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Clinical Paper

# The effect of adherence to ACLS protocols on survival of event in the setting of in-hospital cardiac arrest

Matthew D. McEvoy[a], Larry C. Field[b,*], Haley E. Moore[b], Jeremy C. Smalley[c], Paul J. Nietert[d], Sheila H. Scarbrough[e]

[a] Department of Anesthesiology, Vanderbilt University, Nashville, TN 37232, United States
[b] Department of Anesthesia & Perioperative Medicine, Medical University of South Carolina, Charleston, SC 29425, United States
[c] Department of Orthopedics, Medical University of South Carolina, Charleston, SC 29425, United States
[d] Department of Public Health Sciences, Medical University of South Carolina, Charleston, SC 29425, United States
[e] Critical Interventions Manager, Medical University of South Carolina, Charleston, SC 29425, United States

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ABSTRACT

*Aim:* Advanced Cardiac Life Support (ACLS) algorithms are the default standard of care for in-hospital cardiac arrest (IHCA) management. However, adherence to published guidelines is relatively poor. The records of 149 patients who experienced IHCA were examined to begin to understand the association between overall adherence to ACLS protocols and successful return of spontaneous circulation (ROSC).
*Methods:* A retrospective chart review of medical records and code team worksheets was conducted for 75 patients who had ROSC after an IHCA event (SE group) and 74 who did not survive an IHCA event (DNS group). Protocol adherence was assessed using a detailed checklist based on the 2005 ACLS Update protocols. Several additional patient characteristics and circumstances were also examined as potential predictors of ROSC.
*Results:* In unadjusted analyses, the percentage of correct steps performed was positively correlated with ROSC from an IHCA ($p < 0.01$), and the number of errors of commission and omission were both negatively correlated with ROSC from an IHCA ($p < 0.01$). In multivariable models, the percentage of correct steps performed and the number of errors of commission and omission remained significantly predictive of ROSC ($p < 0.01$ and $p < 0.0001$, respectively) even after accounting for confounders such as the difference in age and location of the IHCAs.
*Conclusions:* Our results show that adherence to ACLS protocols throughout an event is correlated with increased ROSC in the setting of cardiac arrest. Furthermore, the results suggest that, in addition to correct actions, both wrong actions and omissions of indicated actions lead to decreased ROSC after IHCA.


## 1. Introduction

The American Heart Association (AHA) Advanced Cardiac Life Support (ACLS) algorithms are the standard of care for patients suffering cardiac arrest. Although previous reviews did not demonstrate the expected improvement in survival for cardiac arrests of all types, a recent review of 2000–2009 did show an improvement in both return of spontaneous circulation (ROSC) and survival-to-discharge rates.[1–3] It remains unclear how much of the recent improvement is attributable to improved training and adherence to specific algorithms as compared to other improvements, such as in the recommended ACLS algorithms themselves or earlier detection of cardiac arrests.

The presence of ACLS-trained personnel during cardiac arrest increases the likelihood of ROSC and is correlated with significantly better 1-year survival rates.[4] Additionally, the presence of an anesthesiologist has been shown to reduce failure to rescue rates in emergency resuscitation situations.[5] While key personnel are important, adherence to the specific content and timing of guidelines is often poor.[6] The time to defibrillation during in-hospital cardiac arrest (IHCA) is often delayed, which is correlated with worse outcome.[7] There is less robust data on the importance of the choice and timing of the medications, and the relationship between *overall* ACLS algorithm adherence throughout an entire IHCA event and patient outcome has not been documented.[7,8] Accordingly, we compared adherence to the 2005 AHA ACLS algorithms between initial survivors and non-survivors of IHCA. We hypothesized that adherence to the ACLS protocols would be significantly different between the two cohorts.

* Corresponding author.
*E-mail address:* field@musc.edu (L.C. Field).

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## 2. Methods

After the institutional review board approved this study and waived the requirement for written informed consent, a retrospective chart review of adherence to the 2005 AHA ACLS protocols during IHCAs was performed. Information was gathered on all in-hospital cardiac arrests between 2006 and 2008.

### 2.1. Setting and patient population

This study was performed at a 600-bed academic medical center. The personnel notified and responding to an IHCA at our institution include an internal medicine resident, an anesthesiology resident, a pharmacist, a respiratory therapist, an anesthesiology attending, and several nurses including an event recorder. All residents from every department are required to pass the AHA-endorsed ACLS provider course before beginning their training at our institution and to remain AHA ACLS current throughout their training.

For each event, the event recorder fills out a standard IHCA flow sheet, which contains demographic patient information, treated rhythm(s), event outcome, date of event, time of event, location of event, names of responders, and all actions taken during the event. This sheet contains all the data fields described in the Utstein Criteria and those entered into the Get With the Guidelines® database, along with a table for recording each action and the time that it was accomplished (e.g., drug administration, shock, etc.). After each event, the physician leader and the event recorder both sign and date the IHCA flow sheet to verify accuracy of the recorded information. The critical interventions manager then maintains the database of these IHCAs, which are also reported to the Get With the Guidelines® database, for internal quality assurance and improvement.

After Institutional Review Board approval was obtained for this study, the research staff was given access to the internal cardiac arrest database to allow identification of acceptable patients for enrollment. All adult (≥18 years) patients with a recorded cardiac arrest between December 2005 and June 2008 were screened for eligibility. To be included in the analysis, the patient must have suffered an IHCA, and the flow sheet must have been properly completed. Simple respiratory arrest patients were excluded to focus on the patients with cardiac dysrhythmias that required advanced medical management beyond basic life support and airway management. Proper completion of the event flow sheet included legible writing and completion of all data fields in a continuous timeline such that no gaps in data recording were evident.

### 2.2. Design

Enrollment of 150 patients (75 in each group) was targeted. This proportion was based upon published results of approximately 50% of IHCA patients having ROSC.[3,7] This sample size was based upon an estimate of identifying up to seven independent variables and van Belle's recommendations of needing at least 10 cases (deaths) for each independent variable that was to be included in a multi-variable analysis examining associations with ROSC after IHCA.[9] The primary association of interest was ROSC after IHCA and adherence to the established ACLS protocols. In addition to adherence to ACLS protocols, as measured by percentage of correct checklist actions; the most likely confounding variables prospectively identified for analysis were age, BMI, location of event, time of event, training level of code team leader, and expected mortality risk index (derived from each patient's Medicare severity diagnosis-related group severity of illness group-based, severity of illness-adjusted).

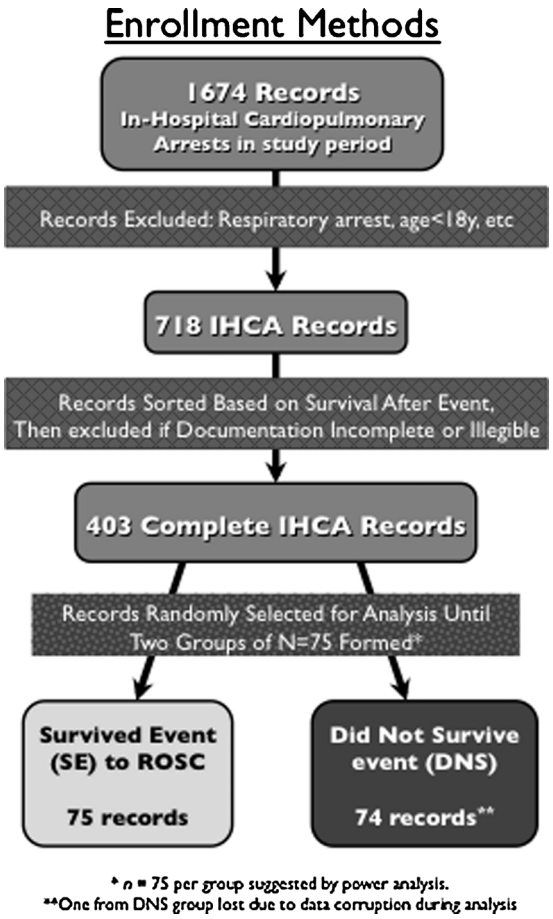


**Fig. 1.** CONSORT diagram for patient inclusion. Only adult in-hospital cardiac arrest patients with legible and complete charts were eligible for randomization. After meeting inclusion criteria, a random sample of 75 patients surviving to ROSC and a random sample of 75 patients that did not survive to ROSC formed the two groups of patients that underwent detailed abstraction and analysis.

### 2.3. Patient selection and data collection

There were 1674 in-hospital cardiac *and* respiratory arrests during the three-year study period. After exclusion for age < 18 years, respiratory arrest, and completeness and legibility of the event sheet, a total of 403 patients were identified who experienced an IHCA event in the specified period with a legible record. From those eligible IHCA patients, 75 patients who did not survive (DNS) to ROSC and 75 patients who did survive the event (SE) to ROSC were randomly selected, resulting in 150 total patients undergoing detailed abstraction for analysis. Prior to statistical analysis of the de-identified cases, one patient had to be removed from the DNS group due to unintended corruption of the case entry in the study database, thus decreasing the final number in the DNS group to 74 patients. Fig. 1 illustrates the CONSORT diagram for final patient inclusion.

From the handwritten event flow sheet and the electronic medical record, the patient's age, sex, BMI, race, date of the event, time of the event, location in the hospital at the time of the event, total number of rhythms treated, training level of the event leader (either resident or fellow/attending), and all actions performed during the event were recorded. Additionally, the expected mortality risk and the categorical severity of illness scores were extracted from the University Health Consortium database for each patient prior to de-identification of each case. Adherence to the 2005 ACLS protocol was then assessed using a validated grading checklist derived from AHA Guidelines.[10] The number of correct expected steps and