Resuscitation 92 (2015) 63–69

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

A performance improvement-based resuscitation programme reduces arrest incidence and increases survival from in-hospital cardiac arrest☆

Daniel P. Davis[a,*], Patricia G. Graham[b], Ruchika D. Husa[c,d], Brenna Lawrence[e], Anushirvan Minokadeh[f], Katherine Altieri[g], Rebecca E. Sell[h]

[a] Department of Emergency Medicine, University of California at San Diego, United States
[b] Department of Nursing Education, Development, Research, University of California at San Diego, United States
[c] Division of Cardiology, University of California at San Diego, United States
[d] Division of Cardiology, Ohio State University, United States
[e] Department of Nursing, University of California at San Diego, United States
[f] Department of Anesthesiology, University of California at San Diego, United States
[g] School of Medicine, University of California at San Diego, United States
[h] Division of Pulmonary and Critical Care Medicine, University of California at San Diego, United States

ARTICLE INFO

Article history:
Received 8 May 2014
Received in revised form 6 April 2015
Accepted 15 April 2015

Keywords:
Cardiac arrest
Resuscitation
CPR
Inpatient
Hospital
Training

ABSTRACT

Background: Traditional resuscitation training models are inadequate to achieving and maintaining resuscitation competency. This analysis evaluates the effectiveness of a novel, performance improvement-based inpatient resuscitation programme.
Methods: This was a prospective, before-and-after study conducted in an urban, university-affiliated hospital system. All inpatient adult cardiac arrest victims without an active Do Not Attempt Resuscitation order from July 2005 to June 2012 were included. The advanced resuscitation training (ART) programme was implemented in Spring 2007 and included a unique treatment algorithm constructed around the capabilities of our providers and resuscitation equipment, a training programme with flexible format and content including early recognition concepts, and a comprehensive approach to performance improvement feeding directly back into training. Our inpatient resuscitation registry and electronic patient care record were used to quantify arrest rates and survival-to-hospital discharge before and after ART programme implementation. Multiple logistic regression analysis was used to adjust for age, gender, location of arrest, initial rhythm, and time of day.
Results: A total of 556 cardiac arrest victims were included (182 pre- and 374 post-ART). Arrest incidence decreased from 2.7 to 1.2 per 1000 patient discharges in non-ICU inpatient units, with no change in ICU arrest rate. An increase in survival-to-hospital discharge from 21 to 45% ($p < 0.01$) was observed following ART programme implementation. Adjusted odds ratios for survival-to-discharge (OR 2.2, 95% CI 1.4–3.4) and good neurological outcomes (OR 3.0, 95% CI 1.7–5.3) reflected similar improvements. Arrest-related deaths decreased from 2.1 to 0.5 deaths per 1000 patient discharges in non-ICU areas and from 1.5 to 1.3 deaths per 1000 patient discharges in ICU areas, and overall hospital mortality decreased from 2.2% to 1.8%.
Conclusions: Implementation of a novel, performance improvement-based inpatient resuscitation programme was associated with a decrease in the incidence of cardiac arrest and improved clinical outcomes.
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1. Introduction

Sudden, unexpected cardiac arrest remains a leading cause of morbidity and mortality. Despite a renaissance in our understanding of the pathophysiology of arrest and potential therapies, reported survival remains low from both inpatient and out-of-hospital arrest.[1,2] The current cardiac arrest resuscitation paradigm

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2015.04.008.

* Corresponding author at: UCSD Emergency Medicine, 200 West Arbor Drive, #8676, San Diego, CA 92103, United States.
E-mail address: danieldavismd@gmail.com (D.P. Davis).

http://dx.doi.org/10.1016/j.resuscitation.2015.04.008
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emphasizes optimal performance of basic skills, such as chest compressions and ventilations.[3,4] However, the actual performance of these skills falls far short of expectations.[5]

Traditional resuscitation training models employ a generic course format based on a universal algorithm for all health care providers regardless of practice setting, equipment, experience, or level of training.[6] This model emphasizes ventricular fibrillation, which is more important in the out-of-hospital environment.[7,8] Traditional course content cannot be modified, exposures are infrequent – typically on a biennial basis, and a critical link to institution-specific performance improvement data does not exist. Providers assume multiple roles during training, which may result in confusion given the infrequency of resuscitation events.

In 2007, our institution implemented a novel resuscitation programme with the following core components: a unique treatment algorithm constructed around the specific capabilities of our providers and equipment, flexible training format and content emphasizing early recognition concepts, and a comprehensive approach to performance improvement with direct feedback to training. The main objective of this analysis was to document the impact of this resuscitation programme on clinical outcomes associated with inpatient cardiac arrest.

2. Methods

The University of California at San Diego Healthcare System includes two urban hospitals with a combined total of approximately 600 beds. Both receive ambulance admissions and have the capability for emergency percutaneous coronary intervention and targeted temperature management. A designated "Code Blue" team includes: physician leader (senior medicine resident or critical care fellow), nurse leader (critical care nurse), airway physician (emergency medicine attending or anesthesiology senior resident), respiratory therapist, and pharmacist. Additional staff from the activating unit and intensive care unit (ICU) may also respond. The nurse leader and respiratory therapist also respond to rapid response team (RRT) activations, with the physician leader available for consultation as needed.

2.1. Data collection and definitions

All adult (age ≥16 years) inpatient cardiac arrests from July 2005 through June 2012 were included. For the purposes of this analysis, a cardiac arrest was defined by the absence of a palpable pulse, the performance of chest compressions, or a defibrillation attempt. Code Blue team activation was not required for inclusion, as certain ICU-level units manage patients using available internal resources and do not request a formal "Code Blue" response. Cardiac arrest occurring in non-admitted patients, the operating room or emergency department, or in patients with active "Do Not Attempt Resuscitation" (DNAR) orders at the time of Code Blue activation were excluded. Eligible patients were identified using an electronic resuscitation database into which all resuscitation events are entered, with or without a formal "Code Blue" activation. The telecommunications log, which records all calls for emergency assistance throughout the hospital, and the resuscitation documentation field of the electronic patient care record (PCR) were cross-referenced to assure complete capture. Data were abstracted from the resuscitation database and the electronic PCR. Discharge rates and overall hospital mortality were available from hospital census data starting in July 2006. Waiver of informed consent was granted for this study by our Investigational Review Board.

2.2. Intervention

Until Spring 2007, all inpatient providers were required to maintain basic life support (BLS) certification; critical care providers were also required to maintain advanced cardiac life support (ACLS) certification. Institutional policies and procedures as well as the content of ACLS/BLS courses were modified in January 2006 to reflect updated American Heart Association (AHA)/International Liaison Committee on Resuscitation (ILCOR) guidelines and specific didactic sessions held for all providers as part of the implementation plan. In Spring 2007, the advanced resuscitation training (ART) programme for resuscitation management was introduced as a flexible, adaptive strategy for resuscitation oversight. The specific programme elements will be described below.

2.2.1. RRT

An institutional RRT was introduced as part of the ART programme to provide critical diagnostic and therapeutic assistance to decompensating patients. The RRT response includes a critical care nurse, respiratory therapist, and the charge nurse from the activating inpatient care unit. Emphasis on early recognition of the signs and symptoms of deterioration was integrated into ART and basic resuscitation training (BART) courses to assure timely and appropriate RRT activations.

2.2.2. Performance improvement

Performance improvement efforts document overall programme effectiveness, inform the training curriculum, and identify opportunity areas for additional intervention. The ART performance improvement team consists of a physician and a nurse, who provide data abstraction and clinical interpretation, as well as a data analyst. Clinical and demographic data are abstracted from the PCR and the institutional incident reporting system, while cardiopulmonary resuscitation (CPR) process data are exported from defibrillators. The ART performance improvement physician or nurse accesses the data card within 48 h of each arrest and analyzes CPR process data using defibrillator-specific software (RescueNet, ZOLL Medical, Chelmsford, MA). Documentation from the PCR is used as a reference to identify periods of spontaneous perfusion to accurately calculate chest compression fraction (CCF) values. All resuscitation events are reviewed by a multi-disciplinary committee to assure data accuracy and identify performance improvement issues.

All resuscitation events are categorized into a unique taxonomy based on four basic pathophysiological processes: circulatory, dysrhythmic, respiratory, and neurologic. Subcategories within each of these stimulate additional performance improvement-related data collection targeting preventability. In addition, the subcategories form the basis for case-specific feedback provided to code team members, which includes commentary regarding preventability, clinical arrest resuscitation performance, and CPR metrics. This feedback is compiled into a brief (2–3 pages) report by a critical care faculty member and disseminated to the participating Code Blue team members within 1 week of the event (see online supplement). In addition, summary data are presented to institutional committees and used to identify opportunity areas for institutional initiatives, guide changes to the institutional algorithms, and direct content of training sessions.

2.3. Treatment algorithms

Institutional treatment algorithms address both cardiac arrest as well as arrest prevention and are updated annually based on scientific evidence, performance improvement data, and available technologies. The algorithm is "hierarchical" and defines five therapeutic considerations: initial assessment, CPR, defibrillation, return of spontaneous circulation (ROSC), and post-arrest care (Fig. 1).

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