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Clinical paper

The effect of time to defibrillation and targeted temperature management on functional survival after out-of-hospital cardiac arrest☆

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ABSTRACT

Background: Cardiac arrest physiology has been proposed to occur in three distinct phases: electrical, circulatory and metabolic. There is limited research evaluating the relationship of the 3-phase model of cardiac arrest to functional survival at hospital discharge. Furthermore, the effect of post-cardiac arrest targeted temperature management (TTM) on functional survival during each phase is unknown.
Objective: To determine the effect of TTM on the relationship between the time of initial defibrillation during each phase of cardiac arrest and functional survival at hospital discharge.
Methods: This was a retrospective observational study of consecutive adult (≥18 years) out-of-hospital cardiac arrest (OHCA) patients with initial shockable rhythms. Included patients obtained a return of spontaneous circulation (ROSC) and were eligible for TTM. Multivariable logistic regression was used to determine predictors of functional survival at hospital discharge.
Results: There were 20,165 OHCA treated by EMS and 871 patients were eligible for TTM. Of these patients, 622 (71.4%) survived to hospital discharge and 487 (55.9%) had good functional survival. Good functional survival was associated with younger age (OR 0.94; 95% CI 0.93–0.95), shorter times from collapse to initial defibrillation (OR 0.73; 95% CI 0.65–0.82), and use of post-cardiac arrest TTM (OR 1.49; 95% CI 1.07–2.30). Functional survival decreased during each phase of the model (65.3% vs. 61.7% vs. 50.2%, $P < 0.001$).
Conclusion: Functional survival at hospital discharge was associated with shorter times to initial defibrillation and was decreased during each successive phase of the 3-phase model. Post-cardiac arrest TTM was associated with improved functional survival.

1. Background/introduction

Every year in North America, there are over 400,000 out-of-hospital cardiac arrests (OHCA) with a survival rate of 5–10%.[1,2] The probability of survival from OHCA decreases from the time of collapse to emergency medical service (EMS) intervention, however, the exact relationship between time and survival is not known. It has been proposed that cardiac arrests transition through three distinct phases of pathophysiology: electrical phase (<4 min), circulatory phase (4–10 min) and metabolic phase (>10 min).[3] Each phase requires specific interventions in order to optimize patient survival.[3] Survival from cardiac arrests in the electrical phase are dependent upon rapid defibrillation, whereas cardiac arrests in the circulatory phase may benefit from an initial method of oxygen delivery (chest compressions and ventilations) prior to defibrillation. Cardiac arrests that enter the metabolic phase generally have poor survival. It is proposed that more advanced techniques, such as targeted temperature management (TTM), may improve patient outcome in this time frame.

Recent studies have examined the 3-phase model in relationship to the timing of initial treatment by EMS providers.[4–7] These studies found that the probability of patient survival decreased over

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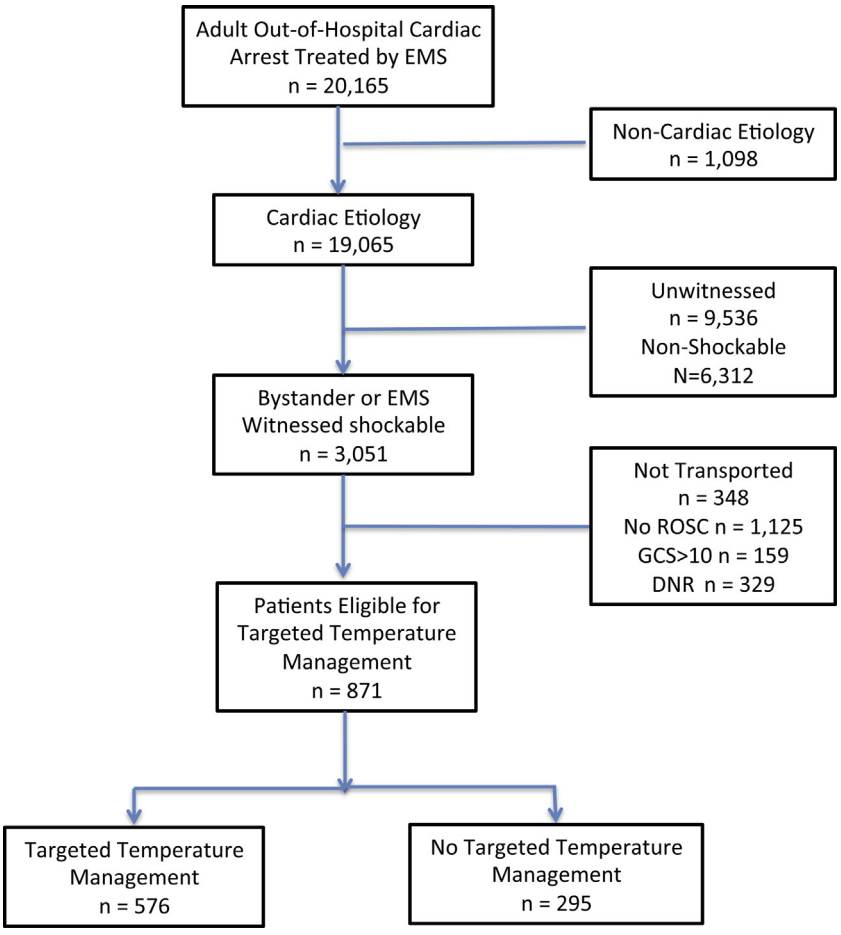

Fig. 1. Consort diagram.

time to initial defibrillation and the decrease in survival was associated with the three phases described by the model. There were, however, inconsistencies in the exact timing of each phase when compared to the original model.[4,5,7] Furthermore, only two studies have reported functional outcome as it relates to the 3-phase model;[6,8] one looking at the effect of bystander CPR and the other the duration of cardiac arrest.

It is unknown how the time to initial defibrillation relates to functional outcome at hospital discharge. None of these studies used data post-implementation of the 2005 American Heart Association (AHA) guidelines and it is unknown how survival from OHCA relates to the 3-phase model of cardiac arrest with current resuscitation strategies. Furthermore, the effect of TTM on the relationship between the time to EMS treatment and functional survival has not been sufficiently studied.

This study will evaluate the association between the time from collapse to initial defibrillation and functional survival at hospital discharge in relation to the 3-phase model of cardiac arrest using cases that occurred post-implementation of the 2005 AHA guidelines. Furthermore, it will evaluate how the relationship is affected by the use of TTM.

2. Materials and methods

2.1. Study design

This was a retrospective, observational study using data from the Toronto Regional RescuNet Epistry database, based upon the Resuscitation Outcomes Consortium (ROC) Epistry-Cardiac Arrest database, whose methods have been described previously.[9] ROC Epistry-Cardiac Arrest is a prospective population based registry of consecutive EMS attended out-of-hospital cardiac arrests.[9] The Toronto Regional RescuNet site contains OHCA from rural and urban regions in southern Ontario, a population of over 6.6 million residents.[10] It is comprised of 7 land EMS agencies (Toronto, York, Peel, Durham, Halton, Simcoe, Muskoka), the provincial air ambulance service (Ornge) and 32 participating destination hospitals. Trained data guardians collect epidemiologic data from participating EMS agencies and destination hospitals, which is then entered into a secured database.

All 32 hospitals were all involved in the Strategies for Post-Arrest Care (SPARC) Network trial (NCT00683683), which implemented a knowledge translation program to improve the delivery of care to post-cardiac arrest patients.[11,12] The use of TTM for all patients was recommended and encouraged as well compliance was reported by each institution.

2.2. Study population

Consecutive adult (≥18 years) witnessed, ventricular fibrillation/tachycardia OHCA of presumed cardiac etiology that remained unconscious (Glasgow Coma Scale < 10) after return of spontaneous circulation (ROSC) were eligible for inclusion in the study. Cardiac arrests occurred between January 1, 2007 and April 30, 2013. Cases were excluded if they were unwitnessed by bystanders or EMS personnel, of obvious non-cardiac etiology, or occurred prior to implementation of the 2005 American Heart Association CPR