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A Quantitative Analysis of Out-of-Hospital Pediatric and Adolescent Resuscitation Quality–A Report from the ROC Epistry–Cardiac Arrest

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*See Appendix A

Conflicts of Interest

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Abstract

Aim—High-quality cardiopulmonary resuscitation (CPR) may improve survival. The quality of CPR performed during pediatric out-of-hospital cardiac arrest (p-OHCA) is largely unknown. The main objective of this study was to describe the quality of CPR performed during p-OHCA resuscitation attempts.

Methods—Prospective observational multi-center cohort study of p-OHCA patients ≥1 and < 19 years of age registered in the Resuscitation Outcomes Consortium (ROC) Epistry database. The primary outcome was an *a priori* composite variable of compliance with American Heart Association (AHA) guidelines for both chest compression (CC) rate and CC fraction (CCF). Event compliance was defined as a case with 60% or more of its minute epochs compliant with AHA targets (rate 100–120 min^{-1}; depth ≥38 mm; and CCF ≥0.80). In a secondary analysis, multivariable logistic regression was used to evaluate the association between guideline compliance and return of spontaneous circulation (ROSC).

Results—Between December 2005 and December 2012, 2,564 pediatric events were treated by EMS providers, 390 of which were included in the final cohort. Of these events, 22% achieved AHA compliance for both rate and CCF, 36% for rate alone, 53% for CCF alone, and 58% for depth alone. Over time, there was a significant increase in CCF ($p < 0.001$) and depth ($p=0.03$). After controlling for potential confounders, there was no significant association between AHA guideline compliance and ROSC.

Conclusions—In this multi-center study, we have established that there are opportunities for professional rescuers to improve prehospital CPR quality. Encouragingly, CCF and depth both increased significantly over time.

Introduction

Pediatric out-of-hospital cardiac arrest (p-OHCA) affects thousands of children around the world each year.[1–4] Over the past decade, there have been significant improvements in survival after pediatric in-hospital cardiac arrest;[5] yet, p-OHCA continues to be associated with poor outcome. Best estimates reveal that less than 10 percent of children will survive to hospital discharge with favorable neurological outcome after p-OHCA.[1–3] The potential years of lost productive life are substantial.

Several studies have demonstrated that professional rescuer CPR has room for improvement.[6–10] Inadequate chest compression rate[9,11,12] and depth,[10,13] and long interruptions in CPR,[6–8] have been particularly problematic. As of yet, these studies have excluded p-OHCA resuscitation, focusing on either adult or in-hospital pediatric CPR quality. As high CPR quality is associated with improved cardiac arrest outcome,[6,9,10,14,15] investigations designed to describe current practice and suggest areas for improvements in prehospital resuscitation quality are an attractive approach to improve outcomes.

When compared to adults, relatively little quantitative CPR data have been collected in children during cardiac arrest. As a result, pediatric CPR guidelines have been developed with data often extrapolated from adult and animal investigations.[16,17] Most of what we know about pediatric resuscitation quality comes from single center in-hospital investigations.[12,14,18–20] As such, there is a need for larger pediatric studies that can describe resuscitation practice, and rigorously evaluate the association between CPR quality measures and survival in children.

The main objective of this study was to describe the quality of CPR performed during p-OHCA resuscitation attempts. The secondary objective was to evaluate the association between American Heart Association (AHA) guidelines and survival outcomes. We hypothesized that the quality of out-of-hospital pediatric CPR would frequently not meet recommended care targets, and further, that CPR performed in compliance with AHA guidelines[17] is associated with improved short term survival.

Methods

Design and Setting

This was a prospective observational cohort study of data collected from the Resuscitation Outcomes Consortium (ROC). The ROC consists of 36,000 EMS professionals within 260 EMS agencies transporting patients to 287 different hospitals.[21] This study includes ROC Epistry–Cardiac Arrest[22] patients treated by EMS and for whom pediatric CPR quality data was available (101 agencies from 11 sites). Appropriate local institutional review boards (U.S.) or research ethics boards (Canada) granted a waiver of documentation of written consent under minimal risk criteria. Strict confidentiality was maintained at all times and no personal identifiers were retained in the database.

Population

We included all children < 19 years of age from the ROC Epistry who received chest compressions (CCs) by EMS providers for non-traumatic cardiac arrest. We excluded patients < 1 year of age in an attempt to omit cases of sudden infant death syndrome (SIDS), where the likelihood of a good outcome irrespective of resuscitation quality is exceedingly rare.[1] We excluded cases with < 1 minute of quantitative data for rate or chest compression fraction (fraction of time during cardiac arrest that CCs are provided; CCF). Compression depth data were available for only a fraction of cases because commercially available CPR recording devices are primarily approved for older children (≥8 years of age)[12] and many monitors do not measure or report this variable.

Data Collection

Quantitative CPR quality data was obtained by commercially available CPR recording defibrillators (Physio-Control, Redmond, WA: n=227; Philips Healthcare, Andover MA: n=40; Zoll Medical Corporation, Chelmsford, MA: n=113; Other/unknown: n=10). CPR feedback was available on all monitors; however, this study did not capture which responding agencies employed the technology (i.e., was feedback enabled?). Therefore, we cannot report with certainty which cases received CPR feedback. The following CPR process measures were collected when available: 1) CC rate (min^{-1}); 2) depth (mm); and 3) CCF. Averages during each minute of recorded CPR were collected for each subject. Only the first ten minutes of CPR with quantitative data were included in the analysis.

Patient and clinical data were abstracted from EMS and hospital records by trained research staff at the individual study sites using standardized definitions for patient characteristics, EMS processes, and outcomes. After local abstraction, data were de-identified and then transmitted electronically to the data coordinating center (DCC). Data quality assurance by the DCC included internal checks for consistency of the data, comparisons to reference ranges, data audits, and site visits.[22]

Study Variables

Event compliance with AHA guidelines was defined *a priori* as a case with 60% or more of its minute epochs[10,14,15] compliant with AHA targets (rate 100–120 min^{-1}; depth ≥38mm (2005 AHA recommendation); and CCF ≥0.80.[23,24] The definition for AHA compliance includes recommendations from the 2013 AHA CPR Quality Consensus Statement[24] and the 2005 Guidelines.[23] The authors chose to include the depth target of 2005 because most of the events happened before deeper compressions (≥51mm) were recommended in the 2010 Guidelines.[17] In a secondary analysis, we defined event compliance as a case with 90% or more of its minute epochs compliant with AHA targets. All available minutes of resuscitation were included up to and including minute ten. We first described an *a priori* composite variable of AHA compliance for both rate and CCF. Additional CPR quality outcomes included AHA compliance for each of the individual CPR quality parameters, the CPR quality targets expressed as continuous variables, and 2010 AHA depth compliance defined as ≥51mm for all subjects ≥1 year of age.[17] Because of varying recording devices, this study has two distinct cohorts: 1) events with at least rate *and* CCF; and 2) a smaller subgroup that also had quantitative depth collected. *A priori* we chose to report CPR quality in two separate age categories (pediatric: ages 1–11 years; adolescent: ≥12 years), a distinction currently recognized by the AHA guidelines.[17]

For our second objective, the primary outcome was return of spontaneous circulation (ROSC), chosen based upon the following considerations: 1) it is the most proximate outcome to the resuscitation, and 2) previous studies of p-OHCA[1–4] demonstrated low rates of survival to hospital discharge which would limit our ability to adjust for potential confounders in multivariable models. Secondary outcomes included survival to 24 hours and survival to hospital discharge. Covariates included in the multivariable logistic regression models evaluating the association between fraction and rate compliance and outcomes were selected *a priori* based on scientific understanding, and included age (categorical), gender, witnessed status, bystander CPR, EMS response time, initial rhythm, defibrillation data, location of arrest, and the natural cubic spline of adult survival to hospital admission at each site. The latter variable was included in an attempt to adjust for site variation in resuscitation care. Univariate association with depth was used to select a reduced subset of potential confounding variables to include in the models of depth and outcomes, and resulted in the inclusion of age, gender, witnessed status, initial rhythm, location of arrest, and site adjustment.

Statistical Analysis

Standard descriptive statistics, appropriate for the distribution of each variable, were used to summarize the quality of CPR performed during p-OHCA resuscitation. In the primary analysis, proportions of resuscitations meeting AHA event compliance definitions were reported. Differences in baseline characteristics between analyzed and excluded patients, and between pediatric and adolescent arrest victims, were evaluated using Student's t-test or chi-squared testing as appropriate. The association between event AHA compliance and survival outcomes was quantified using multivariable logistic regression with Huber-White sandwich standard errors.[25,26] Effect of calendar year on CPR quality was assessed using a Wald test for linear trend. All statistical analyses were performed with commercially available statistical packages (SAS, version 9.3, Cary, NC; R, version 2.14.1, Vienna, Austria; STATA, version 12.0, College Station, TX).

Results

Between December 2005 to December 2012, 2,564 cases of pediatric cardiac arrest were treated by the EMS agencies of the ROC. All but 390 were excluded from the current study for the reasons indicated in Figure 1. Quantitative CC depth was available for 153 cases (pediatric n = 34; adolescent n = 119). There were notable differences between the subjects in the final cohort and the excluded population. Excluded patients were younger with characteristics typical of infant cardiac arrest (e.g., more unwitnessed, less bystander CPR, less VF/VT) and with lower survival rates (Table 1). The included cohort was older with 53% bystander CPR and 16% shockable rhythms. Of subjects in the final cohort, 31.8% had ROSC, 27.4% survived to 24 hours, and 13.8% survived to hospital discharge. Subject characteristics of the pediatric and adolescent subgroups are detailed in Table 1.

Quantitative CPR Quality Data (Table 2)

For the overall cohort, the median number of CPR process minutes included in the analysis is 7 (IQR: 5, 10), which represent a median of 43% (IQR: 27%, 75%) of the overall CPR duration. Summary statistics for the quantitative CPR quality variables are as follows: CPR fraction 0.76 ± 0.17; rate: 118.7 ± 22.2 min^{-1}; depth 39.5 ± 10.7 mm. For the primary analysis (60% of event epochs achieving targets), the proportion of events meeting AHA compliance targets was low. Specifically, 22% of events met criteria for both rate and CCF, 36% for rate alone, 53% for CCF alone, and 58% for depth alone. In arrests from 2011 and later, compliance with 2010 AHA Guidelines for depth was not common (16% overall), with none of the events in 1–11 year olds meeting criteria and only 12 (21.8%) of the events in 12–18 year olds having depth ≥51mm. Compared to events in 12–18 year old subjects, events in 1–11 year olds were characterized by: lower proportions of rate compliance (23.3 vs. 43.9 %) and depth compliance (35.3 vs. 64.7%) and a higher proportion of CCF compliance (63 vs. 46.3 %); p<0.01 for all comparisons. In our secondary analysis (90% of event epochs achieving targets), event compliance was much lower: 18% for rate alone; 15% for CCF alone; and 35% for depth alone. There was an inverted U-shaped relationship between CC depth and rate (test of splines, p<0.01, Figure 2).

Secondary Variables

For the entire cohort, ROSC occurred more frequently when CPR was compliant for rate (39.7% vs. 27.2%), but ROSC occurred less often when cases were compliant with CCF recommendations (26.3% vs. 37.8%; eTable 1; p=0.01 for both comparisons). After adjusting for potential confounders, there was no significant association between rate or CCF compliance and any of the survival outcomes (Table 3a). Age, bystander witnessed arrest, and shockable initial rhythm were associated with a higher odds of ROSC (Table 3a).

In the subset of subjects for whom CC depth data were available (n=153), ROSC occurred more frequently when CPR was compliant with recommended depth (49.4% vs. 29.7%; p=0.01) (eTable 1). After adjusting for potential confounders, there was no significant association between depth compliance and ROSC. In this subset of subjects, shockable initial rhythm was associated with ROSC (Table 3b).

Discussion

In this large multi-center study of out-of-hospital pediatric CPR quality, we observed that prehospital rescuer CPR frequently did not meet AHA guidelines during p-OHCA resuscitation attempts. In spite of a definition of event compliance requiring only 60% of the minutes to have achieved quality goals, less than 25% of the resuscitations met both rate *and* CPR fraction targets. Achieving 2010 AHA depth targets (≥51mm) was even less common, as only 16% of resuscitations from 2011 and later achieved this goal. Encouragingly, the survival to hospital discharge rate in this large multi-center cohort was 13.8%–one of the highest reported for p-OHCA to date. Importantly CCF and depth have both increased significantly over time. A higher percentage of events meeting rate or depth compliance achieved ROSC; however, after controlling for potential confounders, we found no significant association between any of the CPR quality targets and survival.

Most pediatric CPR quality data has come from single center studies of in-hospital resuscitation.[12,14,18–20] This study fills an important gap in the pediatric resuscitation knowledge base by providing multi-center pediatric CPR quality data and describing the landscape of p-OHCA resuscitation quality. Similar to previous in-hospital reports, healthcare providers had difficulty delivering CPR compliant with AHA guidelines. This occurred despite network-wide attention devoted to the study and to the delivery of high quality CPR.[22] We do not know if these data are completely representative of CPR quality outside of this network.

The survival to hospital discharge rate in this study was 13.8%, one of the highest reported for p-OHCA to date.[1–4] Yet, nearly three times as many children will survive to discharge if their cardiac arrest occurs in a hospital compared to this out-of-hospital cohort.[5] Low survival rates after p-OHCA are attributable to numerous factors such as witnessed status, initial rhythms, and period of untreated arrest.[1,4] However, these data suggest that CPR quality is also a modifiable risk factor for survival outcomes. In a recent study by Wolfe et al., post-cardiac arrest debriefing was used to improve pediatric in-hospital CPR quality.[27] In that before-after interventional study, the authors reported doubling AHA compliance rates and concomitantly, the rate of survival to discharge with good neurological outcome rates also *nearly doubled*. In short, achieving high levels of compliance with AHA guidelines is possible, and more importantly, there is an association between improved CPR quality and survival outcome. As the rate of AHA compliance in that study was much higher than what we report here, interventions to improve prehospital pediatric CPR quality are warranted, and if successful, could result in more children surviving their event.

Previous studies of pediatric in-hospital CPR have demonstrated a strong association between CPR quality and survival outcomes, particularly as it pertains to CC depth[10,14,15] and CCF.[6,8] The apparent lack of association in this study deserves comment. The primary aim of this observational study was to quantitatively describe the quality of CPR performed during prehospital resuscitation attempts. This study was not powered to detect differences in ROSC or survival. However, it is encouraging that compared to a previous ROC investigation encompassing events up to 2007,[1] we report a nearly 40% relative increase in the rate of survival to discharge. These improved survival rates occurred as CCF and depth were increasing significantly over time. While speculative, this may suggest that efforts to improve resuscitation quality may lead to improved p-OHCA survival. Further, we hypothesize that life-saving clinical interventions such as defibrillation, which lower CCF, may have “falsely” indicated that CCF compliance is not associated with outcome. This speculation is supported by our data where shockable initial rhythm was most associated with survival (Table 3a and 3b).

In previous adult studies, when rescuers compressed the chest at a high rate, the compressions were less deep,[9] suggesting that rescuers might compromise adequate chest compression depth when trying to increase compression rate. In a previous single center study of pediatric in-hospital CPR quality,[14] the same relationship was not observed. The authors of this pediatric study hypothesized that either lack of variation in chest compression rate (there were no extremes of compression rate which could have compromised depth in this study) or the higher compliance of pediatric chest walls (i.e., providers could push hard and fast) explained this apparent lack of association between chest compression depth and rate. Our data here may provide further insight suggesting the former may be true. In this study, there was a large variation in CC rate and indeed, we found a non-linear relationship between CC rate and depth–which were inversely associated at high CC rates. Therefore, future Guideline iterations may consider emphasizing the importance of avoiding excessive CC rate even in children so as to avoid compromising CC depth. However, the upper limit of rate at which CC depth would be compromised in children still remains an unanswered question.

This study has limitations. First, the data reported here represent a convenience sample of ROC cases during which pediatric CPR quality data was collected. Important differences were noted between the included and excluded populations (Table 1). Our study population was primarily an adolescent population.[17] Future studies of prehospital CPR quality in pre-pubertal children are warranted. Second, ventilation rate, incomplete release between compressions, and peri-shock pauses in CPR, important quality variables,[8,28–30] were not recorded. Third, while we reported the first ten minutes of recorded CPR in an attempt to limit our evaluation to the first critical minutes of the resuscitation, the authors do not know with certainty how long CPR was provided before sensor placement in many cases. While speculative, it is possible that during pediatric resuscitation attempts, which more commonly have a preceding respiratory deterioration,[31,32] that EMS providers focused on early airway management prior to defibrillator deployment. Later assessment of CPR quality could partly explain the lack of association between quality and survival, as children with longer cardiac arrest events (and more eligible minutes of quality recording) would be selected for this analysis. Finally, it is important to note that the compliance targets used in the primary analysis, while based upon the best available science[23,24] and consistent with previous publications,[10,14,15] do entail some level of arbitrary assignment. The optimal cut-points associated with survival represent a significant gap in the pediatric resuscitation science knowledge base that will require further study.

Conclusions

These data fill an important gap in our knowledge related to p-OHCA resuscitation. In this multi-center observational study of pediatric CPR quality, professional rescuers often failed to achieve compliance with AHA guidelines. Encouragingly, CCF and depth have both increased significantly over time in this large multi-center cohort. Future interventions to improve p-OHCA resuscitation quality may improve survival outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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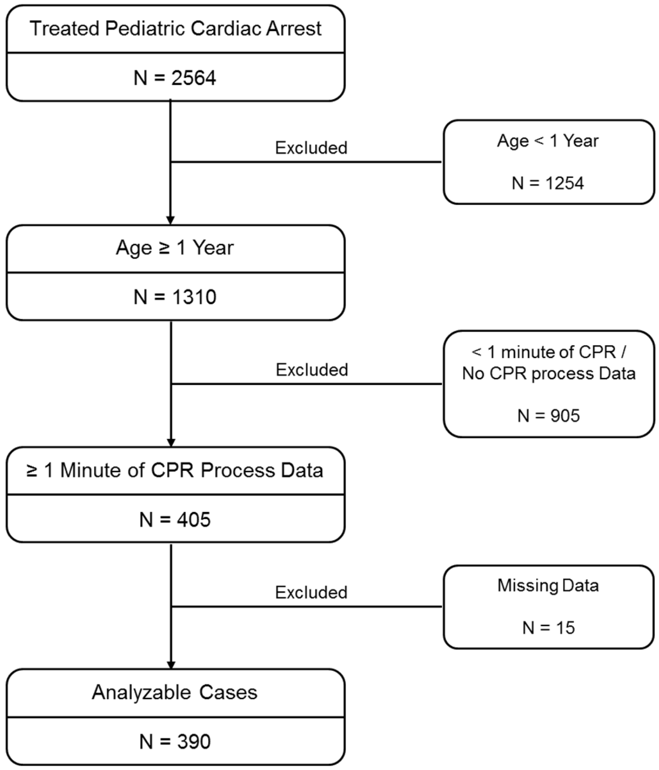

Figure 1.
Patient flow diagram.

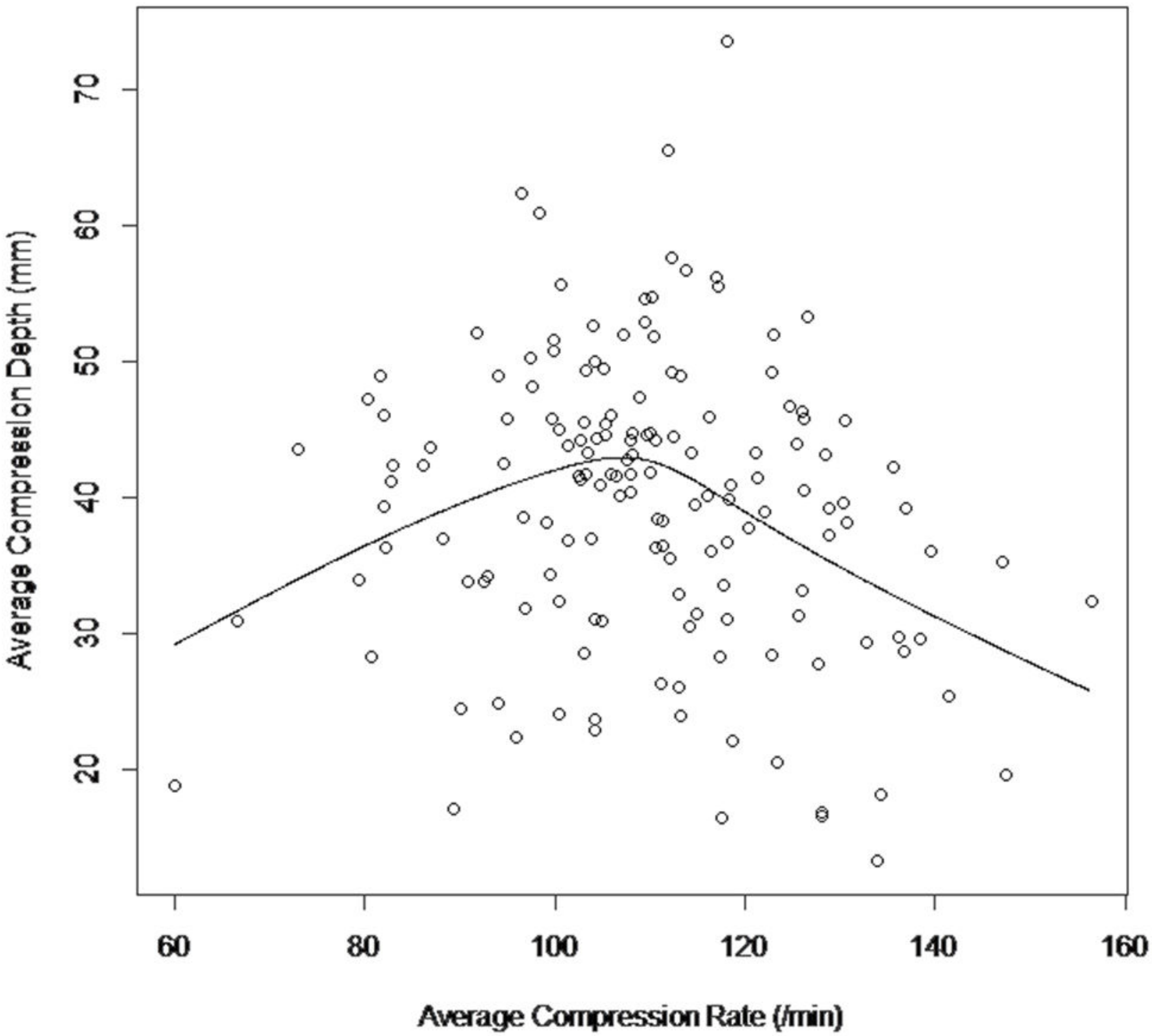

Figure 2.

Spline from a linear regression using a normal spline basis with four degrees of freedom. The F-test of whether the spline is significantly different from a straight line has a p-value <0.001.

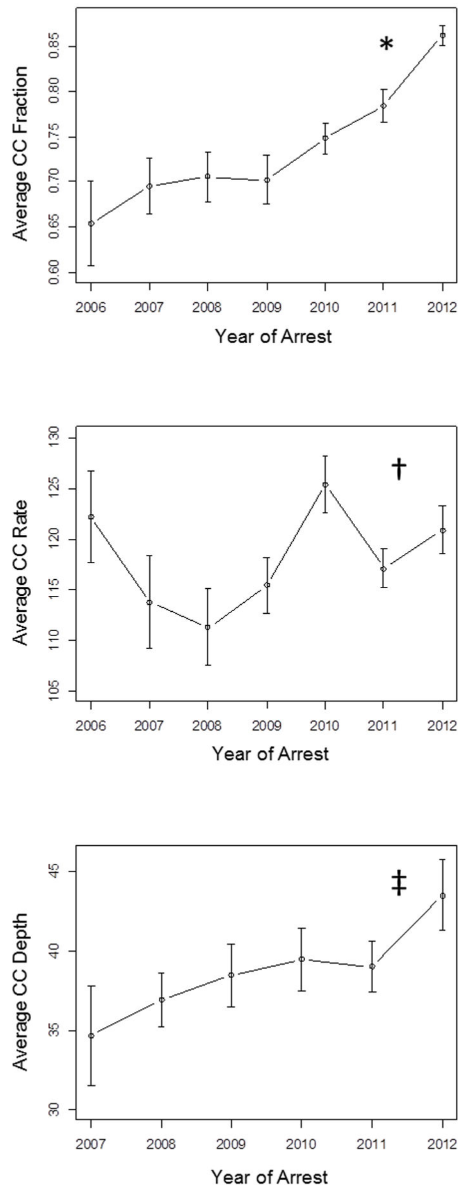

Figure 3.

Averages for chest compression fraction (CCF), CC rate, and CC depth over calendar year. Error bars represent standard error of the mean. Wald test of trend: *p=<0.001; †p=0.09; ‡p=0.03.

Table 1

Descriptive Statistics of Analyzed and Excluded Populations[1]

	Overall Analyzed Cohort		Excluded		p[3]	Analyzed 1 to 11 years		Analyzed 12 to 18 years		p[4]
	N		N			N		N		
N	390		2174			146		244		
Age (years)	390	11.9 (± 5.6)	2174	4.0 (± 5.9)	<0.01	146	5.4 (± 3.5)	244	15.8 (± 1.9)	<0.01
Male	390	247 (63.3 %)	2165	1288 (59.5 %)	0.15	146	85 (58.2 %)	244	162 (66.4 %)	0.10
Witnessed status					<0.01					0.26
EMS witnessed	390	15 (3.8 %)	2174	87 (4 %)		146	4 (2.7 %)	244	11 (4.5 %)	
Bystander witnessed	390	128 (32.8 %)	2174	432 (19.9 %)		146	48 (32.9 %)	244	80 (32.8 %)	
Not witnessed	390	236 (60.5 %)	2174	1459 (67.1 %)		146	87 (59.6 %)	244	149 (61.1 %)	
Unknown/missing	390	11 (2.8 %)	2174	196 (9 %)		146	7 (4.8 %)	244	4 (1.6 %)	
Bystander CPR	390	206 (52.8 %)	2174	1010 (46.5 %)	0.02	146	88 (60.3 %)	244	118 (48.4 %)	0.02
EMS response time (minutes)[2]	375	6 (± 2.6)	1972	5.7 (± 3.5)	0.11	142	5.4 (± 1.9)	233	6.3 (± 2.9)	<0.01
Initial rhythm					<0.01					<0.01
VT/VF/AED-Shock	390	61 (15.6 %)	2174	102 (4.7 %)		146	10 (6.8 %)	244	51 (20.9 %)	
Pulseless Electrical Activity	390	58 (14.9 %)	2174	245 (11.3 %)		146	24 (16.4 %)	244	34 (13.9 %)	
Asystole	390	250 (64.1 %)	2174	1286 (59.2 %)		146	105 (71.9 %)	244	145 (59.4 %)	
Cannot determine/other	390	21 (5.4 %)	2174	541 (24.9 %)		146	7 (4.8 %)	244	14 (5.7 %)	
Shock Delivered	390	104 (26.7 %)	2161	222 (10.3 %)	<0.01	146	19 (13.0 %)	244	85 (34.8 %)	<0.01
Number of shocks (if shocked)	102	2.8 (± 2.4)	219	2.6 (± 2.4)	0.35	17	2.4 (± 1.7)	85	2.9 (± 2.5)	0.23
Public location	390	74 (19.0 %)	2158	203 (9.4 %)	<0.01	146	18 (12.3 %)	244	56 (23.0 %)	<0.01
ROSC	390	124 (31.8 %)	2173	312 (14.4 %)	<0.01	146	28 (19.2 %)	244	96 (39.3 %)	<0.01
Survival to 24 hours	383	105 (27.4 %)	2094	366 (17.5 %)	<0.01	143	26 (18.2 %)	240	79 (32.9 %)	<0.01
Survival to hospital discharge	383	53 (13.8 %)	2097	153 (7.3 %)	<0.01	143	15 (10.5 %)	240	38 (15.8 %)	0.14

[1]Categorical variables are reported as No. (%). Continuous variables are reported as mean (± standard deviation).

[2]Excludes EMS witnessed cases.

[3]p value for comparison across included and excluded populations

[4]p value for comparison across pre-determined age categories

Table 2

Summary of CPR Quality Parameters in Analyzed Population[1]

	Overall Cohort	1 to 11 years	12 to 18 years	p-value[2]
Summary Statistics				
Fraction				
No. (%)	390 (100.0 %)	146 (100 %)	244 (100 %)	
Mean (± SD)	0.76 (± 0.17)	0.78 (± 0.19)	0.75 (± 0.15)	0.16
Rate				
No. (%)	390 (100.0 %)	146 (100 %)	244 (100 %)	
Mean (± SD)	118.7 (± 22.2)	124.7 (± 28.3)	115.1 (± 16.8)	<0.01
Depth				
No. (%)	153 (39.2 %)	34 (23.3 %)	119 (48.8 %)	
Mean (± SD)	39.5 (± 10.7)	32.5 (± 9.8)	41.5 (± 10.1)	<0.01
Compliance with AHA Guidelines				
Fraction **and** Rate Compliant	85 (21.8 %)	22 (15.1 %)	63 (25.8 %)	0.01
Fraction Compliant (≥ 0.80)	205 (52.6 %)	92 (63 %)	113 (46.3 %)	<0.01
Rate Compliant (≥ 100 and ≤ 120 per minute)	141 (36.2 %)	34 (23.3 %)	107 (43.9 %)	<0.01
Depth Compliant (≥ 38 mm)	89 (58.2 %)	12 (35.3 %)	77 (64.7 %)	<0.01
Depth Compliant (≥ 51 mm)[3]	12 (16.0 %)	0 (0 %)	12 (21.8 %)	0.02

[1] Categorical variables are reported as No. (%). Continuous variables are reported as mean (± standard deviation).

[2] p value for comparison across pre-determined age categories

[3] Arrests occurring in 2011 or later.

Table 3a

Adjusted logistic regression of outcome on compliance

	ROSC (n=390)		Survival to 24 Hours (n=383)		Survival to Discharge (n=383)	
	aOR[1] (95% CI)	p	aOR[1] (95% CI)	p	aOR[1] (95% CI)	p
Fraction compliant (≥ 0.8)	0.69 (0.42, 1.15)	0.16	0.96 (0.56, 1.66)	0.89	0.98 (0.41, 2.35)	0.97
Rate compliant (100–120)	1.50 (0.88, 2.54)	0.13	1.07 (0.61, 1.89)	0.80	1.14 (0.51, 2.53)	0.76
Age 1–11 years	0.49 (0.28, 0.85)	0.01	0.53 (0.30, 0.94)	0.03	1.11 (0.47, 2.59)	0.82
Male	0.85 (0.52, 1.40)	0.52	0.64 (0.38, 1.08)	0.09	0.75 (0.35, 1.60)	0.46
Bystander witnessed arrest	1.66 (0.96, 2.87)	0.07	1.04 (0.59, 1.86)	0.88	3.65 (1.62, 8.25)	0.00
EMS witnessed arrest	1.89 (0.52, 6.92)	0.33	0.59 (0.16, 2.21)	0.44	0.95 (0.08, 11.02)	0.97
Shockable initial rhythm	4.58 (2.25, 9.30)	<0.01	6.81 (3.26, 14.20)	<0.01	13.06 (5.56, 30.69)	<0.01
EMS response time (minutes)	0.95 (0.83, 1.08)	0.40	0.88 (0.79, 0.98)	0.02	0.86 (0.75, 1.00)	0.05
Bystander CPR	1.18 (0.70, 1.99)	0.54	1.01 (0.59, 1.73)	0.97	1.05 (0.49, 2.24)	0.90
Public location	1.60 (0.84, 3.03)	0.15	1.58 (0.82, 3.05)	0.17	0.88 (0.31, 2.52)	0.81

[1] Odds ratio also adjusted for adult survival to hospital admission at each site as a measure of site variation in care. A sensitivity analysis that substituted an indicator of study site did not substantially alter the results.

Table 4

Table 3b. Adjusted logistic regression of ROSC on compliance in subset of events with depth

	ROSC (n=153)	
	aOR[1] (95% CI)	p
Depth compliant (≥38 mm)	1.99 (0.90, 4.42)	0.09
Fraction compliant (≥0.8)	0.66 (0.31, 1.40)	0.28
Rate compliant (100–120)	1.13 (0.52, 2.45)	0.75
Age 1–11 years	0.50 (0.19, 1.30)	0.15
Male	0.90 (0.43, 1.89)	0.78
Bystander witnessed arrest	1.13 (0.46, 2.82)	0.79
EMS witnessed arrest	2.70 (0.48, 15.18)	0.26
Shockable initial rhythm	5.62 (1.62, 19.51)	<0.01
Public location	1.19 (0.45, 3.13)	0.73

[1] Odds ratio also adjusted for adult survival to hospital admission at each site as a measure of site variation in care.