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Clinical paper

The association between post resuscitation hemoglobin level and survival with good neurological outcome following Out Of Hospital cardiac arrest☆

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ABSTRACT

Aims: to explore the association between post return of spontaneous circulation (ROSC) hemoglobin level and survival with good neurological outcome following out-of-hospital cardiac arrest.
Methods: We studied adults with non-traumatic out-of-hospital cardiac arrest who achieved ROSC within 50 min of collapse. We quantified the association between post ROSC hemoglobin level and good neurological outcome (defined as Cerebral Performance Category score of 1or 2), using multivariate logistic regression analyses. The impact of Post ROSC hemoglobin level $\geq$10 g dl^{-1} and time varying hemoglobin level $\geq$10 g dl^{-1} on time to Survival with good outcome was assessed using Cox proportional hazard models.
Results: Of 931 cardiac arrest patients, 146 (16%) achieved ROSC and 30 survived to discharge with a good neurological outcome. Of those with post ROSC hemoglobin level $\geq$10 g dl^{-1}, 28% (27/98) had good outcome, whereas of those with level < 10 mg dl^{-1} only 6% (3/48) had good outcome (CPC < 3, P = 0.003). The use of blood transfusions and therapeutic hypothermia were comparable in both good and bad outcome groups. An immediate post ROSC hemoglobin level $\geq$10 g dl^{-1} was significantly associated with good neurological outcome (AOR 8.31 95% CI 1.89–36.52 P = 0.005). Patients with post ROSC hemoglobin $\geq$10 g dl^{-1} were more likely to achieve good outcome earlier (HR 6.02 95% CI 1.75–20.72 P = 0.004).
Conclusions: Post ROSC hemoglobin level $\geq$10 g dl^{-1} is associated with survival with good neurological outcome. The importance of time to achieve such level and the role of blood transfusion warrants further investigation.

Introduction

The International resuscitation committee has recommended comprehensive therapeutic strategies to improve outcome following cardiac arrest, including therapeutic hypothermia, percutaneous coronary intervention, early hemodynamic optimization and supportive care.[1–5] The quintessential goal of such therapies is to achieve neurologically intact survival by maintaining adequate balance between oxygen delivery and consumption, thus alleviating the impact of ischemia and hypoxia on the brain tissue following arrest.

Cardiac arrest is a severe ischemic event that will eventually lead to the failure of organs' defense mechanisms in the absence of adequate supportive therapies. The cerebrovascular system responds to hypoxia by increasing production of nitric oxide and stimulating sympathetic B2 receptors to achieve adequate vasodilatation that will maintain cerebral blood flow.[6,7] However, in the setting of severe anemia, such increase in cerebral blood flow will eventually be insufficient to compensate for the decrease in arterial oxygen content caused by low hemoglobin levels.[8] Moreover, in cardiac arrest as compared to other brain ischemic events, severe hypotension, myocardial dysfunction and lactic acidosis will further complicate the picture and decrease the chance of successful defense.

The optimal neuro-protective hemoglobin level following cardiac arrest has not yet been determined. Two studies maintained hemoglobin level above 9–10 g dl^{-1} in a post cardiac arrest protocol to improve survival.[9,10] The SOS-KANTO study group demonstrated

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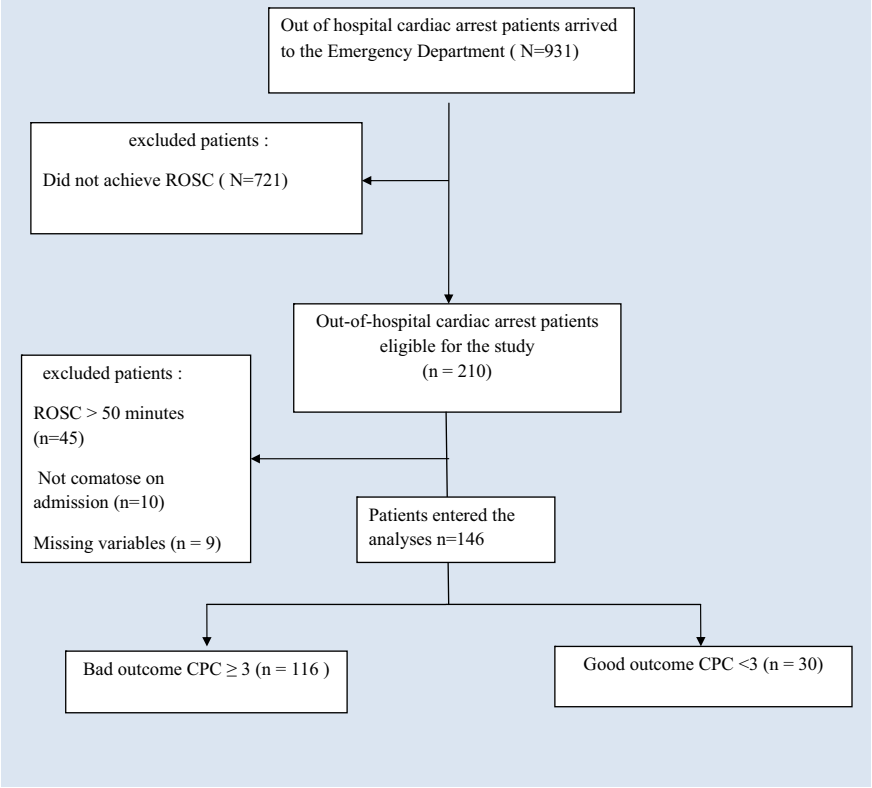

Fig. 1. Study flow diagram. CPC: cerebral performance category, ROSC: return of spontaneous circulation.

an association between higher hemoglobin level and favorable neurological outcome.[11] However, there was no general agreement on the best hemoglobin level and whether such level will impact time to achieve neurologically intact survival following arrest. Hence the goal of this study was to explore the association between post arrest hemoglobin level $\geq 10\,g\,dl^{-1}$ with survival with good neurological outcome, and the time to achieve good neurological outcome following arrest.

Methods

Setting and study design

This study was approved by the Johns Hopkins Institutional Review Board. We performed a retrospective review of all adult patients over 18 years of age with non-traumatic out-of-hospital cardiac arrest who achieved ROSC within 50 min, and admitted to an academic medical center between 2004 and 2010. We excluded patients with traumatic cardiac arrest and those who died upon arrival to the emergency department. Out of 210 patients who achieved ROSC, 64 patients were excluded; 9 patients due to missing data, 10 patients were not comatose upon hospital admission and 45 did not achieve ROSC within 50 min. Those 45 patients were excluded as no one with ROSC > 50 min survived with good outcome (Fig. 1)

Study variables and patient data

Primary outcome was survival with good neurological outcome defined as Cerebral Performance Category score (CPC) of 1 or 2, secondary outcome was time to achieve good neurological outcome in hours from the time of arrest. Patient demographics, cardiac arrest and post cardiac arrest variables were collected according to Utstein guidelines.[12,13] Cardiac catheterization and percutaneous coronary intervention (PCI) were performed in select patients based on the decision of the cardiology attending. Similarly, therapeutic hypothermia was started in select patients according to a pre-defined hospital wide protocol that is based on the American Heart Association guidelines.[2,3] Fluids and vasopressors were used as needed to maintain a mean arterial pressure ≥65 mmHg, and Propofol or Midazolam were used for sedation. Intensive care unit neurological assessments were performed by nursing staff, resident physicians, the ICU attending physician and often the consulting neurologist. Sedation was interrupted each morning to assess for recovery. In rare cases of discrepancy between observers, the report of the attending/neurologist was selected to reflect the status of the patient. Neurological outcome was assessed according to Glasgow-Pittsburgh Cerebral Performance Categories scale (CPC): CPC 1 is conscious and normal; CPC 2 conscious with moderate cerebral disability; CPC 3 conscious with severe cerebral disability; CPC 4 coma or vegetative state; and CPC 5 death.[13] Patients with CPC 1 or 2 were considered to have good neurological outcome while those with CPC 3, 4 or 5 were considered to have bad neurological outcome.

Repeated measures

Hemoglobin levels were measured as follows for patients who met inclusion criteria: Post ROSC, every 6 h for the first 24 h and then every 24 h until reaching good neurological outcome (CPC 1, 2) or bad outcome (CPC 3,4,5). For patients who achieved good outcome on a specific day, the immediate preceding 24 h hemoglobin level was considered the last hemoglobin measured. Then survival analysis was performed to look at the impact of post ROSC hemoglobin level $\geq 10\,g\,dl^{-1}$ and time varying hemoglobin level $\geq 10\,g\,dl^{-1}$ on time to achieve good neurological outcome following cardiac arrest.