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Frequency and survival pattern of in-hospital cardiac arrests: The impacts of etiology and timing☆,☆☆,★

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ABSTRACT

Objective: Define the frequency and survival pattern of cardiac arrests in relation to the hospital day of event and etiology of arrest.
Subject and methods: Retrospective cohort study of adult in-hospital cardiac arrests between July 1, 2005, and June 30, 2013, that were classified by etiology of deterioration. Arrests were divided based on hospital day (HD) of event (HD1, HD2–7, HD>7 days), and analysis of frequency was performed. The primary outcome of survival to discharge and secondary outcomes of return of spontaneous circulation (ROSC) and favorable neurological outcomes were compared using multivariable logistic regression analysis.
Results: A total of 627 cases were included, 193 (30.8%) cases in group HD1, 206 (32.9%) in HD2–7, and 228 (36.4%) in HD>7. Etiology of arrest demonstrated variability across the groups ($p < 0.001$). Arrests due to ventilation issues increased in frequency with longer hospitalization ($p < 0.001$) while arrests due to dysrhythmia had the opposite trend ($p = 0.014$). Rates of survival to discharge ($p = 0.038$) and favorable neurological outcomes ($p = 0.002$) were lower with increasing hospital days while ROSC was not different among the groups ($p = 0.183$). Survival was highest for HD1 (HD1: 38.9% [95% CI, 32.0–45.7%], $p = 0.002$ vs HD2–7: 34.0% [95% CI, 27.5–40.4%], $p < 0.001$ vs HD>7: 27.2% [95% CI, 21.4–33.0%], $p < 0.001$).
Conclusions: The etiology of cardiac arrests varies in frequency as length of hospitalization increases. Survival rates and favorable neurological outcomes are lower for in-hospital arrests occurring later in the hospitalization, even when adjusted for age, sex, and location of event. Understanding these issues may help with focusing therapies and accurate prognostication.

Introduction

Survival from in-hospital cardiac arrest has been historically low with reported rates of success varying across hospitals from 15% to 40% but with the most common estimate around 20%.[1–7] Well-established prognostic parameters for a favorable outcome have been identified, including witnessed events, short time between collapse and arrival of the resuscitation team, short duration of CPR, and ventricular fibrillation as the first recorded rhythm.[4,7–9] However, there are few studies dedicated to evaluating the cause of the cardiac arrest and its relationship to the outcome of in-hospital cardiac arrests. Wallmuller et al. found that 63% of arrests were due to a cardiac etiology which had a significantly better outcome than those who had a non-cardiac cause of arrest (44 vs 23%); the majority of non-cardiac causes were attributed to pulmonary causes.[10] However, this prior study was designed to evaluate in-patient cardiac arrests within an emergency room equipped with ICU beds.

Our study aims to evaluate the outcome of in-hospital cardiac arrests, focusing on the relationship between etiology and outcome and, in particular, in relation to the length of hospitalization prior to the cardiac arrest. We sought to test the hypothesis that cardiac arrests occurring after longer hospitalizations were associated with lower survival rates and worse neurological outcomes compared to shorter hospitalizations.

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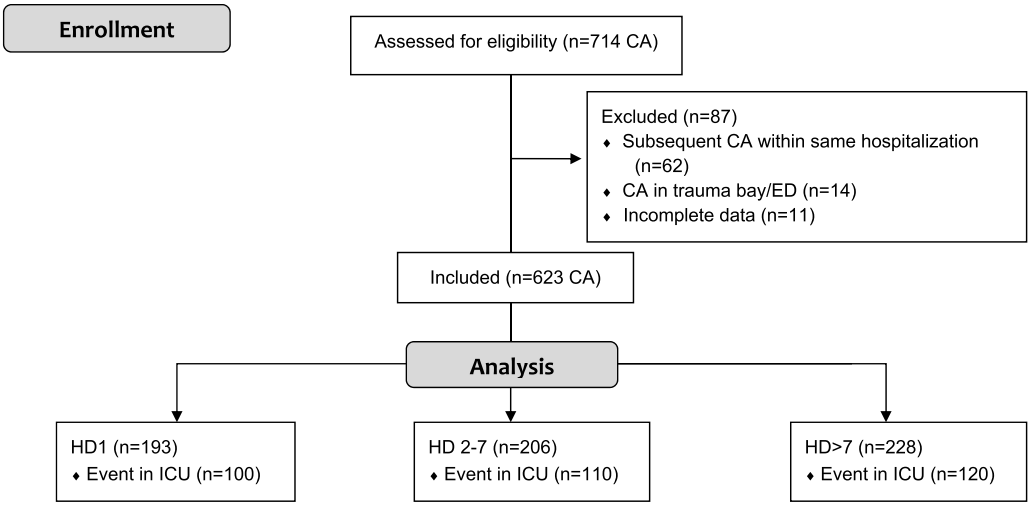

Fig. 1. Flow diagram illustrating the number cardiac arrests (CA) occurring during the study period (ED = emergency department, HD = hospital day group, ICU = intensive care unit).

Methods

Study design and setting

This is a retrospective cohort study that assessed all adult patients admitted to University of California, San Diego (UCSD), a tertiary referral center. Cardiac arrests from two hospitals were included in the study, including the UCSD Hillcrest Medical Center and Thornton Hospital which are comprised of a total of 530 beds of which 74 are licensed ICU beds. The study included all patients who were admitted to the hospital and had a cardiac arrest between July 1, 2005, and June 30, 2013. Resuscitation attempts are conducted by a multidisciplinary team, who have been certified in Advanced Resuscitation Training (ART) and include residents, attending physicians, nurses, pharmacists, and respiratory therapists. ART is a resuscitation management program designed for inpatient cardiopulmonary arrests, which is used as an alternative to advanced cardiac life support (ACLS) at UCSD.[11]

Inclusion and exclusion criteria

Patients who were 18 years or older and experienced a cardiac arrest (defined as the lack of a palpable central pulse, apnea, and unresponsiveness), requiring cardiopulmonary resuscitation (CPR) or defibrillation, were included in the analysis. Only index events, defined as the first arrest for patients having more than 1 arrest during the same hospitalization, were included. Exclusion criteria included all cardiac arrests in which resuscitation was initiated out of the hospital, in the emergency department, in the trauma bay, or if the patient had an active do-not-attempt resuscitation order (Fig. 1).

Data collection and integrity

Cardiac arrests were identified through a robust review of standardized resuscitation records, "code blue" committee minutes, the continuous quality improvement (CQI) database, and the electronic medical record. Information for each cardiac arrest was entered into a database and cross-referenced to ensure data integrity. Detailed chart review for medical history, clinical presentation, and underlying disease was completed. The project was approved by the University of California, San Diego, Institutional Review Board (IRB 150899).

Advanced Resuscitation Training

Hospital-based resuscitation has unique features related to the etiologies of arrest and the spectrum of deterioration. ART was developed as a comprehensive program involving resuscitation training aimed at not only preventing arrests in critically ill patients but also optimizing the treatment of the cardiopulmonary arrest patient by linking CQI with training and incorporating new understanding of resuscitation science.[12] As part of tailoring treatment algorithms and improving recognition of clinical deterioration, the ART Matrix was developed, which represents a taxonomy to describe the various etiologies of cardiopulmonary arrest. The matrix is hierarchical and categorizes resuscitation events as described in Table 1. Patients were designated into one of these groups after review of the medical record, including autopsy reports or imaging studies, if available. ART relies heavily on early recognition and an aggressive rapid response system. Rapid responses can be activated by staff or the patient/family.

Outcome

The primary outcome measure was survival to discharge. Secondary outcomes were return of spontaneous circulation (ROSC) for more than 1 h and favorable neurological outcomes. Neurological outcome was determined using the cerebral performance category (CPC) score. A favorable neurological outcome was defined as a cerebral performance score of 1 or 2 (range, 1–5) at the time of discharge.

In addition, outcome measures were evaluated based on length of hospitalization. Cardiac arrests were divided into three groups based on the hospital day (HD) in which the event occurred. The first group included all arrests that occurred on the first hospital day or within 24 h of the day of admission (HD1), the second group included cardiac arrests on hospital day 2 through 7 (HD2–7), and the third group included all cardiac arrests that occurred after hospital day 7 (HD>7 days). The ranges were chosen to compare three specific cohorts of patients. Given that the average length of hospitalization at UCSD is 4.1 days, HD1 represents the group that had an arrest as an early complication of their hospitalization compared to those with an arrest preceded by an average length of hospital stay (HD2–7) and those with an arrest during a prolonged hospitalization (HD>7).[13]