time of the interview, no steps had been taken to implement it. (Personal communications Dr. Angel Feliciano Bethesda Memorial Hospital, June 12, 2008)

The potential side effects of therapeutic hypothermia are much more substantial for hospital-based medicine than they are for EMS. Possible side effects include: higher rate of infection, increase in blood glucose, increased potassium levels, lower cardiac indexes, pneumatic complications, abnormal clotting factors, as well as shivering and possible pulmonary edema. (Swinhart, 2005) The potentiation of these side effects is exacerbated by the underlying health history of the patient and the cardiac insult that their bodies would have just incurred.

From a technical perspective, IH is still in its relative infancy in the hospital setting. As the protocol evolves and more studies are published, so will the technology and applicability of the protocol. For example, many hospitals differ in their approach to cooling the patient. EMS relies solely on the infusion of cooled IV fluids and ice packs, but hospitals must maintain and monitor the patient’s hypothermic temperature in a more controlled manner. The method of cooling the IH patient is left to the hospital’s discretion and protocol. Surface blanket cooling is one method. Another is the
CoolGuard system which cools by placing an Icy catheter into the femoral vein. The efficacy and affordability of external versus internal cooling are greatly debated. Endovascular cooling is believed to be more precise than external cooling. (Baud, 2007) Whatever method a hospital employs, it must be maintained consistently for the first 24 hours of the patient’s care.

WCEMS reports that prior to implementing their IH protocol, six months of meetings took place between their agency and local ED staff, ICU personnel, cardiologists, neurologists, and nurses to ensure that the continuum of care was in place. (Frank, March 2007) A collaborative effort would seem to be the most prudent when introducing a protocol that would affect both entities in such a manner.

Procedures

This researcher will utilize descriptive research on several different sources to develop the research base in order to provide answers to the research questions. The researcher began the search for source material on induced hypothermia for successfully resuscitated cardiac arrest victims at the National Fire Academy Learning Resource Center. A number of articles were found that gave a baseline of information on this subject as it pertains to EMS providers. The internet research yielded significant information on this subject, both for EMS and for hospital-based medicine. The department’s annual report and EMS software were both utilized, as well, for statistical purposes.

The researcher also conducted numerous personal interviews with local physicians throughout the research process. Dr. Santosh Mathen is the Director of the Emergency Department at Delray Medical Center in Delray Beach, Florida. Dr. Angel
Feliciano is the Director of the Emergency Department at Bethesda Memorial Hospital in Boynton Beach, Florida. Dr. Randall Wolff is the Medical Director for Delray Beach Fire-Rescue. Finally, Dr. Bryan Bledsoe is an ED physician, author, speaker, and faculty member at UNLV. All four physicians were willing participants in being questioned regarding their perspective and familiarity with IH. All communications with these physicians took place between June 10-20, 2008. The following questions were asked of the ED physicians:

Does your facility currently have a protocol for induced hypothermia?

Does your facility currently have the necessary equipment for instituting an induced hypothermia protocol?

Has the concept of induced hypothermia been discussed formally in meetings involving other disciplines? (Cardiology, neurology)

Do you have any imminent plans for developing a protocol?

In addition to being the Medical Director for DBFR, Dr. Wolff is the Medical Director for five other Fire Departments in Palm Beach County. The following questions were asked of Dr. Wolff:

Do you have plans for incorporating induced hypothermia into the EMS protocols?

What additional training would you predict the Paramedics and supervisors would need to be proficient with this protocol?

Would you want refrigerator/freezers on all of the response units, or only on the supervisor’s vehicle?

In order to gain further data to answer the researcher’s questions, a survey was prepared. The survey was developed utilizing the research questions as a guide, and was
aimed at gauging the familiarity with induced hypothermia by the various respondents. All questions were forced choice questions in a multiple choice format. The survey was distributed to all members of the Palm Beach County EMS Providers Association on April 21, 2008. It was delivered via email to the list of members kept by the Secretary/Treasurer of the Association. At the time of distribution, the list contained 46 persons with representatives from every city, county, and private provider of fire and rescue services in Palm Beach County. Of the 46 persons to whom the survey was sent, 28 responded (61%). The 28 that were returned represented all but two very small organizations located within the county. The returned surveys were representative of 16 of the 18 Fire-Rescue departments in Palm Beach County.

The following is a list of limitations and assumptions that may have had an affect on this applied research project: The comparatively small amount of research available explicit to induced hypothermia as it relates to prehospital medicine and time constraints placed on the researcher due to other collateral responsibilities.

Results

Research Question #1

Is there a need for a feasibility study for an induced hypothermia protocol? According to the research, there are currently no hospitals and no EMS providers currently capable of providing IH to successfully resuscitated cardiac arrest victims in Palm Beach County. Questions in the survey (Appendix A) specifically targeted the familiarity and availability of IH for all of the EMS providers in Palm Beach County. Question 3 asked: Does your agency currently have an EMS protocol for IH? Only one agency responded in the affirmative. This agency received a follow up phone call and
confirmed that since none of the hospitals in their catchment area could continue the IH protocol, they were unable to use it in the prehospital setting. Question 5 asked: Which, if any, Emergency Department in your area currently uses IH for treatment of ROSC cardiac arrest patients? Of the respondents queried, not one answered that any of the hospitals in their catchment area were currently using IH. The findings of the survey are consistent with the research in that there is a definitive need for a feasibility study for IH in prehospital medicine in Palm Beach County.

Research Question #2

How would an induced hypothermia protocol be implemented? Research showed that IH has been in use across the United States in EMS since 2006 and is gaining momentum as a viable treatment option for cardiac arrest patients. Although the two counties to the immediate south of Palm Beach County have begun using IH, the survey confirmed that there are no hospitals or EMS providers in Palm Beach County currently capable of inducing hypothermia. Question 6 of the survey asked the respondents to rate their familiarity with IH principles on a scale from “not familiar” to “very familiar.” The results showed that 76% of the respondents rated themselves as only “fairly familiar” with the principles. Interviews held with the Directors of the local ED’s indicated that a) neither hospital has IH or immediate plans to implement it, b) a thorough research of the principles of IH had not been completed, and c) neither hospital had a protocol on hand to analyze or compare. The procurement of the necessary medications, equipment, and training would all have to be preceded by a thorough understanding of the principles and applicability of IH. An analysis of the WCEMS system indicated that upwards of six
months of collaborative meetings took place between their agency and the local hospitals prior to implementation.

Research Question #3

Is the implementation of an induced hypothermia protocol financially possible?

For DBFR, the total cost for the purchase of refrigerator/freezers, medication, and training would be less than $10,000.00. The department’s annual budget is in the vicinity of $20 million. Proper budgeting for the necessary equipment and training would need to be arranged. Survey question #7 asked the EMS providers to identify any barriers which would prohibit their agency from incorporating an IH protocol. Nine of the agencies (32.1%) that responded identified funding as one of their primary barriers. Admittedly, the hospitals would incur a significantly higher cost for introducing IH, with the main cost being equipment and training. Specifics on these dollar amounts are outside the scope of this research.

Research Question #4

Do local Emergency Departments have protocols in place for continuity of care?

As stated, 98% of the patients transported by DBFR go to one of two local hospitals: Delray Medical Center or Bethesda Memorial Hospital. Interviews took place with the respective Directors of these Emergency Departments. The interviews revealed that neither facility is currently capable of providing IH at this point and time. Further, there are no immediate plans for introducing one. Neither Director was opposed to the principles of IH; rather the simple fact was that they did not have it. Both physicians stated that their initial barrier had been that they did not have a hospital-based protocol to model theirs after. Additionally, both agreed that the process for introducing the protocol
would involve having the protocol approved by the in-house medical steering committee, the purchasing of new equipment, and hospital-wide interdisciplinary training.

Discussion

Induced hypothermia, as a medical treatment option, has been around for decades. It is only in the last seven years that the concept of its applicability for cardiac arrest patients who are successfully resuscitated has been thoroughly investigated and researched. In 2000, the AHA Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care noted that mild hypothermia “may be beneficial but should not be actively induced.” (Frank, 2007) The first of two major studies on IH was resulted in 2002, which showed positive neurological outcomes for cardiac arrest patients. By 2005, the AHA guidelines began recommending the induction of moderate hypothermia for adult patients.

The science of medicine is dynamic and constantly evolving. Constant medical trials, research, and studies have guided the principles of most disciplines throughout time. The evolution of a treatment modality from a concept to a recommendation to a standard of care can take years. Although not yet considered a standard of care per the AHA, the momentum of IH in prehospital medicine has been significant in the last two years.

These advancements in medicine have greatly increased the chances of survival for cardiac arrest patients. A combination of education and practice both in and out of the hospital has resulted in better and more aggressive care for patients. The AHA and the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) have instituted cardiac catheterization requirements for hospitals wherein patients who
necessitate catheterization must have the procedure done within ninety minutes of reaching the hospital. The onus is on hospitals and providers to initiate appropriate and timely care of their patients to maximize their chances for survival and recovery.

The quality of life of many survivors of cardiac arrest is a topic of much concern, debate, and research. Many of these survivors endure a life of twenty-four hour oxygen, multiple medications, physical and psychological disability, and the prospect of being homebound. In addition, the manifestation of the oxygen deprivation endured during the cardiac arrest can have lasting neurological effects, including speech, memory, and cognitive function impairment. While other medications, equipment, and skills target resuscitation, IH is specifically aimed at the neurological recovery of these patients. The Wake County EMS System (WCEMS) was one of the first EMS providers to institute a protocol for IH. In October 2006, WCEMS began their program, and by August 2007 they had initiated the protocol for 65 patients. (Myers, 2007) The results of their program are ongoing and long-term; definitive results will take some time before they can be seen and statistically gathered.

The evolution of treatment for cardiac arrest patients is one of the more highly researched elements of prehospital medicine. The AHA produces the Advanced Cardiac Life Support (ACLS) and Cardiopulmonary Resuscitation (CPR) guidelines that are followed by EMS providers and ED personnel. From analyzing CPR compression to ventilation ratios, to updated uses of various antidysrhythmics, the AHA is responsible for the science behind these changes. From CPR instruction for the laymen to the advancement of Automatic External Defibrillators (AED’s) in offices, malls, and airports, the AHA has paved the way through the evolution and promulgation of these guidelines.
After research and studies have been conducted, the AHA may decide to make a certain treatment a “standard of care.” This term holds some legal weight and is defined simply as, “A diagnostic and treatment process that a clinician should follow for a certain type of patient, illness, or clinical circumstance.” The transition from a recommendation to a standard of care can take years to implement. The next AHA guidelines are scheduled to be updated and redistributed in 2010.

With regards to IH, two major studies have been resulted, the European and Australian studies, both in 2002. Both studies showed that statistically patients who are successfully resuscitated from cardiac arrest have a better chance for full neurological recovery when induced hypothermia is used. For its part, the AHA has changed its language to reflect a change in viewpoint about IH. In 2001, the AHA guidelines suggested that IH “may” be used for cardiac arrest patients. By 2005, the guideline had been changed to state that IH is “recommended.” Although not a standard of care yet, the protocol is indeed in use in both the prehospital and hospital settings.

In addition to being used for ROSC patients, future uses of IH include strokes and certain trauma situations. On September 11, 2007, Kevin Everett of the NFL’s Buffalo Bills suffered a severe cervical spine injury. The early prognosis indicated a very small chance of full neurological recovery, and that paralysis was likely. Furthermore, his injury was described as potentially life-threatening because of the chance of infection, aspiration, and blood clots. IH was initiated on Mr. Everett while en route to the hospital. Surgery was performed and despite all predictions, Mr. Everett gained full neurological recovery and can ambulate without assistance. The use of IH in this instance is still in the research period and his care received enormous publicity.
Research is being done at the University of Miami to identify the specific role of IH for patients with spinal cord injuries, and the American Stroke Association has reports as early as 2004 exploring the uses of IH for stroke patients. (Krieger, Yenari, 2004) IH represents a cutting edge protocol whose usefulness can be found in cardiology, neurology, and surgery alike.

Recommendations

Based on a thorough review of information gathered in this study, the following recommendations are made. The department must make a more demonstrative effort to incorporate IH into its current EMS protocols. The unique nature of this protocol is that collaboration between EMS and the hospitals is imperative. Whereas EMS may decide to proceed with instituting the protocol in the field, they are in essence prohibited from initiating it if none of their local ED’s have the capability of sustaining and continuing it. Although we have been proactive in patient education, prevention initiatives, and public access to defibrillation (PAD) initiatives, we must continue to stay progressive with our EMS services. IH represents a cutting edge treatment protocol that, although not yet a standard of care, is growing in popularity.

The first step is to convince both the department’s Medical Director and the Directors of the local ED’s of the timeliness and proactive nature of the protocol. Interviews with the latter indicated a willingness to introduce the protocol, but both physicians had a general lack of knowledge as to the required equipment or precisely what the protocol entails. Neither physician had a copy of a current in-use protocol. The best approach would be to furnish them with a copy of both the prehospital and hospital-based protocols and then to develop a committee to synchronize the efforts of all
involved. The WCEMS protocol took upward of six months to develop and implement, and the same time frame would be anticipated. Both hospitals already offer continuing education opportunities for EMS on a monthly basis. By developing a team approach, the paramedics, nurses, physicians, and ancillary staff would all be on the “same page.” More importantly, the patients who partake in the protocol would have a substantially increased chance for a full neurological recovery.

Prior to the Medical Director implementing the protocol for DBFR, all of the necessary equipment, medication, and training would need to be purchased and placed in service. For an investment of less than $10,000, the department could retrofit all of the rescue vehicles, including the reserve units, with a refrigerator/freezer capable of cooling the saline units to the necessary temperature. The training of all DBFR personnel would be a joint effort between the in-house EMS Training Lieutenant and an outsourced EMS training company. Finally, purchasing Vecuronium for all units would need to be done and added to the future inventory and EMS budget.

DBFR already works closely with the ED’s in its catchment area to gather and analyze data on cardiac arrest patients. Elements such as response times, time to first defibrillation, and initial presenting cardiac rhythm are all detailed in an effort to improve the service provided, and also to ultimately improve patient outcomes. Further, departmental policy dictates that quality assurance (QA) is performed on 100% of EMS reports. The recommendation would be made to create specific files to track the outcomes of the patients that receive IH. At the same time, we would need to track why patients are contraindicated from receiving IH. Whereas it is difficult to predict how many patients would qualify for IH within the first year, the increasing number of
patients with ROSC after cardiac arrest has improved steadily over the years with the advent of the Auto Pulse, changes by the AHA, public access to defibrillator (PAD) programs, and aggressive prehospital treatment. This data would be analyzed and comparative analysis done periodically to ascertain ways of improving the protocol.

It is the opinion of the author that IH should be implemented into the EMS protocols of DBFR. The incorporation of this life-saving protocol would have a relatively low impact on the EMS budget and would greatly improve the quality of life for hundreds of people in years to come. The researcher would recommend to future readers of this paper that IH represents a proactive, cutting edge medical advancement and that its applicability for ROSC and other medical conditions is inevitable. EMS agencies are encouraged to develop a close working relationship with both their Medical Director, as well as the staff of their local ED’s, for protocol development and implementation.
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Appendix A

Induced Hypothermia Survey

1) How many cardiac arrest responses did your agency respond to in 2007?

2) In 2007, how many cardiac arrest patients had ROSC upon arrival at the Emergency Department?

3) Does your agency currently have an EMS protocol for induced hypothermia?
   a) Yes
   b) No

4) Does your agency have any plans for implementing a protocol for induced hypothermia?
   a) Yes
   b) No

5) Which, if any, Emergency Departments in your area currently use induced hypothermia for treatment of ROSC cardiac arrest patients?

6) On the following scale rate your familiarity with induced hypothermia principles:
   a) Not familiar
   b) Fairly familiar
   c) Very familiar

7) Identify any barriers which would prohibit your agency from incorporating an IH protocol:
   a) Financial barriers
   b) Lack of protocol
   c) Lack of equipment
d) Time constraints (other responsibilities, etc.)
Appendix B

Induced Hypothermia Survey Results

1) How many cardiac arrest responses did your agency respond to in 2007? Average of 112 annually

2) In 2007, how many cardiac arrest patients had ROSC upon arrival at the Emergency Department? Average of 74 per agency annually

3) Does your agency currently have an EMS protocol for induced hypothermia?
   a. Yes 1 (3.6%)
   b. No 27 (96.4%)

4) Does your agency have any plans for implementing a protocol for induced hypothermia?
   a. Yes 71.4%
   b. No 28.6%

5) Which, if any, Emergency Departments in your area currently use induced hypothermia for treatment of ROSC cardiac arrest patients? None

6) On the following scale rate your familiarity with induced hypothermia principles:
   a. Not familiar 4 (14.3%)
   b. Fairly familiar 21 (75%)
   c. Very familiar 3 (10.7%)

7) Identify any barriers which would prohibit your agency from incorporating an IH protocol:
   a. Funding barriers 9 (32.1%)
   b. Lack of protocol 16 (57.2%)
c. Lack of equipment  
2 (7.1%)

d. Time constraints (other responsibilities, etc.)  
1 (3.6%)
Appendix C

Wake County EMS Protocol for Induced Hypothermia

Figure 1: Wake County’s Protocols for Induced Hypothermia

**Induced Hypothermia**

**History:**
- Non-Traumatic Cardiac arrest

**Signs/Symptoms:**
- Return of pulse

**Differential:**
- Continue to address specific differentials associated with the original etiology

---

**Postresuscitation Protocol**

**Unsuccessful**

**Intubation Protocol**

**Successful**

**Criteria for Induced Hypothermia and initial temp > 34°C**

**ET Tube Placed and ETCO₂ reading > 14 mmHg**

**Perform Neuro Exam and complete checklist**

**Expose patient**
- Apply ice packs to Axilla, Neck & Groin

**Verapamil 0.15 mg/kg, to max 10 mg**

**Vesnarinum 3.1mg/kg, to max 10 mg**

**Calc Saline Bolus 10mL/kg to max of 2 liters**

**Dopamine 10-20 mcg/kg/min for MAP 10-160**

**Pearls:**
- Criteria for Induced Hypothermia:
  - ROSC after cardiac arrest not related to trauma or hemorrhage.
  - Age greater than 16
  - Initial temperature > 34°C
  - Patient remains comatose (no purposeful response to pain)
  - Intubated
  - If patient meets other criteria for induced hypothermia and is not intubated, then intubate according to protocol before inducing cooling. If unable to intubate DO NOT initiate induced hypothermia.
  - When exposing pattern for purpose of cooling garments may remain in place. Be mindful of your environment and take steps to preserve the patient's modesty.
  - Do not delay transport for the purpose of cooling.
  - Reassess airway frequency and with every patient move.
  - Patients develop metabolic alkalosis with cooling. Do not hyperventilate.
  - If there is loss of ROSC after cooling is initiated or any other complication as the result of this protocol please complete hypothermia unaware event reporting form and contact a Medical Director on completion of the call.

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Version 8.2.06  Wake County EMS System Protocols  CA-X
Table 1  Delray Beach Cardiac Arrest Data 2003-2008

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* 2008 was calculated through July 8, 2008