Published in final edited form as:

Resuscitation. 2014 March ; 85(3): 381–386. doi:10.1016/j.resuscitation.2013.12.008.

Outcomes associated with amiodarone and lidocaine in the treatment of in-hospital pediatric cardiac arrest with pulse less ventricular tachycardia or ventricular fibrillation☆

Santiago O. Valdes^{a,b,*}, Aaron J. Donoghue^c, Derek B. Hoyme^a, Rachel Hammond^a, Marc D. Berg^a, Robert A. Berg^c, Ricardo A. Samson^a, and the American Heart Association Get With The Guidelines-Resuscitation Investigators

^a Department of Pediatrics and Steele Children's Research Center, University of Arizona College of Medicine, Tucson, AZ, United States

^b Lillie Frank Abercrombie Section of Pediatric Cardiology, Texas Children's Hospital. Baylor College of Medicine, Houston. TX. United States

^c Departments of Anesthesiology and Critical Care and Pediatrics, Children's Hospital of Philadelphia, University of Pennsylvania School of Medicine, Philadelphia, PA, United States

^d Weslat Biostatistics & Data Management Core, Children's Hospital of Philadelphia, United States

Abstract

Aim—To determine the association between amiodarone and lidocaine and outcomes in children with cardiac arrest with pulse less ventricular tachycardia (pVT) and ventricular fibrillation (VF).

Background—Current AHA guidelines for CPR and emergency cardiovascular care recommend amiodarone for cardiac arrest in children associated with shock refractory pVT/VF, based on a single pediatric study and extrapolation from adult data.

Methods—Retrospective cohort study from the Get With the Guidelines-Resuscitation database for in-patient cardiac arrest. Patients < 18 years old with pVT/VF cardiac arrest were included. Patients receiving amiodarone or lidocaine prior to arrest or whose initial arrest rhythm was unknown were excluded. Univariate analysis was performed to assess the association between patient and event factors and clinical outcomes. Multivariate analysis was performed to address independent association between lidocaine and amiodarone use and outcomes.

Results—Of 889 patients. 171 (19%) received amiodarone, 295 (33%) received lidocaine. and 82 (10%) received both. Return of spontaneous circulation (ROSC) occurred in 484/889 (54%), 24-h survival in 342/874 (39%), and survival to hospital discharge in 194/889 (22%). Lidocaine

☆A Spanish translated version of the summary of this article appears as Appendix in the final online version at <http://dx.doi.org/10.1016/j.resuscitation.2013.12.008>.

© 2013 Elsevier Ireland Ltd. All rights reserved.

* Corresponding author at: 6621 Fannin Street Suite 19345-C. Houston. TX 77030. United States. svaldes@bcm.edu (S.O. Valdes).

Conflict of interest statement

The authors have no conflicts to disclose.

was associated with improved ROSC (adjusted OR 2.02, 95% CI 1.36-3). and 24-h survival (adjusted OR 1.66, 95% CI 1.11-2.49), but not hospital discharge. Amiodarone use was not associated with ROSC, 24 h survival, or survival to discharge.

Conclusions—For children with in-hospital pVT/VF, lidocaine use was independently associated with improved ROSC and 24-h survival. Amiodarone use was not associated with superior rates of ROSC, survival at 24 h. Neither drug was associated with survival to hospital discharge.

Keywords

Amiodarone; Lidocaine; Cardiac arrest; Pediatrics; Ventricular fibrillation

1. Introduction

Cardiac arrest in the pediatric population remains a significant cause of morbidity and mortality.¹ Most pediatric in-hospital cardiac arrests present with the non-shockable rhythms of asystole or pulseless electrical activity (PEA). Nevertheless, pulseless ventricular tachycardia (pVf) and ventricular fibrillation (VF) occur in up to 27% of in-hospital events.^{2,3} Although the data for pharmacologic treatment of pediatric refractory pVT/VF are limited, current American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and emergency cardiovascular care (ECC) recommend the use of amiodarone as the first anti-arrhythmic medication for shock refractory pVT/VF.⁴ The recommendation is based on a single pediatric study⁵ supporting the safety and efficacy of amiodarone in children with ventricular tachycardia without cardiac arrest and on data in adult populations of out-of-hospital cardiac arrest showing improved survival to hospital admission with the use of amiodarone as compared to lidocaine.⁶⁻⁹ While data from adults is often extrapolated to the pediatric population, the comparison may not be ideal since the etiology of cardiac arrest is often different in adults. To date, there have been no pediatric studies directly assessing the effectiveness of lidocaine for ventricular arrhythmias, and no studies evaluating anti-arrhythmic medication use and hospital outcome in pediatric patients having cardiac arrest.

The aim of our study was to determine the association between amiodarone and lidocaine use and clinical outcomes in children¹⁰ with cardiac arrest due to pVT/VF. Based on adult literature, we hypothesized that the use of amiodarone would be associated with improved survival outcomes, and that lidocaine would not be associated with improved survival outcomes. We addressed these hypotheses through analysis of in-hospital pediatric CPR events reported to the American Heart Association's multi-center Get With The Guidelines-Resuscitation (GWTG-R) registry from 2000 to 2008.

2. Methods

This was a retrospective cohort study from a multihospital database of patients receiving chest compressions and/or defibrillation for in-hospital cardiac arrest from January 2000 to February 2008. The study was approved by the Institutional Review Boards of The University of Arizona College of Medicine and The Children's Hospital of Philadelphia.

2.1. GWTG-R

The American Heart Association's Get With the Guidelines-Resuscitation registry (GWTG-R; formerly the National Registry of Cardiopulmonary Resuscitation) is a prospective, multisite, in-hospital resuscitation registry sponsored by the AHA. Hospitals join the GWTG-R registry voluntarily. At each participating institution, research coordinators abstract information about cardiac arrests from hospital medical records. The database contains precisely defined variables derived from the Utstein-style data reporting guidelines for cardiac arrest.^{10,11} Data abstractors must complete a certification examination consisting of multiple-choice questions and mock scenarios covering operational definitions and criteria for inclusion and exclusion. Case study methodology is used to evaluate data abstraction, entry accuracy, and operational definition compliance before acceptance of data transmission.

The six major categories of variables are facility data, patient demographic data, pre-event data, event data, outcome data, and quality improvement data. Explicit operational definitions were generated for every data element. Cardiac arrest is defined as the cessation of cardiac mechanical activity, determined by the absence of palpable central pulse, unresponsiveness and apnea. Initial pulseless VT and VF are defined as pVT and VF that occurs as the first documented cardiac arrest rhythm. Subsequent pVT or VF is defined as pVT or VF that occurs at some time during the subsequent resuscitation but not as the first documented cardiac arrest rhythm. Subsequent pVT and VF arrests are combined as a single data element in this database because they have similar epidemiologic characteristics, behavior and treatment.

Each patient is assigned a unique code, and specific patient identifiers are not sent to the central database repository, which is in compliance with the Health Insurance Portability and Accountability Act. The data are securely transmitted to the central database repository. The AHA oversees the entire process of data collection, analysis, and reporting through its national center staff, scientific advisory board and executive database steering committee. The primary purpose of the GWTG-R is quality improvement by benchmarking against national and peer standards; participating hospitals are therefore not required to obtain approval from their institutional review boards.

2.2. Inclusion and exclusion criteria

Data were analyzed from 242 hospitals that provided data for at least 6 months during the study period from January 2000 to February 2008. All patients who were younger than 18 years and sustained a clinical event that required chest compressions for at least 2 min at a participating hospital were eligible for inclusion. According to GWTG-R operational definitions, a CPR event includes any event characterized by either pulselessness or critically compromised perfusion treated with chest compressions and/or defibrillation, when a unit-wide or hospital-wide emergency response was activated. Events that commence out-of-hospital and events in newborn infants in the delivery suite are excluded. Patients whose resuscitation response was altered as the result of an advanced directive or pre-existing "do not attempt resuscitation (DNAR)" order were excluded.

For our study, all patients meeting database operational definitions who had documented pVT/VF at some point during their event were included. Patients were excluded if they had no pVT/VF, if they were receiving lidocaine and/or amiodarone therapy prior to their event, or if their initial arrest rhythm was unknown.

For the purpose of this study, the prospectively determined primary outcome variable was return of spontaneous circulation (ROSC). Secondary outcomes included 24-h survival and survival to hospital discharge.

2.3. Descriptive and univariate analysis

A list of patient and event characteristics were defined by the investigators *a priori* for consideration as possible confounders based on significant associations with clinical outcomes in prior analyses of pediatric data from the GWTG-R registry (Table 1).^{2,3,12,13} Event duration was defined as the time interval from the delivery of the first chest compression until either the time of sustained ROSC (lasting >20 min) or the time when resuscitation efforts were terminated. Respiratory support was defined as the presence of one of the following: assisted ventilation, mechanical ventilation, or inhaled nitric oxide. Cardiovascular support was defined as the presence of one of the following: any vasoactive infusion, any antiarrhythmic infusion (other than lidocaine or amiodarone), a pulmonary artery catheter, or an intra-aortic balloon pump. Monitored was defined as presence of ECG, pulse oximetry, or apnea monitor. Newborns were those patients < 1 month of age, infants were 1 month to 1 year old, children were 1- 11 years old and adolescents were 12- 17 years old. Univariate comparison between survivors and non-survivors for each outcome was made for each variable in the *a priori* set of potential confounders using Chi Square testing with a significance level of 0.05.

2.4. Multivariate analysis

All continuous variables of interest were collapsed to nominal variables by observing the results of a logistic regression for every possible binary cut point and choosing the cut point with the maximum test statistic, for each outcome. Logistic regression models were used to examine the effect of variables of interest on binary survival outcomes. For each outcome, a multivariable model was fit to include the covariates determined to be significant with a *p*-value < 0.10 in the univariate model. A final model, for each binary survival outcome, consisted of all factors that were associated with the outcome in the multivariable model with a *p*-value < 0.05. Generalized estimating equations with the facility as a random intercept were used to control for within-facility covariance.

3. Results

There were 9280 index cardiac arrests events in children during the study period with pVT/VF documented in 1099 (12%) at some point during their resuscitation event. After excluding patients with lidocaine or amiodarone therapy in place prior to the event and patients with missing data, 889 patients were included in the final data set.

Clinical characteristics of patients are shown in Table 2. There are no differences in clinical characteristics in patients receiving amiodarone, lidocaine, both, or no anti-arrhythmics.

Event characteristics and treatment variables are summarized in Tables 3A and 3B. There were 171 (19%) subjects who received amiodarone, 295 (33%) who received lidocaine, and 82 (10%) who received both. In the study data set, ROSC occurred in 484/889 (54%), 24-h survival in 342/874 (39%), and survival to hospital discharge in 194/889 (22%).

Of 89 patients who received only amiodarone, 39 (44%) had ROSC, 27 (30%) survived 24 h and 15 (17%) survived to hospital discharge. Of 213 patients who received only lidocaine, 136 (64%) had ROSC, 100 (47%) survived 24 h and 54 (25%) survived to hospital discharge. There were 82 patients receiving both amiodarone and lidocaine. Of these, 48 (59%) had ROSC, 32 (39%) survived 24 h and 22 (27%) survived to hospital discharge. Of 505 patients that received no anti-arrhythmic medication 260 (51%) had ROSC, 120 (24%) survived 24 h and 103 (20%) survived to hospital discharge. Patients receiving lidocaine only had statistically significant better ROSC compared to patients receiving amiodarone only or no anti-arrhythmic medication (p values 0.002 and 0.002 respectively), and better 24-h survival ($p = 0.01$ and <0.001). There was no statistically significant difference at ROSC and 24-h survival for patients receiving amiodarone only compared to no anti-arrhythmic medication. There was no statistically significant difference in survival to hospital discharge in all three groups.

Results of multivariate analysis for each outcome are shown in Table 4. Because there was no univariate association between amiodarone and any of the outcomes of interest, amiodarone was excluded from the final multivariate analysis. Amiodarone use was not associated with ROSC, 24-h survival or survival to hospital discharge. Interestingly, lidocaine use was independently associated with ROSC and 24-h survival, but there was no association between lidocaine use and survival to hospital discharge.

Results of outcomes of patients with initial pVT/VF and subsequent pVT/VF are summarized in Table 5. Of 514 patients with initial pVT/VF, 56 received amiodarone, 135 received lidocaine and 56 received both. Of 375 patients with subsequent pVT/VF, 33 received amiodarone and 78 received lidocaine, and 26 received both. Rates of ROSC, 24-h survival and survival to hospital discharge were higher with initial pVT/VF compared to subsequent pVT/VF.

Because the 2005 AHA guidelines for CPR and ECC clearly recommended amiodarone use for pVT/VF rather than lidocaine, we compared the use of amiodarone versus lidocaine in the period of 2000- 2005 compared with 2006 to 2008. There was an increase in the use of amiodarone in 2006 and after from 11% to 37%, as well as a decrease in the use of lidocaine from 64% to 45% ($p < 0.001$). Lidocaine use continued to be more prevalent than amiodarone despite the changes in the guidelines.

4. Discussion

This report of in-hospital cardiac arrests is the first report examining the association between amiodarone and lidocaine administration and outcomes in pediatric cardiac arrest with pVT/VF. We found that, among children with in-hospital cardiac arrest due to pVT/VF, lidocaine was independently associated with ROSC and 24 h survival. Contrary to our

hypothesis, amiodarone had no association with any survival outcomes. The association between lidocaine use and survival remained significant while controlling for important patient, event, and treatment confounders, which have previously been shown to influence outcomes from pediatric in-hospital cardiac arrest. Importantly, neither lidocaine nor amiodarone was associated with survival to discharge in this cohort of patients.

Among the other significant findings from our analysis were that cardiac surgical and non-surgical patients had improved survival to discharge, while trauma patients had worse outcomes. Subsequent pVT/VF was associated with worse outcomes and events in the operating room were associated with improved survival. Finally, events greater than 10 min duration, events where greater than 3 doses of epinephrine were given, and events having 4 or more attempts at defibrillation were all associated with worse survival. All of these findings are in keeping with previously reported data from the NRCPR/GWTG-R registry.^{2,3} The association between lidocaine and ROSC and 24 h survival remained significant while controlling for all of these confounders.

Among pediatric cardiac arrest patients, shockable rhythms have traditionally been considered relatively uncommon, occurring as the initial rhythm in only 10% of patients. However, recent publications from the NRCPR/GWTG-R registry have shown that pVT/VF may be more prevalent than previously appreciated. Samson et al. showed that a shockable rhythm occurred at some point during resuscitation for cardiac arrest in 27% of children, and that the development of a shockable rhythm during an ongoing resuscitation that began with a non-shockable rhythm (so-called 'subsequent' pVT/VF) was a predictor of nonsurvival.² This greater prevalence of shockable rhythms in children with in-hospital cardiac arrest highlights the lack of robust experimental data clearly demonstrating optimal management strategies in pediatric pVT/VF. One recent example of the evolving understanding of pediatric pVT/VF is the change in published recommendations for initial defibrillation dose from 2J/kg to 2-4J/kg⁴, a change prompted by multiple studies demonstrating the ineffectiveness of an initial dose of 2J/kg.^{14,15} On the other hand, the most recent data from the NRCPR/GWTG-R registry by Meaney et al. suggest that lower electricity doses (<2J/kg) are associated with a higher frequency of ROSC.³ Substantial knowledge gaps remain in the treatment of pediatric pVT/VF, including but not limited to the use of antiarrhythmic medications.

Current AHA guidelines for CPR and ECC⁴ recommend amiodarone as initial antiarrhythmic medication treatment for pVT/VF refractory to defibrillation and epinephrine based on randomized controlled trials in adults with out-of-hospital VF demonstrating improved survival to admission⁶⁻⁹ and a single pediatric case series of patients with life-threatening arrhythmias, including VT⁵. The consensus statement accompanying the guidelines clearly states that no data exist investigating the efficacy of lidocaine or amiodarone in pediatric cardiac arrest associated with pVT/VF. Thus, our study represents the first analysis of antiarrhythmic use in children with cardiac arrest from these shockable rhythms. Similar to the adult studies cited above which serve as the basis for antiarrhythmic drug use in current Advanced Cardiac Life Support guidelines, our data demonstrate that lidocaine is associated with ROSC and short term survival, but not survival to hospital discharge.

It is noteworthy that, despite amiodarone being a recommended treatment for pediatric cardiac arrest due to pVT/VF, only 19% of patients in the GWTG-R database meeting these criteria during the study period received amiodarone, while 33% received lido-caine. Reasons for the lack of widespread use of amiodarone for children with pVT/VF are not clear. Published articles on amiodarone toxicity in children have shown a significant prevalence of significant hemodynamic side effects such as hypotension and bradycardia,¹⁶ as well as prolongation of ventricular repolarization and potentiating ventricular dysrhythmias in patients with Long QTsyndrome.^{17,18} Longstanding historical use of lidocaine for pediatric ventricular arrhythmia may also be a factor. Nevertheless, the use of amiodarone for cardiac arrests in children associated with pVT/VF increased over time, during the study period, as has been described in adults with in-hospital cardiac arrest.¹⁹

Several limitations of our study should be acknowledged. Our study utilized a retrospective database, which uses strict operational definitions and mandatory periodic abstraction to maintain data integrity. Despite these quality assurances, issues related to data integrity at individual sites must be considered a potential limitation. The GWTG-R registry consists of a finite group of hospitals that voluntarily participate and enroll patients; generalization of our findings to all hospitals may be limited. Finally, the existing data fields in the GWTG-R registry contain detailed times to administration of common vasopressors (epinephrine and vasopressin) and defibrillation, but there is no data on the dosage, timing or sequence of antiarrhythmic medication administration. It is not possible to determine whether any differences in outcome are related to the dosing and timing of lidocaine and/or amiodarone administration during an ongoing resuscitation.

5. Conclusions

In a multihospital database of children with in-hospital cardiac arrest due to pVT/VF, the use of lidocaine was independently associated with ROSC and 24 h survival while controlling for confounding patient, event, and treatment factors. Amiodarone had no association with ROSC or 24 h survival. Neither drug was associated with survival to discharge. Future randomized studies should prospectively examine the impact of antiarrhythmic drug therapy on children with pVT/VF.

Abbreviations

AHA	American Heart Association
CPR	cardia pulmonary resuscitation
DC	discharge
ECC	emergency cardiovascular care
ECG	electrocardiogram
GWTG-R	Get With The Guidelines-Resuscitation
NRCPR	National Registry of Cardiopulmonary Resuscitation
ROSC	return of spontaneous circulation

pVT	pulseless ventricular tachycardia
VF	ventricular fibrillation

References

1. Nadkarni VM, Larkin GL, Peberdy MA, et al. First documented rhythm and clinical outcomes from in-hospital cardiac arrest among children and adults. *JAMA*. 2006; 295:50–7. [PubMed: 16391216]
2. Samson RA, Nadkarni VM, Meaney PA, Carey SM, Berg MD, Berg RA. Outcomes of in-hospital ventricular fibrillation in children. *N Engl J Med*. 2006; 354:2328–39. [PubMed: 16738269]
3. Meaney PA, Nadkarni VM, Atkins DL, et al. Effect of defibrillation energy dose during in-hospital pediatric cardiac arrest. *Pediatrics*. 2011; 127:e16–23. (Epub 2010 December 20).
4. Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: pediatric advanced life support : 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and emergency cardiovascular care. *Circulation*. 2010; 122:S876–908. [PubMed: 20956230]
5. Perry JC, Fenrich AL, Hulse JE, Triedman JK, Friedman RA, Lamberti JJ. Pediatric use of intravenous amiodarone: efficacy and safety in critically ill patients from a multicenter protocol. *J Am Coll Cardiol*. 1996; 27:1246–50.
6. Kudenchuk PJ, Cobb LA, Copass MK, et al. Amiodarone for resuscitation after out-of-hospital cardiac arrest due to ventricular fibrillation. *N Engl J Med*. 1999; 341:871–8. [PubMed: 10486418]
7. Dorian P, Cass D, Schwartz B, Cooper R, Gelaznikas R, Barr A. Amiodarone as compared with lidocaine for shock-resistant ventricular fibrillation. *N Engl J Med*. 2002; 346:884–90. [PubMed: 11907287]
8. Scheinmann MM, Levine JH, Cannom OS, et al. Dose-ranging study of intravenous amiodarone in patients with life-threatening ventricular tachyarrhythmias. The Intravenous Amiodarone Multicenter Investigators Group. *Circulation*. 1995; 92:3264–72. [PubMed: 7586313]
9. Somberg JC, Bailin SJ, Haffajee CI, et al. Intravenous lidocaine versus amiodarone (in a new aqueous solution) for incessant ventricular tachycardia. *Am J Cardiol*. 2002; 90:853–9. [PubMed: 12372573]
10. Zaritsky A, Nadkarni V, Hazinski MF, et al. Recommended guidelines for uniform reporting or pediatric advanced life support: the Pediatric Utstein Style. A statement for healthcare professionals from a task force of the American Academy of Pediatrics, the American Heart Association, and the European Resuscitation Council. *Resuscitation*. 1995; 92:2006–20.
11. Jacobs I, Nadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Councils of Southern Africa). *Circulation*. 2004; 110:3385–97. [PubMed: 15557386]
12. Donoghue AJ, Nadkarni VM, Elliott M, Durbin D. Effect of hospital characteristics on outcomes from pediatric cardiopulmonary resuscitation: a report from the National Registry of Cardiopulmonary Resuscitation. *Pediatrics*. 2006; 118:995–1001. [PubMed: 16950990]
13. Meaney PA, Nadkarni VM, Cook EF, et al. Higher survival rates among younger patients after pediatric intensive care unit cardiac arrests. *Pediatrics*. 2006; 118:2424–33. [PubMed: 17142528]
14. Berg MB, Samson RA, Meyer RJ, et al. Pediatric defibrillation doses often fail to terminate prolonged out-of-hospital ventricular fibrillation in children. *Resuscitation*. 2005; 67:63–7. [PubMed: 16199288]
15. Rossano JW, Quan L, Kenney MA, Rea TD, Atkins DL. Energy doses for treatment of out-of-hospital pediatric ventricular fibrillation. *Resuscitation*. 2006; 70:80–9. [PubMed: 16762479]
16. Saul JP, Scott WA, Brown S, et al. Intravenous amiodarone for incessant tachyarrhythmias in children: a randomized, double-blind, anti-arrhythmic drug trial. *Circulation*. 2005; 112:3470–7. [PubMed: 16316969]

17. Nkomo V, Shen WK. Amiodarone-induced long QT and polymorphic ventricular tachycardia. *Am J Emerg Med.* 2001; 19:246–8. [PubMed: 11326361]
18. Fishberger SB, Hannan RL, Welch EM, Rossi AF. Amiodarone for pediatric resuscitation: a word or caution. *Pediatr Cardiol.* 2009; 30:1006–8. [PubMed: 19495851]
19. October TW, Schleien CL, Berg RA, et al. Increasing amiodarone use in cardiopulmonary resuscitation: an analysis of the National Registry of Cardiopulmonary Resuscitation. *Crit Care Med.* 2008; 36:126–30. [PubMed: 18090352]

Table 1

Patient and event factors.

Patient factors (dichotomous)	Event factors (dichotomous)	Treatment variables (continuous)
•Pre-existing CV support	•Witnessed	•Defibrillation attempts (number)
•Pre-existing respiratory support	•Weekend	•Epinephrine doses (number)
•Monitored	•Subsequent vs. initial pVT/VF	•Event duration (minutes)
Patient factors (categorical)	Event factors (categorical)	•Time from event to CPR (minutes)
•Age	•Event location	•Time from pVT/VF to defibrillation (minutes)
•Illness category	○ICU	•Time from event to epinephrine (minutes)
Cardiac surgery	○ED	
○Cardiac - non-surgical	○OR/PACU	
○Trauma	○Diagnostic/interventional	
○All others	○Ward	
	○Other	

CV. cardiovascular; pVT/VF, pulseless ventricular tachycardia/ventricular fibrillation; ICU, intensive care unit; ED, emergency department; OR, operating room; PACU, post anesthesia care unit; CPR. cardiopulmonary resuscitation.

Table 2

Patient clinical characteristics.

Patient characteristic	All (N = 889)	ROSC (N = 484)	24-h survival (N = 342)	Survival to discharge (N = 194)
Age category				
Newborn (<1 month)	149	99 (66%)	83 (56%)	36 (24%)
Infant (1 month-1 year)	196	104 (53%)	79 (23%)	49 (25%)
Child (1-11 years)	280	161 (58%)	108 (39%)	61 (22%)
Adolescent (12-17 years)	264	120 (45%)	72 (27%)	48 (18%)
Illness category				
Cardiac - surgical	216	144 (67%)	136 (63%)	71 (33%)
Cardiac - non-surgical	185	104 (56%)	79 (26%)	51 (28%)
Trauma	123	52 (42%)	16(13%)	11 (9%)
All others	364	184 (51%)	111 (31%)	61 (17%)
Cardiovascular support				
Yes	41 1	227 (55%)	157 (38%)	72 (18%)
No	478	257 (53%)	185 (39%)	122 (26%)
Respiratory support				
Yes	683	382 (56%)	265 (38%)	137 (20%)
No	206	102 (50%)	77 (37%)	57 (28%)

Note: Percentages in each row reflect the percentage of patients within each group; ROSC, return of spontaneous circulation for >20 min.

Table 3A

Treatment variables.

Treatment	All (N= 889)	ROSC		24-h survival		Survival to discharge	
		Yes	No	Yes	No	Yes	No
Duration of CPR (minutes)	35 ($\pm$ 36) ^a	20 ^b	34	20 ^b	31 ^b	17 ^b	30 ^b
Defibrillation attempts	3 ($\pm$ 4) ^a	2 ^b	3 ^b	2 ^b	3 ^b	2 ^b	3 ^b
Epinephrine doses	5 ($\pm$ 4) ^a	3 ^b	5 ^b	3 ^b	5 ^b	3 ^b	4 ^b
Lidocaine (number of patients)	295/889 (33%)	184/295 (62%)	111/295 (38%)	132/295 (45%)	163/295 (55%)	76/295 (26%)	219/295 (74%)
Amiodarone (number of patients)	171/889 (19%)	87/171 (51%)	84/171 (49%)	59/171 (35%)	112/171 (65%)	37/171 (22%)	134/171 (78%)

Note: Percentages in each row reflect the percentage of patients within that group.

^a Mean($\pm$ SD).

^b Mean ROSC - return of spontaneous circulation for >20 min.; CPR, cardiopulmonary resuscitation.

Table 3B

Event characteristics.

Event characteristics	All (N=889)	ROSC		24-h survival		Survival to discharge	
		Yes (N = 484)	No (N = 405)	Yes (N = 342)	No (N = 547)	Yes (N = 194)	No (N = 695)
Monitored							
Yes	843 (95%)	95%	94%	97%	94%	93%	95%
No	46 (5%)	5%	6%	3%	6%	7%	5%
Witnessed							
Yes	852 (96%)	96%	96%	97%	95%	95%	96%
No	37 (4%)	4%	4%	3%	5%	5%	4%
Weekend							
Yes	263 (33%)	31%	36%	28%	37%	29%	35%
No	526 (67%)	69%	64%	72%	63%	71%	65%
Event location							
ICU	649 (73%)	74%	72%	77%	72%	69%	74%
ED	86 (9%)	9%	11%	5%	12%	9%	10%
Ward	60 (7%)	6%	8%	5%	8%	5%	7%
OR/PACU	44 (5%)	6%	4%	6%	4%	10%	4%
Diagnostic/interventional	24 (3%)	3%	3%	3%	3%	3%	3%
Other	26 (3%)	4%	2%	4%	2%	4%	3%
Initial pVT/VF	514 (58%)	68%	45%	71%	49%	76%	53%
Subsequent pVT/VF	375 (42%)	32%	54%	29%	51%	24%	47%

The percentages in each row reflect the percentage of patients within that group. ROSC, return of spontaneous circulation for >20 min; pVT/VF, pulseless ventricular tachycardia/ventricular fibrillation; ICU, intensive care unit; ED, emergency department; OR, operating room; PACU, post anesthesia care unit.

Table 4

Multivariate analysis.

Characteristic	Adjusted OR for ROSC (95% CI)	Adjusted OR for 24-h survival (95% CI)	Adjusted OR for survival to discharge (95% CI)
Patient characteristics			
Cardiovascular support	NS	NS	0.43 (0.24-0.78)
Respiratory support	NS	NS	0.45 (0.24-0.83)
Cardiac surgery patient (compared to non-cardiac)	2.15 (1.35-3.45)	4.22 (2.65-6.71)	2.65 (1.36-5.20)
Cardiac non-surgical patient (compared to non-cardiac)	NS	1.95 (1.19-3.19)	2.14 (1.08-4.23)
Trauma patient (compared to non-cardiac)	0.51 (0.28-0.93)	0.18 (0.08-0.40)	0.18 (0.06-0.59)
Event characteristics			
Subsequent pVT/VF (compared with initial pVT/VF)	NS	0.45 (0.30-0.67)	0.38 (0.21-0.67)
Event in operating room/PACU	NS	NS	5.37 (1.63-17.74)
Treatment characteristics			
Lidocaine	2.02 (1.36-3.00)	1.66 (1.11-2.49)	NS
Event duration ^a	16 min	10 min	11 min
	3.23 (1.96-5.34)	4.55 (2.68-7.73)	2.50 (1.28-4.85)
Defibrillation attempts ^a	4 attempts 2.49 (1.57-3.96)	4 attempts 3.05 (1.77-5.24)	3 attempts 2.03 (1.09-3.79)
Epinephrine 3 doses	2.17 (1.43-3.29)	NS	2.22 (1.24-3.98)
Time to defibrillation	NS	1.66 (1.06-2.58)	NS
<1 min			

CI, confidence interval; NS, not statistically significant; pVT/VF, pulseless ventricular tachycardia/ventricular fibrillation; OR, odds ratio; ROSC, return of spontaneous circulation for >20min; PACU, post anesthesia care unit.

^aSpecific cutoff points for continuous variables are shown for each multivariate model.

Table 5

Outcomes of patients with initial pVT/VF and subsequent pVT/VF.

Treatment group	ROSC	24 h survival	Survival to DC
Initial pVT/VF (N = 514)	328 (64%)	244 (47%)	148 (29%)
Amiodarone (N = 56)	30 (54%)	23 (41%)	14 (25%)
Lidocaine (N = 135)	94 (70%)	72 (53%)	43 (32%)
None (N = 267)	169 (64%)	60 (25%)	73 (27%)
Both (N = 56)	35 (63%)	26 (46%)	18 (32%)
Subsequent pVT/VF (N = 375)	155 (41%)	98 (26%)	46 (12%)
Amiodarone (N = 33)	9 (27%)	4 (12%)	1 (3%)
Lidocaine (N = 78)	42 (54%)	28 (36%)	11 (14%)
None (N = 238)	91 (38%)	60 (25%)	30 (13%)
Both (N = 26)	13 (50%)	6 (23%)	4 (15%)

DC, discharge; pVT/VF, pulseless ventricular tachycardia/ventricular fibrillation; ROSC, return of spontaneous circulation for >20 min.