

CARES Abstracts – Resuscitation Science Symposium & Scientific Sessions 2018

Helen B. Taussig Memorial Lecture:

Conventional Bystander CPR is Associated With Higher Neurologically Favorable Survival in Children Compared to Compression Only CPR Following Pediatric Out of Hospital Cardiac Arrest

Maryam Y Naim, Heather Griffis, Robert A Berg, Richard N Bradley, Rita V Burke, David Markenson, Bryan F McNally, Vinay M Nadkarni, Lihai Song, Kimberly Vellano, Joseph W Rossano

Introduction: There are conflicting data regarding the benefit of conventional bystander CPR (BCPR) compared to compression only BCPR (CO-BCPR) for children following out of hospital cardiac arrest (OHCA).

Hypothesis: Conventional BCPR is associated with improved outcome compared to CO-BCPR in infants, children and adolescents following OHCA.

Methods: An analysis of the Cardiac Arrest Registry to Enhance Survival was conducted. Inclusion criteria were age \leq 18 years and non-traumatic OHCA from 2013 through 2017. The primary outcome was neurologically favorable survival (cerebral performance category score of 1 or 2). Age groups included infants (\leq 1 year), children (2-11 years), and adolescents (\geq 12 years).

Results: Of 6249 cardiac arrests, 1191 received conventional BCPR, 1386 received CO-BCPR, and 3672 received no BCPR. The highest neurologically favorable survival was associated with conventional BCPR (adjusted proportion 12.5%, OR 2.5, 95% CI 1.9, 3.2) for the overall cohort compared to CO-BCPR (9%, OR 1.6, 95% CI 1.2, 2.0) and no BCPR (6.4%). Conventional BCPR was significantly associated with improved neurologically favorable survival vs. no BCPR in the overall cohort and in all age groups (infants 9.4% vs. 5.4%, children 17.9% vs. 6.2%, adolescents 14% vs. 8.1%, p-value (for all) <0.001). Conventional BCPR was also significantly associated with improved neurologically favorable survival vs. CO-BCPR in the overall cohort and for infants (9.4% vs. 6.1%, $p=0.02$). CO-BCPR was significantly associated with improved neurologically favorable survival compared to no BCPR in the overall cohort and in children (13.5% vs. 6.2%, $p<0.001$), but not in infants or adolescents.

Conclusion: Conventional BCPR was associated with higher neurologically favorable survival compared to no BCPR in all children and compared to CO-BCPR in most age groups. These results support current AHA/ILCOR recommendations for the provision of conventional BCPR in pediatric OHCA.

Oral Presentations:

Evaluating Variation in Return of Spontaneous Circulation Rates Across EMS Agencies in Michigan

Mahshid Abir, Rama Salhi, Jason Goldstick, Jessica Lehrich, Sydney Fouche, Claude Setodji, Bill Forbush, Steve Kronick, Teri Shields, Erin Brennan, Robert Swor, Brian O'Neil, Robert Neumar, Brahmajee Nallamothu

Background: Out-of-hospital cardiac arrest (OHCA) outcomes vary significantly across U.S. communities; however, systems of care factors that increase the likelihood of survival have not been well elucidated. The Enhancing Pre-Hospital Outcomes for Cardiac Arrest (EPOC) study is quantifying variation in the rate of sustained return of spontaneous circulation (ROSC) upon ED arrival across Michigan EMS agencies as a first step to identifying 'best practices' in prehospital OHCA care.

Methods: Michigan Cardiac Arrest Registry to Enhance Survival (CARES) data for the years 2014-2016 was used. EMS agencies with 5+ arrests over the study years were included in the analysis. Using mixed-effects logistic regression, we calculated each agency's reliability-adjusted sustained ROSC upon ED arrival; these rates were standardized across patient-, community-, and arrest-level characteristics.

Results: A total of 91 agencies covering >6.8 million lives met inclusion criteria. We included 14,219 OHCA patients with a mean age of 62.6, 40.0% female, and 18.2% with a shockable rhythm in the analyses. Across all agencies, the mean patient-standardized rate of sustained ROSC with pulse upon ED arrival was 25.3% (range, 6.1%-51.9%; IQR range, 18.9%-31.2%) (**Figure 1**). There were 14 agencies with patient-standardized rates and 95% CIs that exceeded the overall mean survival rate suggesting better-than-average outcomes while 16 agencies had rates and 95% CIs that were lower than the overall mean survival rate.

Conclusion: We found more than 8-fold variation in OHCA survival rates across EMS agencies in Michigan, suggesting large differences in the effectiveness of prehospital systems of care. Future qualitative work will seek to identify 'best practices' by further determining the role of key factors such as tele-dispatch CPR, EMS agencies, fire, and police within high performing systems.

When Laws Save Lives: Impact of Legislation Requiring Cardiopulmonary Resuscitation Education in High Schools on Survival After Sudden Cardiac Arrest

Victoria L. Vetter, Katherine F. Dalldorf, Joseph Rossano, Maryam Y. Naim, Andrew C. Glatz, Kimberly Vellano, Bryan McNally, Heather Griffis

Introduction: Thirty eight states have laws requiring education of high school students on cardiopulmonary resuscitation (CPR) and the use of automated external defibrillators (AED). No study has measured the association of these laws and outcomes.

Hypothesis: Out of hospital cardiac arrests (OHCAs) occurring in states with CPR high school education laws will have higher bystander CPR, survival, and favorable neurological survival than states without such laws.

Methods: We conducted an analysis of the Cardiac Arrest Registry to Enhance Survival database and included all nontraumatic OHCAs with at least 50% population catchment from 1/2013-12/2017 in all ages. We excluded OHCAs witnessed by 911 responders, in healthcare facilities, or nursing homes. Outcomes were bystander CPR, survival to hospital discharge and neurologically favorable survival (Cerebral Performance Category score of 1 or 2 at hospital discharge). Chi-square tests were used to assess associations.

Results: The 110,902 subjects with OHCA included Male, 64.0%; <18 yrs., 3.2%; <35 yrs., 10.7%; <50 yrs., 23.9%; White, 49.3%; Black, 19.1%; Hispanic, 2.3%; Other, 2.9%; Unknown, 26.5%. Most OHCAs occurred at home, 81.4%. 44.4% were witnessed by bystanders. 75.5% occurred in states with CPR high school education laws. A higher percent of OHCAs received bystander CPR prior to emergency medical services (EMS) arrival in states with CPR high school education laws (40.1%) compared to states without laws (37.0%) ($p<0.001$). Bystander CPR was less common in males (40.3% vs. 37.7% for females), those >50 yrs. (38.9% vs. 40.7% for ≤ 50 yrs.), Black and Hispanic subjects (25.7% and 34.9%, respectively, vs. 42.4% for Whites) ($p<0.001$ for all). Overall survival to hospital discharge was 10.4%; 8.8% had a favorable neurological outcome. A higher percent survived to hospital discharge in states with CPR high school education laws (11.0%) compared to states without laws (8.7%) ($p<0.001$). Neurologically favorable survival was more likely in states with CPR high school education laws, (9.3%) compared to states without laws (7.5%) ($p<0.001$).

Conclusions: Bystander CPR, survival to hospital discharge, and neurologically favorable survival was higher in states that had CPR high school education laws.

Posters:

Estimating the Impact of Bystander Interventions on Disability-Adjusted Life Years Following Adult Out-of-Hospital Cardiac Arrest in the United States

Ryan A. Coute, Brian Nathanson, Ashish Panchal, Michael Kurz, Nathan Haas, Bryan McNally, Robert Neumar, Timothy Mader

Background: Disability-adjusted life years (DALY) are a common public health metric used to consistently estimate and compare disease burden. The impact of bystander interventions on DALY following out-of-hospital cardiac arrest (OHCA) is unknown. Our objective was to estimate the effect of bystander CPR (B-CPR) and bystander AED (B-AED) application on DALY following OHCA in the United States (U.S.).

Methods: DALY were calculated as the sum of years of life lost (YLL) and years lived with disability (YLD) using all adult non-traumatic EMS-treated OHCA from the national CARES database for 2016. A multivariable linear regression model was constructed for effect estimation with DALY values as the outcome and standard Utstein variables as independent variables. Marginal effect estimates for B-CPR and B-AED were derived in models that used all independent variables as main effects. A sensitivity analysis included interaction terms. The analysis for B-CPR was limited to bystander witnessed events. The B-AED analysis was limited to public OHCA events. The marginal effects on DALY were used to derive national estimates of life years saved.

Results: A total of 19,324 OHCA cases met study inclusion criteria. The provision of B-CPR was associated with an absolute mean decrease of -0.36 DALY; 95% CI (-0.44, -0.27) per OHCA, when compared to cases without B-CPR ($p<0.001$). When extrapolated to a national level, the cumulative effect of B-CPR resulted in an estimated 25,317 healthy life years saved; 95% CI (19,342, 31,292). Bystander AED application was associated with a mean reduction of -0.32 DALY; 95% CI (-0.41, -0.23) per OHCA ($p<0.001$). The cumulative effect of B-AED application was an estimated 22,755 healthy life years saved 95% CI (16292, 29218). From a regression model that incorporated interaction effects, B-CPR with defibrillation was associated with an estimated 74,758; 95% CI (58511, 91004) healthy life years saved.

Conclusion: Bystander interventions are associated with a decrease in DALY following adult OHCA. These results highlight the importance of national bystander CPR and AED education and surveillance.

The Influence of Age, Race, and Ethnicity on Public Automated External Defibrillator Use and Outcomes of Pediatric Out-of-Hospital Cardiac Arrest in the United States: An Analysis of the Cardiac Arrest Registry to Enhance Survival (CARES)

Heather Griffis, Lucy Wu, Maryam Naim, Joshua Tobin, Bryan McNally, Kimberly Vellano, Linda Quan, David Markenson, Richard Bradley, Joseph Rossano

Introduction: Automated external defibrillators (AEDs) are an important link in the chain of survival following out-of-hospital cardiac arrest (OHCA). While the use of AEDs are clearly beneficial for OHCA in adults, there are few data on the overall use and outcomes of public AED use in children.

Hypothesis: AED use is uncommon in children and associated with neurologically favorable survival.

Methods: We conducted an analysis of the Cardiac Arrest Registry to Enhance Survival database. Inclusion criteria were age ≤ 18 years of age, public arrests, and non-traumatic OHCA from January 1, 2013 through December 31, 2017. Neurologically favorable survival was defined as a Cerebral Performance Category Scale of 1 or 2 at hospital discharge.

Results: Of 971 public pediatric OHCA (66% male, 32% white), AEDs were used by bystanders in 117 (10.3%). AEDs were used among 2.3% of children aged ≤ 1 year (infants), 8.3% of 2-5 year-olds, 12.4% of 6-11 year-olds, and 18.2% of 12-18 year-olds ($p < 0.001$). AED use was similar among white (11.1%), black (9.1%), and Hispanic children (8.1%) ($p = 0.84$). AED use was more common with the provision of bystander CPR (19.1%) vs no bystander CPR (0.9%), witnessed arrests (16.0%) vs unwitnessed arrests (4.7%), and arrests with a shockable rhythm (23.6%) vs a nonshockable rhythm (6.3%) ($p < 0.001$ for all). Overall, adjusted neurologically favorable survival was 29.1% (95% CI 22.7%, 35.5%) when a bystander used an AED compared to 23.7% (95% confidence interval [CI] 21.1%, 26.3%) for no bystander AED use ($p = 0.11$). There was a significant interaction with age and race/ethnicity. AEDs were associated with neurologically favorable survival among children aged 12-18 years ($p = 0.04$) but not associated with neurologically favorable survival in children ≤ 1 year ($p = 0.43$), 1-5 years ($p = 0.16$) or 6-11 years (0.41). AEDs were also associated with neurologically favorable survival in white children ($p = 0.01$) but not with black ($p = 0.97$) or Hispanic children ($p = 0.06$).

Conclusions: AED use is uncommon in children suffering OHCA but is associated with improved neurologically favorable survival. The benefit of AEDs was evident mostly for adolescents and white children. Further study is needed to understand these disparities in AED use and outcomes after AED use.

The Epidemiology of Airway Management Following Pediatric Out-of-Hospital Cardiac Arrest in the United States

Maryam Y. Naim, Heather Griffis, Robert A. Berg, Richard N. Bradley, Matthew L. Hansen, David Markenson, Bryan F. McNally, Vinay M. Nadkarni, Kimberly Vellano, Joseph W. Rossano

Introduction: Bag mask ventilation (BMV) has been associated with improved survival following out of hospital cardiac arrest (OHCA), however advanced airway placement remains part of pre-hospital protocols for many emergency medical services (EMS) agencies.

Hypothesis: To characterize airway management for pediatric OHCA and assess whether BMV alone vs. BMV plus advanced airway (supraglottic airway or tracheal intubation) is associated with neurologically favorable survival.

Methods: Analysis of the Cardiac Arrest Registry to Enhance Survival database. Inclusion criteria were age ≤ 18 years, non-traumatic OHCA from 2013 through 2017, resuscitated by EMS. To adjust for covariate imbalance, propensity score matching and entropy balancing were utilized; variables included age category, sex, bystander CPR, and shockable rhythm. The primary outcome was favorable neurologically favorable survival defined as a cerebral performance category scale of 1 or 2.

Results: Of 5241 cardiac arrests, 2588 (49.3%) had BVM and 2653 (50.6%) had advanced airway placement. The majority 5118 (97.7%) were resuscitated by agencies using both BMV and advanced airways. Advanced airway placement was more common in older children compared to infants, arrests with bystander CPR, in white and Hispanic children, witnessed arrests, arrests with a shockable rhythm, and AED use (Table). Neurologically favorable survival was significantly higher with BMV compared to advanced airways in bivariate analysis (11.4% vs. 5.7%, $p < 0.001$). In multivariable analysis, advanced airway placement was associated with lower neurologically favorable survival (adjusted proportion 4.9% vs. 13.5% BVM, OR 0.21, 95% CI 0.17, 0.28). These results were robust on propensity analysis 3.0% advanced airway vs. 11.9% BMV (OR 0.18, 95% CI 0.14, 0.25), and entropy balance 5.9% advanced airway, 15.0% for BMV (OR 0.28, 95% CI 0.22).

Conclusion: In pediatric OHCA, advanced airways are placed in half of cardiac arrests where resuscitation is

attempted. Advanced airway, compared to BMV alone management, is associated with lower neurologically favorable survival.

Comparison of Tracheal Intubation vs. Supraglottic Airway Following Pediatric Out of Hospital Cardiac Arrest

Maryam Y. Naim, Heather Griffis, Robert A. Berg, Richard N. Bradley, Matthew L. Hansen, David Markenson, Bryan F. McNally, Vinay M. Nadkarni, Kimberly Vellano, Joseph W. Rossano

Introduction: There are few data comparing Tracheal Intubation (TI) and SupraGlottic Airway (SGA) following pediatric out of hospital cardiac arrest (OHCA).

Hypothesis: TI is associated with improved outcomes compared to SGA following pediatric OHCA.

Methods: Analysis of the Cardiac Arrest Registry to Enhance Survival database. Inclusion criteria were age \leq 18 years, non-traumatic OHCA from 2013 through 2017, resuscitated by Emergency Medical Services (EMS). To adjust for covariate imbalance, propensity score matching and entropy balancing were utilized; variables included age category, sex, bystander CPR, and initial rhythm. Primary outcome was neurologically favorable survival defined as a cerebral performance category scale of 1 or 2. Secondary outcome was survival to hospital discharge.

Results: Of 2653 cardiac arrests evaluated, 2178 (82.1%) had TI and 475 (17.9%) had SGA placed during OHCA. 835 (31.2%) arrests were resuscitated by agencies used bag valve mask (BVM) and TI and 1818 (68.0%) arrests had agencies that used all 3 airway types (BVM/TI/SGA). Overall, unadjusted favorable neurological survival was 5.7% for TI and 5.3% for SGA, $p=0.67$ and survival to hospital discharge was 7.9% for TI and 7.5% for SGA, $p=0.73$. In multivariable analysis (adjusting for age, sex, race/ethnicity, bystander witness, bystander CPR, initial rhythm, AED use, year of arrest, and agency category), SGA was associated with lower neurologically favorable survival compared to TI (adjusted proportion 3.7% vs. 6.3%, OR 0.49, $p=0.01$), and lower survival to hospital discharge (5.5% vs. 8.5%, OR 0.57, 95% CI 0.36, 0.89). These results were robust on tests for unmeasured confounding and covariate balance; propensity analysis neurologically favorable survival 4.4% vs. 7.6% (OR 0.54, 95% CI 0.30, 0.96), survival to hospital discharge 6.6% vs. 10.5% (OR 0.58, 95% CI 0.35, 0.95); and entropy balance neurologically favorable survival 5.0% vs. 9.7% for ETI (OR 0.44, 95% CI 0.27, 0.72), survival to hospital discharge 7.3% vs. 12.5% (OR 0.51, 95% CI 0.34, 0.78).

Conclusion: In pediatric OHCA, TI, compared with SGA advanced airway management is associated with improved neurologically favorable survival and survival to hospital discharge.

Higher Walk Score Associated With Higher Rates of Bystander AED Use in Street-Level Cardiac Arrest

John Chen, Valery Effoe, John Lisko, Nabil Sabbak, Shawn Reginauld, Yi-An Ko, Frank Corrigan III, Stamatios Lerakis

Introduction: Bystander CPR (BCPR) and AED use are crucial life-saving measures in out-of-hospital cardiac arrest (OHCA). OHCA occurring in low-income black neighborhoods are less likely to receive bystander assistance. In addition to socioeconomic disparities, characteristics of the built environment may also contribute to large variation in BCPR and bystander AED rates.

Hypothesis: We hypothesized that pedestrian-friendly spaces have higher rates of BCPR and bystander AED use.

Methods: Using the Cardiac Arrest Registry to Enhance Survival, we studied OHCA occurring in street/highway locations in the US in 2016. We excluded cardiac arrests that were witnessed by a 911 responder. Each incident address was assigned a 0-100 Walk Score[®] using an open-source algorithm and linked to census tract race and income data. We analyzed the relationship between Walk Score and key elements of bystander behavior: witness of arrest, provision of BCPR, and use of AED.

Results: Of 3225 OHCA, 1666 (51.7%) were witnessed, 934 (29.0%) received BCPR, and 165 (5.1%) used an AED. After adjusting for age, gender, neighborhood median household income, and neighborhood percent black, every 10-point increase in Walk Score was associated with higher odds of bystander AED use (OR, 1.23; 95% CI, 1.14 to 1.32) but lower odds of witnessed arrest (OR, 0.95; 95% CI, 0.93 to 0.97) and BCPR (OR, 0.92; 95% CI, 0.90 to 0.95) (Table). Lower neighborhood household income predicted less BCPR and AED use; higher neighborhood black composition also predicted less BCPR.

Conclusions: After adjusting for neighborhood-level race and income, OHCA occurring in walkable areas had higher rates of bystander AED use but lower rates of witnessed arrest and BCPR. The effects of built environments on bystander behavior and AED availability warrant closer investigation.