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Early Initiation of Therapeutic Hypothermia in the Emergency Department

by

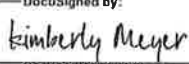


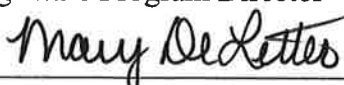
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Abstract

Therapeutic hypothermia (TH) is a treatment initiated by critical care providers for the management of cardiac arrest. It has been shown to lower the body temperature, reduce the inflammatory response, and suppress many of the pathways leading to delayed cell death. The American Heart Association (AHA) has strongly recommended to initiate cooling within 4-6 hours after return of spontaneous circulation (ROSC); however, despite the recommendation, the use of TH in emergency departments (ED) is not routine and it is commonly delayed. The purpose of this project was to evaluate the impact of an educational intervention on the timing of initiation of TH after ROSC in the ED. The overall aim of this project was to improve registered nurse (RN) knowledge of importance of TH in the ED by 20% and decrease door to TH initiation time to under 2 hours. Implementation began by conducting an educational intervention to the RN's in the ED addressing the importance of TH using brochures during the February staff meetings. Fliers were used for supplementation as a reminder to initiate TH early and were posted around the ED. Pre and post-test scores were analyzed using a paired t-test and door to TH initiation times were compared using an independent t-test. Of all 72 participants, pre-test mean score was 81.48% and post-test mean score was 98.61%. Of all 10 TH cases, the mean time for door to TH initiation in the historical group was 111 minutes and mean time for door to TH initiation in the post-implementation group was 184 minutes. There should be ongoing education and collaboration between the ED and critical care to improve door to TH initiation times.

Keywords: Therapeutic Hypothermia; Cooling; Targeted Temperature Management; Evidence-based Practice; Cardiac Arrest; Emergency Department

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Introduction

Out of hospital cardiac arrest (OHCA) is a leading cause of morbidity and mortality in the developed world. According to a report from the American Heart Association (AHA), approximately 350,000 adult OHCA occur in the United States each year and nearly 90% of them are fatal (Benjamin, et al., 2018). Successful return of spontaneous circulation (ROSC) is the first step towards the goal of complete recovery from cardiac arrest. Once ROSC is achieved, the complex pathophysiological processes that occur following have been termed post cardiac arrest syndrome. Post-cardiac arrest syndrome is comprised of post-cardiac arrest brain injury, post-cardiac arrest myocardial dysfunction, and systemic ischemia/reperfusion response (Neumar, et al., 2008). Studies show an overall survival to hospital admission after EMS treated non-traumatic OHCA was 29%, with higher survival rates in public places (39.5%) and lower survival rates in homes/residences (27.5%) and nursing homes (18.2%) (Benjamin, et al., 2018). Survival to hospital discharge was 10.8% among adults, 9% with good neurological function (Benjamin, et al., 2018). Outcomes of survivors are inconsistent, but poor-quality survival is common. Nevertheless, proper post-resuscitation care has been shown to reduce mortality and morbidity. The early post-cardiac arrest phase, defined as the period between 20 minutes and 6-12 hours after ROSC, is when early interventions might be most effective before the inflammatory cascade begins (Neumar, et al., 2008). Therapeutic hypothermia (TH), also known as targeted temperature management (TTM), is a cooling treatment initiated by critical care providers for the management of cardiac arrest. Soon after circulation is restored, reperfusion injury occurs and may persist for hours/days; subsequently, cooling devices are used to lower the body temperature, reduce the inflammatory response, and suppress many of the pathways leading to delayed cell death. In 2015, the AHA strongly recommended to initiate cooling within 4-6

hours to 32 to 36 degrees Celsius for 12 to 24 hours in comatose patients who present after having been resuscitated from cardiac arrest during the early post-cardiac arrest phase (Calloway, et al., 2015). The initial recommendation made in 2005, resulted from a significant number of clinical trials in patients who were resuscitated and demonstrated reduced neurologic disability and mortality among those receiving TH. Since then, several hospitals have implemented TH protocols within their emergency departments (ED) and critical care units with the aim of improving neurologic outcomes and survival. However, despite the recommendation, the use of TH in ED's is not routine, and it remains to be established how the time of TH initiation impacts neurologic outcomes. Animal trials suggest that more favorable neurological outcomes are associated with early initiation of TH and shorter times to reach the target temperature range of 32 to 36 degrees Celsius. Human clinical trials are inconclusive, and a significant number of studies show that whenever TH is initiated it is commonly delayed; thus, taking longer time to reach target temperature and prolonging the inflammatory response leading to significant neurological disability.

Literature Review

A search of PubMed and CINAHL was conducted in September of 2019 to retrieve literature published from 2009 to 2019 using a traditional evidence-practice approach. While conducting this review, the project leader found a lack of rigorous and superior evidence on the topic. A total of 15 studies were critically appraised. Studies were not excluded on basis of quality but were assessed for relevance in terms of sample and topic area pertaining to the question guiding the literature review. The specific question to be answered by the review was: In all registered nurses (RN) who care for OHCA patients (P), how does an educational intervention on early TH initiation (I) compared to no educational intervention (C) impact time of TH initiation (O) in the ED (T)? Table 1 exhibits a summary of a few of the quantitative

studies that helps support the proposed intervention for this project and Table 2 exhibits a summary of several of the qualitative studies that supports the significance of the problem.

Table 1

Summary of Quantitative Studies

	Alongi et al (2010)	Wolff et al (2009)	Yochum et al (2017)
Level of Evidence	Level 6	Level 6	Level 7
Design	Observational Prospective Quantitative Study	Quantitative Descriptive Outcome Study	Quality Improvement Project
Purpose/Aim	To investigate the relationship between the timing of initiation of TH and both patient survival and neurologic outcome.	Hypothesized whether a more rapid achievement of TH improves the outcome after CA.	To increase TH initiation in the ED of a large community medical center by 25% and to decrease the time to initiation of TH from an average of 127 min to less than 90 min.
Outcome	No change in Neurological Outcomes	Improved Neurological Outcomes	Increased frequency of ED initiation of TH

Note. Table 1 exhibits a summary of a few of the quantitative studies that helps support the proposed intervention for the project. Each column describes each individual study.

Table 2

Summary of Qualitative Studies

	Bigham et al (2010)	Galloway et al (2010)	Patil et al (2011)
Level of Evidence	Level 6	Level 6	Level 7
Design	Descriptive Study by use of Questionnaire of Expert Opinion	Descriptive Study by use of Survey of Expert Opinion	Quality Improvement Project
Purpose/Aim	To evaluate self-reported physician	To determine whether cooling starts in the	To audit the performance of an

	adoption, predictors of adoption, and barriers to use among Canadian emergency and critical care physicians.	ED in the UK with use of telephone survey.	ED in implementing TH and achieving target temperature in survivors of OHCA arrested admitted to the ICU.
Outcome	TH has not been universally adopted	Initiation of TH is delayed and commonly initiated in the ICU	TH was successfully implemented by the ED staff with a protocol

Note. Table 2 exhibits a summary of several of the qualitative studies that supports the significance of the problem. Each column describes each individual study.

The full-text documents were assessed by one independent reviewer, using assessment technique sheets modified from available literature regarding steps of critically appraising the evidence. The rating of evidence was determined using a modified chart of the rating system for the hierarchy of evidence for intervention/treatment questions (Melnik & Fineout-Overholt, 2015). The results of the literature review reveal that there is a substantial body of knowledge that exists to support the use of TH after OHCA. However, despite the growing body of literature, little exploration has been done to determine whether early initiation in the ED is in fact crucial for better neurological outcomes. A comprehensive understanding will advance nursing knowledge and can guide both nursing education and practice.

Theoretical Framework

Rosswurm and Larrabee's "A Model for Change" framework was used to guide the educational process. This model consists of six phases which help guide practitioners through the entire process of changing to evidence-based practice, beginning with the assessment of the need for change and ending with a change in practice and/or the integration of an evidence-based protocol (Rosswurm & Larrabee, 1999). Each phase of the framework and how it relates to the project is described in table 3.

Table 3*Rosswurm and Larrabee's A Model for Change Framework*

A Model for Change Framework	Project Relation
Phase 1: Assess a Need for Change	Involved discussing the clinical problem, assessing nursing knowledge about the problem, and reviewing the data associated with the problem.
Phase 2: Link Problem with Interventions and Outcomes	Better neurological outcomes have been associated with TH initiation.
Phase 3: Synthesize Best Evidence	A literature review was conducted on the clinical problem and the evidence has been rated.
Phase 4: Design a Change in Practice	An educational intervention was designed for the RN's in the ED addressing the clinical problem and proposing TH be initiated early in the ED.
Phase 5: Implement and Evaluate the Practice Change	The educational intervention was conducted during the February staff meetings. Collection and analyzation of data followed.
Phase 6: Integrate and Maintain the Practice Change	Met with stakeholders to communicate project information, make modifications, and plan ongoing monitoring of outcomes.

Note. The model is used to guide practitioners through the entire process in phases of developing and integrating an evidence-based practice change. Each phase has the project relation described in the second column.

Setting

The project was conducted at a Magnet certified tertiary-care hospital located in Louisville, Kentucky, in their 44-bed ED. The ED has three resuscitation rooms and over 100 staff members who treat an estimated 20-30 OHCA per month. The hospital sits approximately five miles from the downtown area and is strategically located near a major interstate. Many of the patients seen in the ED are middle-aged and older adults. The hospital prides itself in fostering the need for change and leads in clinical excellence, compassionate care, and growth to meet the needs of the patients.

Purpose

The purpose of this project was to evaluate the impact of an educational intervention on the timing of initiation of TH after ROSC in the ED. The hospital's existing protocol has a door to TH initiation goal time of 3 hours; however, internal data shows that the organization does not consistently meet that goal. According to a study done by Mooney et al. (2011), for every 1 hour in delay to initiation of TH, mortality increased by 20%. This suggests that there is a possibility that neurological outcomes are improved if TH is initiated earlier in the treatment plan. The overall aim of this project was to improve RN knowledge of importance of TH in the ED by 20% and decrease door to TH initiation times to under 2 hours. It is anticipated that the project data will lead to modification of the current TH protocol by initiating TH sooner in the ED. Outcomes from this project will facilitate improved quality metrics and contribute to accreditations for the hospital.

Intervention

Following approval from the University of Louisville Institutional Review Board and the hospital's research committee, staff in the ED was approached for participation in the project by email. A pre-test was administered during the February staff meetings prior to the education to assess current RN knowledge of TH importance. Each RN is required to attend at least one of the staff meetings per month. Test questions for the pre and post-test were derived from current literature and structured around the existing TH protocol. Following administration of the pre-test, an educational intervention to the RN's in the ED was conducted. Education addressed the importance of TH using brochures during the February staff meetings. The brochures highlighted the following: (1) Significance of the clinical problem, (2) Existing TH protocol, (3) Use of the Arctic Sun, (4) Importance of initiating TH early in the ED. The ED providers are not required to attend staff meetings; therefore, they were not the target for education. However, informal

discussions were conducted with them on the importance of ordering TH. Additionally, supplemental fliers were used as a reminder to initiate TH early and were posted around the ED for all staff, including the providers, to see. Following the educational intervention, the use of TH continued on all OHCA using the Arctic Sun as per the existing protocol. The Arctic Sun Temperature Management System is a non-invasive system for controlling and monitoring body temperature. It is intended for use in adults who are comatose after cardiac arrest with the aim of rapidly inducing mild hypothermia to reduce brain injury and improve neurological outcomes (NICE, 2017).

Participants

The target sample included all ED RN's within the hospital. Inclusion criteria included each RN who was advanced cardiovascular life support (ACLS) certified and Arctic Sun Temperature Management System competent. Exclusion criteria included each RN who did not match inclusion criteria, as well as float and travel RN's. Target sample size was 80 RN's. A waiver of consent was granted as this was approved as a quality improvement project with minimal risk.

Data Collection

A post-test was administered during the month of May to determine the effectiveness of the educational intervention and whether the RN's had increased their knowledge of TH importance. With the help of the hospital's TH committee, TH data was collected on a historical group for three months prior to the intervention in February. Following the intervention, TH data was then collected for the next three months. No identifying information was collected from the participants or patients; therefore, anonymity remained protected. Per the existing TH protocol, inclusion criteria for TH initiation included OHCA with ROSC and a non-purposeful response to painful stimuli (Glasgow Coma Score < 6), initial body temperature greater than 30 degrees

Celsius, and age greater than 18 years. The pre and post-test were voluntary and anonymous from the RN's. All data was de-identified by the hospital's TH committee prior to data collection. Pertinent data was reviewed and discussed only at the hospital. Supplies were provided by the hospital's ED as part of normal operating cost and the project leader's time as a consultant was free of charge as part of educational requirements.

Measurements

Primary outcomes included RN knowledge of TH importance and healthcare delivery. Both outcomes were measured by pre and post-test scores and door to TH initiation times. Pre and post-test scores were obtained and compared. Door to TH initiation times were obtained from the TH committee, who routinely collects this data for other hospital purposes. Door to TH initiation times post intervention were compared to an historical group.

Results

Microsoft Excel (2006) was used for statistical analysis, utilizing a paired t-test to compare mean pre and post-test scores and an independent t-test to compare mean door to TH initiation times. A mean, median, and mode score, along with a range, were calculated for pre and post-test scores and for door to initiation times and then compared. A mean, median, and range were calculated for the historical and post implementation groups and then compared.

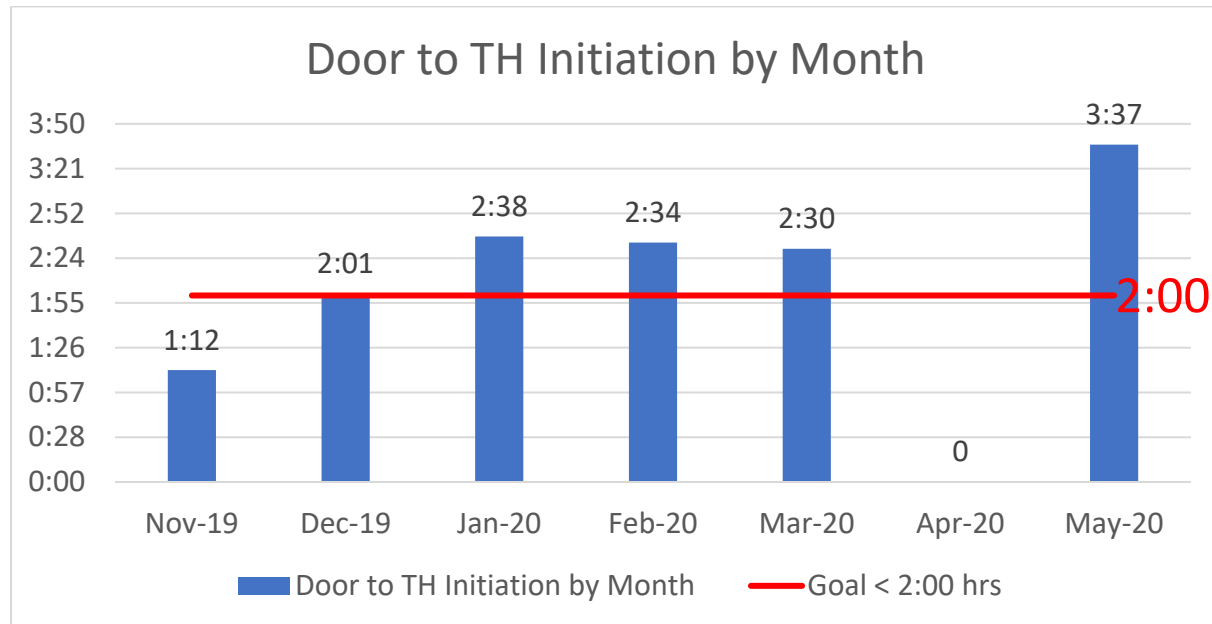
The total number RN's who participated was 72, out of the projected 80. Staff turnover was the suspected reason for not reaching target goal. Pre-test scores during the implementation month of February 2020 included a mean score of 81.48%, median score of 83.33%, mode score of 83.33%, and range from 50% to 100%. Post-test scores during project conclusion in May 2020 included a mean score of 98.61%, median score of 100%, mode score of 100%, and range from 83.33% to 100%. The results from the pre-test ($M = 81.48$) and post-test ($M = 98.61$) indicate

that the educational intervention resulted in an improvement in RN knowledge of TH importance by 21.02%, $t = -9.83$, $p < .001$.

The total number of OHCA that had a documented TH initiation time between the months of November 2019 and May 2020 was 14; however, four of the cases in February 2020 were excluded due to project implementation. The remaining 10 cases met inclusion criteria and were cooled, according to existing protocol. Historical data encompassed a three-month period (November 2010 to January 2020) with a total of six cases before the educational intervention began. The mean time for door to TH initiation in the historical group was 111 minutes (1 hour and 51 minutes), median time was 81.5 minutes (1 hour and 21 minutes), and the range was 62 minutes (1 hour and 2 minutes) to 209 minutes (3 hours and 29 minutes). Post-implementation data encompassed a three-month period (March 2020 to May 2020) with a total of four cases after the educational intervention was conducted. The mean time for door to TH initiation in the post-implementation group was 184 minutes (3 hours and 4 minutes), median time was 176.5 minutes (2 hours and 56 minutes), and the range was 114 minutes (1 hour and 54 minutes) to 269 minutes (4 hours and 29 minutes). The 4 patients who received the TH after the educational intervention ($M = 184$) compared to the 6 participants in the historical group ($M = 111$) demonstrated longer times to TH initiation, $t = -1.82$, $p = .12$. See figures 1 and 2 for a visual breakdown of door to times of TH initiation.

Figure 1

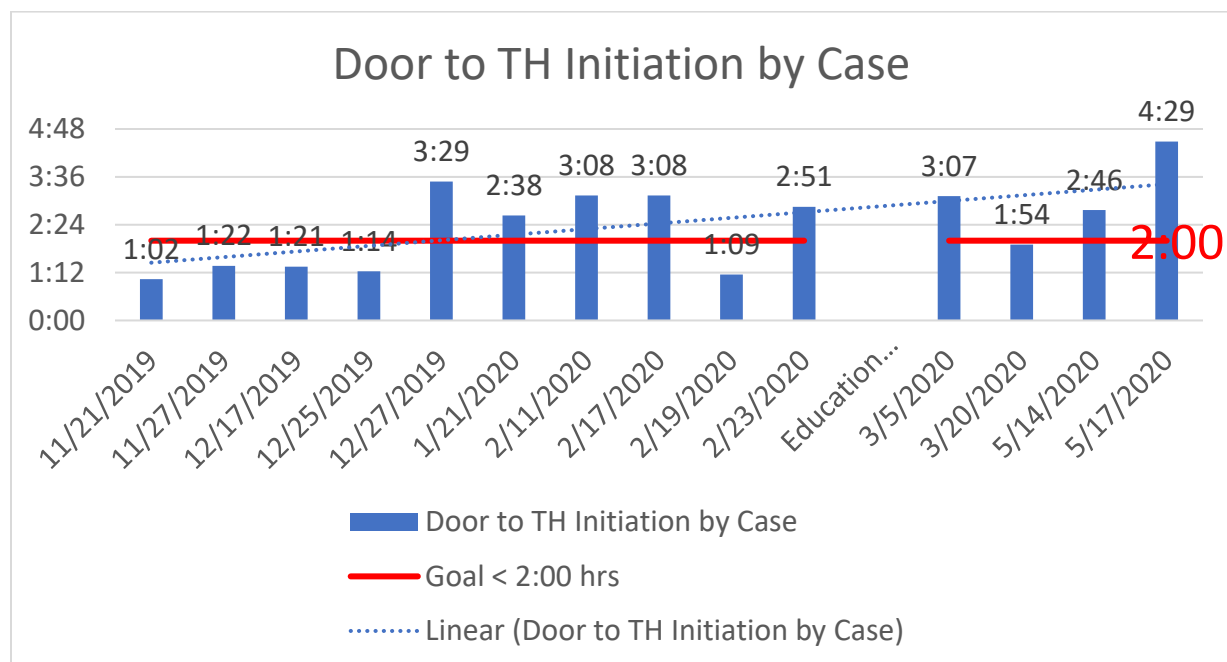
Door to TH Initiation by Month



Note. Figure 1 exhibits door to initiation times by hours each month. April had zero cases.

Figure 2

Door to TH Initiation by Case



Note. Figure 2 exhibits door to initiation times by hours each case.

Discussion

Interpretation

This project helped to successfully educate the RN's in the ED and TH was implemented on all patients who met inclusion criteria after project implementation. The mean test scores increased from the pre-test ($M = 81.48$) to the post-test ($M = 98.61$) showing an increase in RN knowledge of TH importance. The mean door to initiation times increased in the post implementation group ($M = 184$) compared the historical group ($M = 111$) showing that the staff were unable to initiate TH under the projected 2-hour aim. The dramatic increase in TH door to initiation times in the post implementation group can be explained by several causes, see Appendix A. Of all 14 documented TH cases, two were initiated in the ED, one was initiated in the cardiac catheterization lab, and 11 were initiated in the critical care units. The results of this project support former studies in concluding that whenever TH is initiated, it is commonly delayed.

Moreover, the educational intervention with the ED RN's did not include collaboration with the ED providers or critical care RN's. Potential barriers to implementation in the ED can include lack of efficient protocol, lack of interdisciplinary collaboration between the ED and the critical care RN's, and variable nursing awareness. Also, lack of documentation became a barrier during data collection. The TH committee had trouble gathering relevant data because it was unclear in a few cases which unit initiated the treatment. This project shows that one brief education can improve knowledge of TH importance; however, it will not be enough to improve door to initiation times. The delays in initiation can be improved by conscious awareness of initiating TH earlier, ongoing education and effective collaboration between ED and critical care RN's, and clearer documentation by each department. Ultimately, the most effective way in shortening door to initiation times is to start TH in the ED as soon as ROSC is achieved.

Limitations

In the early phases of the project, a global pandemic surfaced which drastically affected the project results. Due to concerns of contracting the COVID-19 virus many patients did not seek healthcare for acute medical problems, such as myocardial infarctions. A recent United States model from 9 major centers observed a 38% decrease in total ST-Segment Elevation Myocardial Infarction (STEMI) activations (Garcia et al., 2020). This is similar to the early Hong Kong experience demonstrating a significant delay in the time of symptom onset to the first medical encounter by about 318 min (Tam et al., 2020). Reluctance to visit a hospital due to fear of morbidity related to COVID-19 only added to time delays in managing STEMI's due to increased precautionary measures and accessory testing in the ED, delayed triaging, short staffing, and slow activation of cardiac catheterization labs, putting patients at risk of worse clinical outcomes (Tam et al., 2020). Other limitations of this project included a short evaluation time, small target sample, and limited geographic setting. These limitations could be managed in future projects by the following modifications. One can study patients over a longer time span by conducting a longitudinal project. Having a short evaluation time due to project time constraints limited the amount of data needed to evaluate the impact of the intervention. One can increase the sample size. The small sample size in this project made it difficult to find significant relationships from the data. Statistical tests normally require a larger sample size to ensure a representative distribution of the population and to be considered representative of groups of people to whom results will be generalized. One can conduct a multisite project. This project was conducted at one tertiary care hospital which increases the likelihood of less diverse participants/cases. Lastly, there was a lack of rigorous research on this specific topic; therefore, patient outcomes could benefit from future projects addressing interaction between relative variables, such as the time to TH initiation and its impact on neurological outcomes.

Conclusion

This project has shown to effectively improve RN knowledge of TH importance. There should be ongoing education and collaboration between the ED and critical care to improve door to TH initiation times. Results of this project were shared with the hospital's administration and TH committee to continue the project's impact and modify the hospital's existing TH protocol. Additionally, the organization's TH committee will continue having bi-monthly meetings and performing TH statistic reviews of outcome monitoring. The plan for dissemination includes a poster presentation that outlines the projects details and results. The key audience for dissemination is comprised of all ED/critical care staff and providers.

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Appendix A

Cause and Effect Diagram

