A Novel Scoring System May Predict Neurologic Non-Survival at 24 Hours during Therapeutic Hypothermia Following Out of Hospital Cardiac Arrest: A Retrospective Review

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Abstract

Introduction: This investigation summarizes initial data which indicates neurologic outcome may be predicted during therapeutic hypothermic treatment following out of hospital cardiac arrest by using clinical observation of four risk factors assessed within the first 24 hours following ICU admission.

Methods: In this retrospective, observational study conducted at a tertiary care university hospital, we retrospectively reviewed the medical records of 13 consecutive patients undergoing therapeutic hypothermia following out of hospital cardiac arrest in which a novel disposable monoplane Transesophageal Echocardiography probeClariTEE™ (Imacor Inc., Garden City, NY, USA) was placed to observe myocardial recovery. During the first 24 hours following ICU admission the seven neurological non-survivors displayed 2 or more of the following risk factors: Bispectral Index < 40 (8-24 hours), arterial pH < 7.34 (12-20 hours), best left ventricular fractional area of change < 25% (0-24 hours), and right ventricular dysfunction of at least moderate severity (0-24 hours). The six neurological survivors displayed 0 or only 1 of these risk factors. The presence of 2 or more risk factors thus predicted neurologic non-survival with a 100% sensitivity (95% CI: 0.56-1 due to small sample size) and 100% specificity (95% CI: 0.52-1 due to small sample size), p=0.0006. Statistical significance was calculated with the most conservative appropriate test, Fisher’s two-tailed exact test.

Conclusions: This preliminary evidence suggests that a prognostic scoring system consisting of bispectral index, echocardiographic evaluation of right and left ventricular function, and arterial pH obtained within the first 24 hours of ICU admission may predict neurologic non-survival in patients undergoing therapeutic hypothermia following out of hospital cardiac arrest. Multimodal prognostic scoring systems may serve to identify patients whom would benefit most from intensive therapy.

Keywords: Hypothermia; Transesophageal echocardiography; Out-of-hospital cardiac arrest; Myocardial reperfusion; Neurologic recovery; Cerebral performance category; Bispectral index

Abbreviations: CPC: Cerebral Performance Category; TEE: Transesophageal Echocardiography; BIS: Bispectral Index

Introduction

Therapeutic hypothermia following resuscitation after out of hospital cardiac arrest is cost effective and supported by medical evidence [1-6]. Unfortunately some patients emerge from therapeutic hypothermia with devastating neurological complications. The Cerebral Performance Category (CPC) is an established classification scheme that uses neurologic outcome to group patients into one of five categories [7,8]. Patients in CPC of 1 or 2 are able to independently perform activities of daily living and return to some form of work; patients discharged from the ICU in CPC 1 or 2 are designated neurologic survivors. By contrast, patients in CPC 3-5 exhibit at least severe cerebral disability but may be comatose or brain dead; patients discharged from the ICU with a CPC of 3-5 are designated neurologic non-survivors. The dichotomization of outcomes into neurologic survivorship and non-surviviorship based on the CPC is clinically useful for reporting outcomes. Predictors of neurologic survival may serve to identify patients who would benefit from intensive therapy thus promoting appropriate resource utilization. Preliminary evidence suggests the bispectral index (BIS) has some prognostic value particularly when the BIS is zero (100% sensitive for neurologic non-surviviorship), however BIS alone is insufficient to predict neurologic survivorship [7,8]. The investigators report initial clinical evidence that in the first 24 hours following ICU admission a multiple risk factor model including BIS, echocardiographic, and metabolic parameters may predict neurologic survivorship or non-survivorship based on the CPC.

Materials and Methods

After obtaining Institutional Review Board approval, we retrospectively reviewed the medical records of 13 consecutive patients being treated with therapeutic hypothermia following out of hospital cardiac arrest at tertiary care university hospital in which a novel hemodynamic monitor was used by the investigators during a product quality assessment trial. This novel hemodynamic monitor, a miniaturized disposable monoplane transesophageal echocardiography (TEE) probeClariTEE™ (Imacor Inc., Garden City, NY, USA), was used for assessment of myocardial function and ventricular filling. Qualitative assessment of the left ventricle (LV) was performed using the mid-esophageal four-chamber and transgastric mid short axis...
views. Quantitative assessment of LV function was performed using a simple fractional of change (FAC) calculation utilizing the transgastric mid short axis view. Qualitative assessment of right ventricular (RV) function was performed using the mid-esophageal four-chamber view. RV function was elucidated from the apical displacement of the lateral tricuspid annulus, right ventricular free wall thickening, motion of the inter-ventricular septum, and right ventricular diameter relative to the left ventricle. An individual certified in Advanced Perioperative Transesophageal Echocardiography by the National Board of Echocardiography confirmed all echocardiographic assessments. There were no complications from utilizing the disposable TEE probe.

The investigators retrospectively dichotomized patients into two groups based on neurologic survivorship (CPC 1,2) or neurologic non-survivorship (CPC 3-5) and examined the medical records seeking to identify parameters that distinguished the two groups. Since the data showed a clear cut point between neurological survivors (0 or 1 risk factors) and neurological non-survivors (2 or more risk factors), sensitivity and specificity were calculated from a 2x2 contingency table with this cut point. Statistical significance was calculated with the most conservative appropriate test, Fisher’s two-tailed exact test (GraphPad Software, La Jolla CA, USA).

**Results and Discussion**

Risk factors for neurologic non-survival (CPC 3-5) present and identifiable within 24 hours after ICU admission include BIS < 40 (8-24 hours), arterial pH < 7.34 (12-20 hours), best left ventricular fractional area of change < 25% (0-24 hours), and right ventricular dysfunction of at least moderate severity (0-24 hours). Tables one and two list the demographic and risk factors for the neurologic survivors and non-survivors respectfully [Table 1,2]. Neurologic survivors exhibited 0.67 ± 0.52 risk factors while neurologic non-survivors exhibited 2.57 ± 0.79 risk factors (p = 0.0004). The presence of two or more risk factors predicts neurologic non-survival (CPC 3-5) with 100% sensitivity (95% CI: 0.56-1 due to small sample size) and 100% specificity (95% CI: 0.52-1 due to small sample size), p=0.0006, Fisher’s two-tailed exact test.

Our observations, limited by a small sample size and by the high percentage of drowning victims in our population, must be interpreted with caution. Whether or not our results can be reproduced there is little likelihood that BIS alone will have the sensitivity and specificity to be truly prognostic for all patients undergoing therapeutic hypothermia.
following out of hospital cardiac arrest. The authors postulate that an index consisting of neurologic, echocardiographic, and metabolic parameters collected within the first 24 hours following ICU admission may be useful to differentiate neurologic survivors and non-survivors. If these results can be reproduced in larger investigations, a similar scoring system may serve to identify patients who would most benefit from intensive therapy. Such a prognostic scoring system would also serve to address family angst and guide appropriate resource utilization.

Conclusion

In 13 patients retrospectively reviewed who underwent post cardiac arrest therapeutic hypothermia we found that within the first 24 hours BIS < 40 (8-24 hours), arterial pH < 7.34 (12- 20 hours), best left ventricular fractional area of change < 25% (0-24 hours), and right ventricular dysfunction of at least moderate severity (0-24 hours) were significant risk factors for neurologic prognostication. Future studies should delve into the value of a multiple risk factor model in neurologic prognostication post therapeutic hypothermia from cardiac arrest.

Key Messages

- Preliminary evidence suggests that a prognostic scoring system consisting of neurologic, cardiac, and metabolic parameters in the first 24 hours of ICU admission may predict neurologic non-survival in patients undergoing therapeutic hypothermia following out of hospital cardiac arrest.

- Echocardiographic data was obtained in all patients with the disposable TEE probe without complication.

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