CARES RESEARCH UPDATE 2011

CARES Site Participant Map 2011

Developing a culture of high quality resuscitation

Out-of-hospital Cardiac Arrest Outcomes Stratified By Rhythm Analysis

From the Cardiac Arrest Registry to Enhance Survival (CARES) database 2004-2009

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BACKGROUND

• Cardiopulmonary arrest is defined by one of four rhythms on surface ECG: pulseless ventricular tachycardia (pVT), ventricular fibrillation (VF), pulseless electrical activity (PEA), or asystole. Two of these, PEA and asystole, are classified as non-shockable rhythms while pVT and VF are shockable rhythms.

• In a small subset of patients with a first documented rhythm of PEA or asystole, progression to a shockable rhythm may occur during attempted resuscitation. Currently, when a non-shockable rhythm converts to a shockable rhythm during resuscitation efforts, immediate defibrillation (aka rescue shock [RS]) is recommended, regardless of arrest duration or the underlying myocardial physiology. There are no treatments specifically directed at VF under these circumstances.

• Controversy exists regarding the appropriateness of this approach because alternatives have never been studied. The authors of a recent study have suggested that such patients do not benefit from defibrillation and that new treatment strategies may be necessary while results from three subsequent studies failed to support this assertion.

OBJECTIVE

• This study was done to compare resuscitation outcomes in out-of-hospital cardiac arrest (OHCA) among a large cohort of adults in the Cardiac Arrest Registry to Enhance Survival (CARES) dataset stratified by rhythm into 3 groups: initial shockable rhythm (IS), non-shockable first documented rhythm converted to a shockable rhythm during resuscitation efforts (CS), and never shocked (NS).

METHODS

• A secondary analysis of data prospectively submitted to the CARES from 2004 through 2009 was conducted.
•The study was reviewed and approved by the Baystate Medical Center IRB.
•All adult (> 18 yrs old) index cardiac arrests at participating sites were study eligible and all data elements were included.
•Statistical analyses were performed using a commercially available software package (Stata/SE 10.1, College Station, TX).
•The primary outcome measures were based on the group proportions of survival to hospital discharge.
•Secondary outcome measures included the proportions of return of spontaneous circulation (ROSC) and favorable neurologic outcome (CPC 1 and 2) in each group.

METHODS

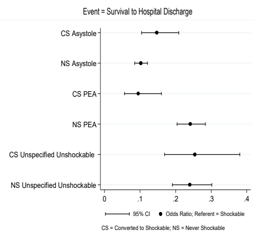
•Our initial dataset contained 20,018 patient records. We excluded patients who were under age 18 as well as patients with an unknown mortality outcome, which left 19,315 patients. We further excluded patients with an unknown first documented rhythm, patients for whom CPR was not initiated, and patients with an unknown (rather than presumed cardiac) etiology. This left 19,164 patients for the analysis.
•Patients with a first documented rhythm (FDR) of VF, VT, or Unknown Shockable Rhythm were classified as IS (n=4,553 [24%]). Those with FDR of asystole, idioventricular/PEA, or Unknown (i.e., unspecified) Unshockable Rhythm who subsequently received at least 1 shock (either manual or via an AED) were considered to be CS (n=1,939 [10%]). Those in this subset with no shocks delivered were deemed to be NS (12,672 [66%]).
•Descriptive statistics were compiled and differences between the 3 groups were compared using either a one-way ANOVA analysis or a Chi-Square test. A p-value < 0.05 was considered to be statistically significant.
•We used logistic regression for the multivariate analyses and the outcome of interest was survival to hospital discharge.
•Odds ratios and 95% CIs were derived for all covariates (referent=IS). Wald tests were used to determine if the categories in the Rhythm Category variable were equal (i.e., CS = NS) after multivariate adjustment.
•The overall fit of the logistic regression model(s) were assessed by the area under the ROC curve (c-statistic) and the Hosmer-Lemeshow statistic.

RESULTS

- Raw survival rates of CS and NS patients were similar (4.0% vs. 3.8% respectively; p=0.65) but significantly lower than IS patients (25.5%; p<0.001).
- The adjusted OR of survival to hospital discharge for CS was 0.15 (95% CI 0.12, 0.20) and for NS it was 0.17 (95% CI 0.15, 0.19) with IS as the referent.
- However when stratified by PEA and asystole, CS PEA had a lower OR than NS PEA (0.10 [95% CI 0.06, 0.16] vs. 0.24 [95% CI 0.19, 0.30], p<0.001) but CS asystole had a higher OR than NS asystole (0.15 [95% CI 0.10, 0.21] vs. 0.10 [95% CI 0.09, 0.12], p=0.053).
- Good cerebral performance category classification in survivors was as follows: 33.8% for CS, 28.2% for NS and 61.5% for IS.

Selected univariate results

	IS (n=4,553)	CS (n=1,939)	NS (n=12,672)	p-value
Median age [IQR]	61 [51,72]	66 [54,79]	67 [55,80]	<0.001
Black race	23.06%	25.48%	30.05%	<0.001
Male gender	72.63%	62.82%	55.96%	<0.001
Arrest occurred at home	57.65%	70.71%	67.83%	<0.001
Arrest occurred at a nursing home	4.83%	9.90%	17.93%	<0.001
Witnessed event	68.04%	50.18%	40.33%	<0.001
Arrest occur after EMS arrival	40.33%	9.54%	10.49%	0.004
EMS or first responder initiated CPR (vs. lay person etc.)	62.18%	68.54%	67.27%	<0.001
Total number of shocks	2 [1,4]	2[1,3]	0 [0,0]	<0.001
AED used	33.78%	34.24%	25.55%	<0.001
Hypothermia provided in the hospital	3.53%	2.73%	1.67%	<0.001
Survival to Hospital Discharge	25.52%	4.02%	3.83%	<0.001



LIMITATIONS

• CARES is a multicenter registry so data integrity and validity could be challenged and sampling bias may have occurred.
•Accuracy of first documented and subsequent rhythms were not independently confirmed.
•We assumed that patients with a non-shockable FDR who subsequently received a defibrillation attempt had conversion to a shockable rhythm.

CONCLUSIONS

•After OHCA, the survival rate for CS victims is significantly lower than for IS patients.
•These findings suggest that CS and IS are different entities and that alternatives to the existing VF resuscitation algorithm tailored to patients with CS should be investigated.

CARES is funded by the Center for Disease Control under a cooperative agreement with Emory University School of Medicine andit is implemented by EMS agencies across the US including Atlanta, GA and Springfield, MA.

Out-of-hospital Cardiac Arrest Outcomes Stratified By Rhythm Analysis

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- The OR of survival to hospital discharge for CS was 0.15 (95% CI 0.12-0.20) and for NS it was 0.17 (95% CI 0.15-0.19) with <u>IS as the referent</u>.

- However when stratified by PEA and asystole, CS PEA had a lower OR than NS PEA (0.10 vs. 0.24, $p<0.001$) but CS asystole had a higher OR than NS asystole (0.15 vs. 0.10, $p=0.053$).

- Good cerebral performance category classification in survivors was as follows: 33.8% for CS, 28.2% for NS and 61.5% for IS.

Using the Cardiac Arrest Registry to Enhance Survival to Examine Regional Variation in the Utilization of Automated External Defibrillators

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BACKGROUND

●Cardiac arrest is estimated to cause 250,000 deaths annually in the United States and is a major public health concern. Cardiac arrest is primarily a fatal event. On average, 9 out of 10 people die from cardiac arrest.

●Automated External Defibrillators have been shown to increase survival by shocking a victim during a ventricular fibrillation/tachycardia arrest.

●Little is known about how AEDs are used by bystanders across the U.S. and how this correlates with cardiac arrest events.

OBJECTIVES

To estimate the associations between demographic and event characteristics on the probability of automated external defibrillator (AED) used during an out-of-hospital cardiac arrest (OHCA) in a public location.

METHODS

Design: Secondary analysis of the public arrests from the CARES dataset.

Setting: CARES comprises 29 U.S. cities in 17 states with a catchment of over 22 million people.

Population: Consecutive arrests restricted to those that occurred in a public location from October 1, 2005 through December 31, 2009.

Data Analysis: Hierarchical logistic regression analysis using city as a random effect was used to examine the associations between demographic, event characteristics, and whether an AED was used.

Table 1: Demographics of Public Arrests in 4 U.S. Regions

	Northeast (n=227)	Midwest (n=635)	South (n=2535)	West (n=613)
Age Category (%)				
0-17 Years (n=69)	4 (1.8)	7 (1.1)	48 (1.9)	10 (1.7)
18-34 Years (n=192)	13 (5.7)	40 (6.3)	115 (4.5)	24 (3.9)
35-49 Years (n=774)	36 (15.9)	104 (16.4)	537 (21.2)	97 (15.8)
50-64 Years (n=1527)	84 (37.0)	252 (39.7)	977 (38.5)	214 (34.9)
65-79 Years (n=973)	59 (26.0)	164 (25.9)	583 (23.0)	167 (27.2)
80 Years and Older (n=475)	31 (13.6)	68 (10.6)	275 (10.9)	101 (16.5)
Sex (%)				
Female (n=1060)	57 (25.1)	146 (22.9)	699 (27.6)	158 (25.8)
Male (n=2946)	170 (74.9)	489 (77.1)	1832 (72.4)	455 (74.2)
Race				
White (n=1669)	25 (11.0)	425 (65.3)	1014 (40.3)	215 (35.1)
Black (n=940)	5 (2.2)	152 (23.9)	743 (29.5)	40 (6.5)
Hispanic/Latino (n=264)	3 (1.3)	6 (1.0)	211 (8.4)	44 (7.2)
Other (n=104)	1 (0.5)	7 (1.1)	58 (2.3)	38 (6.2)
Unknown (n=1015)	193 (85.0)	55 (8.7)	491 (19.5)	276 (45.0)
Witnessed Arrest				
Witnessed by EMS (n=431)	28 (12.3)	48 (7.6)	296 (11.7)	59 (9.6)
Witnessed by Bystander (2265)	121 (53.3)	355 (55.9)	1425 (56.2)	364 (59.4)
Unwitnessed Arrest (n=1313)	78 (34.4)	232 (36.5)	813 (32.1)	190 (31.0)
Location of Arrest				
Public Building (n=1152)	72 (31.7)	197 (31.0)	729 (28.8)	154 (25.1)
Street/Highway (n=967)	50 (22.0)	165 (26.0)	593 (23.4)	159 (25.9)
Physician's Office/Medical Building (n=	12 (5.3)	46 (7.2)	263 (10.4)	58 (9.6)
Recreation/Sports Facility (n=263)	7 (3.1)	39 (6.1)	157 (6.2)	60 (9.8)
Residence/Institution (n=254)	21 (9.3)	26 (4.1)	155 (6.11)	52 (8.5)
Industry (n=168)	3 (1.3)	36 (5.7)	114 (4.5)	15 (2.5)
Jail (n=91)	1 (0.4)	7 (1.1)	66 (2.6)	17 (2.8)
Airport (n=83)	14 (6.2)	8 (1.3)	45 (1.8)	16 (2.6)
Hospital (n=79)	7 (3.1)	7 (1.1)	53 (2.1)	12 (2.0)
Educational Institution (n=55)	7 (3.1)	6 (0.9)	39 (1.5)	3 (0.5)
Farm (n=1)	1 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)
Other (n=518)	32 (14.1)	98 (15.4)	321 (12.7)	67 (10.9)
Presenting Rhythm				
VF/VT/Unknown Shockable (n=1749)	94 (41.4)	310 (48.8)	1065 (42.0)	280 (45.7)
Unknown Unshockable (n=468)	20 (26.4)	82 (12.9)	255 (10.1)	71 (11.6)
Asystole (n=1122)	39 (17.2)	154 (24.3)	775 (30.6)	154 (25.1)
Pulseless Electrical Activity (n=668)	32 (14.1)	89 (14.0)	439 (17.3)	108 (17.6)
Other (n=1)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)
Unknown (n=2)	2 (0.1)	0 (0.0)	0 (0.0)	0
Who First Applied AED				
Bystander (n=461)	36 (16.0)	63 (9.9)	304 (12.0)	58 (9.5)
First Responder (n=1469)	66 (29.3)	237 (37.4)	863 (34.1)	303 (49.4)
EMS (n=2070)	123 (54.7)	334 (52.7)	1361 (53.9)	252 (41.1)

Table 2: Association of Demographic and Event Characteristics on the Utilization of an AED in a Public Arrest

	(Age, Male, Race, Region, Witnessed)
AGE CATEGORY	
0-17 Years	0.82(0.46-1.46)
18-34 Years	1.59(1.12 - 2.25)**
35-49 Years	REF GROUP
50-64 Years	1.40(1.15 - 1.70)**
65-79 Years	1.46(1.18 -1.81)**
80 Years & Older	1.12(0.86 - 1.46)
MALE	1.19(1.01-1.39)*
RACE	
White	REF GROUP
Black	0.86(0.72 - 1.04)
Hispanic/Latino	0.83(0.62 - 1.11)
Other	0.98(0.63 - 1.53)
Unknown	1.06(0.86 - 1.32)
REGION	
Northeast	1.14(0.45 - 2.89)
Midwest	0.77(0.35 - 1.72)
South	REF GROUP
West	0.36(0.17 - 0.77)**
WITNESSED	1.06(0.92 - 1.23)

95% Confidence Intervals Shown
***Significant at 5%**
****Significant at 1%**

RESULTS

•A total of 20,018 arrests occurred during the study period, with 4,010 arrests included in the final sample.

•An AED was used in 1,458 (36.4%) arrests. The percentage of bystander-applied AEDs (someone other than a first responder) was only 11.5% (n=461).

•The overall survival to hospital discharge for all patients included in the sample was 19.1% (n=767), while 22.5% (n=328) of those patients who had an AED used survived to hospital discharge (Table 1).

•In the fully adjusted model, patients who were 18-34 years old (odds ratio [OR] 1.59 95% confidence interval [CI] 1.12-2.25) and male (OR 1.19; 95% CI 1.01-1.39) were more likely to have an AED used during an OHCA event. Those patients who lived in the western region were least likely of the 4 regions to have an AED used (OR 0.36; 95% CI 0.17-0.77) (Table 2).

LIMITATIONS

•It is unknown why bystanders did not apply an AED for an event.
•This dataset does not capture every event in the United States, so regional variation is not representative of the country at large.

CONCLUSIONS

•There appears to be regional variation in the utilization of AEDs in the CARES dataset.
•Only one out of every 10 patients who had a public arrest had an AED applied by a bystander.
•Further research at the city level is required to understand what is driving these variations in AED utilization.
•National strategies for increasing the visibility and utilization of AEDs should be considered.

Using CARES to Examine Regional Variation in the Utilization of AEDs

- An AED was used in 1,458 (36.4%) arrests. The percentage of bystander-applied AEDs used in public locations was only 11.5% (n=461).

- The overall survival to hospital discharge for all patients included in the sample was 19.1% (n=767), while 22.5% (n=328) of those patients who had an AED used survived to hospital discharge.

- In the fully adjusted model, patients who were 18-34 years old (OR 1.59; 95% CI 1.12-2.25) and male (OR 1.19; 95% CI 1.01-1.39) were more likely to have an AED used during an OHCA event. Those patients who lived in the western region were least likely of the 4 regions to have an AED used (OR 0.36; 95% CI 0.17-0.77).

Seasonal Variation in Out-of-Hospital Cardiac Arrests in 17 United States Cities

Linda Schieb, Greg Schwartz, CDC Atlanta, GA; Bryan McNally, Emory University School of Medicine, Paul Chan, Mid-Atlantic Heart Institute; Comilla Sasson, University of Colorado School of Medicine

Background

Cardiac Arrest Burden and Outcomes

- [illegible]
- [illegible]
- [illegible]
- [illegible]

Seasonal Variation in Cardiovascular Disease

- [illegible]

Study Objectives

- [illegible]
- [illegible]
- [illegible]

Methods

Data and statistical methods

- [illegible]

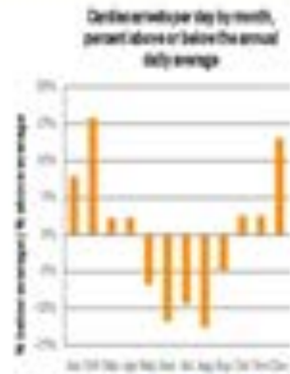
Inclusion criteria

Results

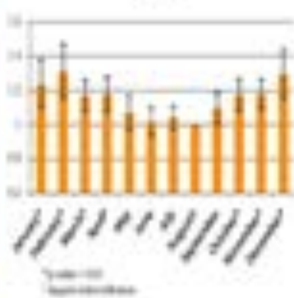
Cardiac arrest demographic data

Characteristic	N	%
[illegible]	[illegible]	[illegible]

Cardiac arrests per day by month, percent above or below the annual daily average



Cardiac arrest rate ratio by month – all sites



Cardiac arrest rate ratio of winter (Dec-Feb) vs. summer (Jun-Aug) for each site

Site	Rate Ratio	95% CI
[illegible]	[illegible]	[illegible]

Association of temperature (continuous) and cardiac arrests – Poisson regression estimate

Variable	Estimate	p-value
[illegible]	[illegible]	[illegible]

Association of temperature and cardiac arrests – rate ratio of quintiles calculated by site

Variable	Rate ratio	CI
[illegible]	[illegible]	[illegible]

Summary

- [illegible]
- [illegible]
- [illegible]
- [illegible]

Strengths and Limitations

- [illegible]
- [illegible]
- [illegible]

Conclusions

- [illegible]

References

Seasonal Variation in Out-of-Hospital Cardiac Arrests in 17 US Cities

- OHCA in the CARES dataset were more likely to occur in winter as compared to summer months.

- This seasonal pattern held for sites located in both northern and southern climates.

- Relative changes in temperature may explain some of the seasonal variation in out-of-hospital cardiac arrests.

- Temperate was associated only when comparing quintiles calculated for each location separately (i.e. the lowest temperature quintile varied from -13.8ºF-20.0ºF for Anchorage, Alaska to 36.3ºF-59.0ºF for Houston, Texas).

Women of Childbearing Age Have a Survival Benefit After Out-of-hospital Cardiac Arrest

Johnson A, Haukoos J, McNally B, Larabee T, Sasson C

- **Background**: Female sex hormones (estrogens and progesterone) have been shown to be protective in ischemic reperfusion injuries, but few studies have examined the relationship between these hormones and survival after OHCA. We hypothesized that younger females (ages 12–49), who have the highest estrogen levels, would have increased survival after OHCA when compared to other combined age/sex groups.

- **Objectives**: To estimate the association between high levels of female sex hormones and survival after OHCA.

Results:

- Young females had the highest survival prevalence (F12-49:11.6%; M12-49: 11.2%; F≥50: 6.9%; M≥50: 9.6%).
- In the fully-adjusted model, the younger female group was associated with an increased survival as compared to all other groups (OR 1.63; 95% CI 1.33-1.99).
- In a subgroup analysis, younger females had an increased odds of survival in both shockable and nonshockable rhythms (shockable: OR 1.66; 95% CI 1.26–2.19; nonshockable: OR 1.54; 95% CI 1.14–2.08).

Conclusion:

Younger females are associated with increased survival following cardiac arrest. Further research needs to be conducted on the pathophysiologic mechanisms of female sex hormones in relation to survival from cardiac arrest.

Hospital Volume and Survival in OHCA

Cudnik M, Sasson C, Rea T, Sayre M, Bobrow B, Spaite D, McNally B, Denninghoff K, Stolz U

Objectives:

Cardiac arrest centers may improve outcomes by achieving sufficient experience in post-arrest care. We analyzed the relationship between survival and hospital volume among patients suffering OHCA.

Results:

- Among those admitted, individual hospital survival varied widely (0–100%).
- Survival differed between the hospitals, grouped by annual call volume (16% for ≤10 vs. 18% for 11–39 vs. 14% for ≥40; $p<0.001$).
- Compared to patients cared for at hospitals with ≤10 arrests/year, the aOR of survival was 1.10 (95% CI 0.84–1.43) among 11–39 annual volume, and 1.14 (95% CI 0.87–1.49) among ≥ 40 annual volume.
- When volume was modeled continuously, no significant relationship was identified between hospital volume and survival (OR 1.00; 95% CI 0.99–1.00).

Conclusion:

Hospital OHCA volume was not associated with the likelihood of survival. Additional efforts are required to determine what hospital characteristics might account for the variability observed in OHCA hospital outcomes.

Hospital Characteristics Associated With Therapeutic Hypothermia

Cudnik M, Sayre M, McNally B, White L, Agnello S

- **Background**: Therapeutic hypothermia (TH) improves clinical outcomes after sudden cardiac arrest (SCA). The use of TH has been suggested as one criterion for Cardiac Arrest Resuscitation Centers.

- **Objectives**: We sought to determine which hospital characteristics are associated with the use of TH in hospitals that care for SCA patients.

Results:

- 67% of hospitals provided TH.
- TH hospitals were more likely to be teaching hospitals (33% vs. 13%, $p<0.05$), trauma centers (42% vs. 23%, $p<0.05$), non-profit centers (82% vs. 71%, $p<0.05$) with a higher number of annual admission (22,165 vs. 12,986, $p<0.001$).
- TH hospitals were more likely to provide cardiac catheterization than non-TH hospitals (87% vs. 67%, $p<0.05$).
- Patients cared for in hospitals offering TH were more likely to have presented in VF or VT (30% vs. 22%, $p<0.05$), arrest in a public place (35% vs. 30%, $p<0.05$), have a pulse restored (45% vs. 32%, $p<0.05$), and survive to hospital discharge (13% vs. 7%, $p<0.05$).

Conclusion:

Larger, non-profit, teaching hospitals with a cardiac catheterization lab were more likely to provide TH than smaller, for-profit community hospitals. These TH hospitals are also more likely to receive patients who can benefit from TH.

Small Area Variations in Out-of-Hospital Cardiac Arrest: Does the Neighborhood Matter?
Annals of Internal Medicine April 2011

Comilla Sasson, MD, MS; Carla C. Keirns, MD, PhD, MS; Dylan Smith, PhD; Michael Sayre, MD; Michelle Macy, MD, MS; William Meurer, MD; Bryan F. McNally, MD, MPH; Arthur L. Kellermann, MD, MPH; and Theodore J. Iwashyna, MD, PhD, the CARES Study Group April 2011

Neighborhoods with more cardiac arrests and fewer bystander cardiopulmonary resuscitations are promising targets for community-based interventions

A Descriptive analysis of the participating EMS systems in CARES
Resuscitation Accepted June 2011

Prasanthi Govindarajan, Lisa Lin, Adam Landman , Jason McMullan MD, Bryan F. McNally, Allison J. Crouch MPH, Comilla Sasson MD MS
Resuscitation Accepted June 2011

Other Investigations

- CDC-MMWR – Surveillance Summary, 2005-2010
- 17 City Census Track Analysis-SEC/Disparity
- Hypothermia Analysis (2011)
- Probabilistic linkage with Medicare Database
- Age and Outcome for ROSC vs Non-ROSC

Future Collaborative Studies

CARES
Cardiac Arrest Registry to Enhance Survival

PAROS

- Incidence of pVfib resuscitations by country
- Incidence pediatric OHCA by country

Future

CARES/PAROS Research Committee Potential Dates

- AHA Orlando October 2011
- PAROS Taiwan November 2011
- NAEMSP Tucson January 2012
- ICEM Dublin June 2012

CARES
Cardiac Arrest Registry
to Enhance Survival

PAROS

CARES WEBSITE

https://mycares.net

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