Cardiac Arrest Registry to Enhance Survival (CARES) Report on the Public Health Burden of Out-of-Hospital Cardiac Arrest

Prepared for:

Institute of Medicine

Submitted by:

Kimberly Vellano, MPH

Allison Crouch, MPH, MBA

Monica Rajdev, MPH

Bryan McNally, MD, MPH

For the CARES Surveillance Group

June 2015

Table of Contents

Tables and Figures

I. INTRODUCTION

In 2004, the Centers for Disease Control and Prevention (CDC) established the Cardiac Arrest Registry to Enhance Survival (CARES) in collaboration with the Department of Emergency Medicine at the Emory University School of Medicine. CARES was developed to help communities determine standard outcome measures for out-of-hospital cardiac arrest (OHCA), by linking the three sources of information that define the continuum of emergency cardiac care: 911 dispatch centers, emergency medical services (EMS) providers, and receiving hospitals. Participating EMS systems can compare their performance to de-identified aggregate statistics, allowing for longitudinal benchmarking capability at the local, regional, and national level.

CARES began data collection in Atlanta, with nearly 600 cases captured in 2005. At present, the registry now captures that same number of records weekly. The program has expanded to include 12 state-based registries (Alaska, Delaware, Hawaii, Idaho, Illinois, Michigan, Minnesota, North Carolina, Oregon, Pennsylvania, Utah, and Washington) with more than 50 community sites in 23 additional states, representing a catchment area of almost 80 million people or approximately 25% of the US population. To date, the registry consists of over 150,000 records, with more than 800 EMS agencies and over 1,300 hospitals participating nationwide. Future expansion will focus on state-level participation, with several states (Maryland, Nebraska, and South Carolina) slated for enrollment in 2015.

CARES has also grown internationally by collaborating with the Pan Asian Resuscitation Outcomes Study (PAROS), currently representing 8 countries (South Korea, Japan, Taiwan, Singapore, Malaysia, Thailand, Turkey, and Dubai). The CARES/PAROS partnership was established as the first international collaboration for OHCA utilizing a uniform taxonomy and shared web-based software platform.

CARES transitioned from government to private funding in 2012. The funding partners include American Red Cross, Medtronic Foundation HeartRescue Project, American Heart Association, and Zoll Corporation.

II. BENEFITS OF PARTICIPATION

At the local level, most EMS agencies lack a mechanism or process to collect basic survival data for OHCA patients. As a result, quality improvement efforts are difficult, if not impossible. CARES allows communities to benchmark their performance with local, state, or national metrics to better identify opportunities to improve performance in OHCA care. CARES offers a comprehensive understanding of where arrests are occurring, whether bystanders are providing intervention prior to EMS arrival, and on-scene EMS performance, providing the data necessary to make informed decisions and allocate limited resources for maximal community benefit. By creating an easy-to-use and flexible system to collect OHCA data and forming a community to share best practices, CARES has transformed the way EMS agencies are treating OHCA. Participating agencies are able to make decisions in their community based on real-time feedback and analysis, in order to increase OHCA survival.

III. METHODS

A. Data Collection and Elements

The CARES software (https://mycares.net), developed and maintained by Sansio, Inc., links three sources to describe each OHCA event: 1) 911 call center data, 2) EMS data, and 3) hospital data. The registry evaluates OHCA events of non-traumatic etiology that involve persons who received resuscitation efforts, including CPR and/or defibrillation. Data can be submitted in two ways: using a data-entry form on the CARES website, or via daily upload from an agency's electronic patient-care record (ePCR) system. Access to the CARES website is restricted to authorized users, who are prohibited from viewing data from another agency or hospital.

The CARES dataset was designed with the end user in mind, including a minimal number of mandatory data elements that identify an OHCA event and its outcome. In order to make the registry sustainable and ensure continuous participation, brevity in the dataset was critical as EMS agencies and hospitals had to be able to devote time to data collection and oversight without significant resources.

Data elements collected from EMS providers include demographics (i.e. name, age, date of birth, incident address, sex, and race/ethnicity), arrest-specific data (i.e. location type of arrest, witness status, and presumed etiology), and resuscitation-specific data (i.e. information regarding bystander CPR initiation and/or AED application, defibrillation, initial arrest rhythm, return of spontaneous circulation [ROSC], field hypothermia, and pre-hospital survival status). EMS providers are also able to enter a number of optional elements, which further detail arrest interventions (i.e. usage of mechanical CPR device, ITD, 12 Lead, automated CPR feedback device, and advanced airway; administration of drugs; and diagnosis of STEMI). Supplemental data elements collected from the 911 call centers include the time that each 911 call was received, the time of dispatch for both first responder and EMS providers, and arrival time at the scene. Data elements collected from receiving hospitals include emergency department outcome, provision of therapeutic hypothermia, hospital outcome, discharge location, and neurological outcome at discharge (using the Cerebral Performance Categories [CPC] Scale). Receiving facilities may also complete optional elements outlining hospital procedures, including targeted temperature management (TTM), coronary angiography, CABG, and stent or ICD placement.

B. Reporting Capability

The CARES software has the functionality to automate data analysis for participating EMS agencies. The reports include 911 response intervals, delivery rates of critical interventions (i.e. bystander CPR, dispatcher CPR, public access defibrillation [PAD]), and community rates of survival using the Utstein template. An EMS agency has continuous access to their data and can generate reports by date range at their convenience. The software is also capable of aggregate reporting such that CARES staff can generate custom reports for benchmarking and surveillance purposes. In addition, hospitals have access to a facility-specific report, allowing users to view pre-hospital and in-hospital characteristics of their patient population with benchmarking capability. A robust query feature also allows agencies and hospitals to create customized searches of their own data. These search results can be easily exported to Microsoft Excel for further analysis.

C. Data Validation

The CARES quality assurance process is one of the strengths of the registry, as a number of measures are taken to ensure the integrity and cleanliness of the data. These measures include standardized training of all CARES users, built-in software logic, an audit algorithm ensuring consistent data validation across the registry, and a bi-annual assessment of population coverage, survival data, and case ascertainment.

1. Training, Education, and Support

Training, education, and ongoing technical and operations support are key components of CARES that contribute to the registry's success and enhance the experience for participating sites. During the enrollment process, EMS and hospital users receive extensive training from CARES staff on the data elements, data collection process, and features of the CARES website. This training includes a one-on-one session with a CARES Program Coordinator or a CARES state coordinator prior to being granted access to the software. EMS and hospital users are also provided with numerous resources, including a detailed CARES data dictionary, a list of frequently miscoded data elements, and a CARES user guide. Once a community has been participating in the registry for an extended period of time, CARES provides ongoing support in the form of answering questions as needed, providing updated training documents, and responding to individual reporting requests.

2. Software Logic and Auditing

In order to provide consistent data validation across the registry, each CARES record is reviewed for completeness and accuracy through an audit algorithm. Once the record is processed by the algorithm, data entry errors are flagged for review by EMS and hospital users (as appropriate) and CARES staff. Logic is also incorporated into the data-entry form to minimize the number of incomplete fields and implausible answer choices during the data entry process. Finally, aggregate data is analyzed on a regular basis to identify agency-specific anomalies. CARES staff utilize site-by-site comparison tools to detect outliers and compare each agency's data with the national average.

3. Case Ascertainment

Each EMS agency is asked to confirm their non-traumatic call volume to ensure capture of all arrests in a defined geographic area, through either an electronic query of their ePCR or a manual review of paper charts. The volume of OHCA per month is compared with historic monthly volumes by CARES staff; when a substantial drop in the number of events occurs, the EMS contact is notified to determine if the variation was real or the result of a lag in the data-entry process. In addition, CARES conducts a bi-annual assessment of population coverage, survival data, and case ascertainment. CARES staff and state coordinators provide each EMS agency's geographic coverage, census population, and start date via a standardized Excel template. This information is then linked with survival data and record volume, by etiology, to identify outliers across the entire registry. In the event that an outlier is found, CARES staff or the state coordinator works closely with the EMS agency to identify any issues in the data collection process and resolve as needed.

IV. RESULTS

Analysis of all worked, non-traumatic OHCA events submitted to the registry from January 1 – December 31, 2013 was conducted using JMP® version 10 (SAS Institute, Cary, NC). A map of the communities and states included in the 2013 dataset can be found in Figure 1. The population represented is 62,773,841 or approximately 20% of the U.S. population in 2013.

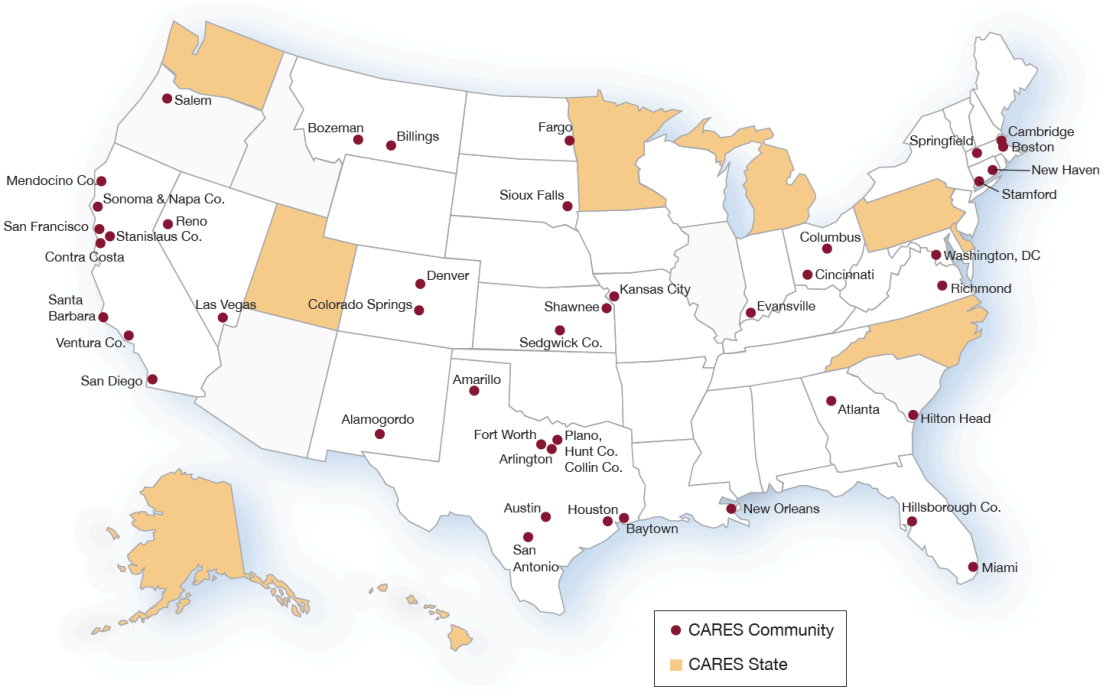


FIGURE 1. Communities and States included in 2013 CARES Dataset

35,721 OHCA events were reported; approximately 87.1% of which were of presumed cardiac etiology (Table 1). The incidence of non-traumatic, worked arrests was 56.9 per 100,000 while the incidence of presumed cardiac, worked arrests was 49.6 per 100,000. Using the 2013 census data (using estimates of the US population as of July 1, 2013, <http://www.census.gov/popclock/>, accessed on December 18, 2014), CARES estimates that there were 179,877 (incidence of 56.9 *316,128,839 /100,000) EMS-treated non-traumatic OHCAs in 2013.

TABLE 1. Number* and percentage of persons who experienced and who survived an out-of-hospital cardiac arrest†, by presumed arrest etiology --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013

	Experienced		Survived§	
Presumed cardiac arrest etiology	**N**	**%**	**N**	**%**
Presumed cardiac	31,127	87.1	3,315	10.6
Respiratory	2,591	7.3	348	13.4
Drowning	248	0.7	35	14.1
Electrocution	27	0.1	9	33.3
Other	1,728	4.8	194	11.2
Total	**35,721**	**100.0**	**3,901**	**10.9**

* N=35,721
† Defined as a cardiac arrest that occurred in the prehospital setting, had a non-traumatic cardiac etiology, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.
§ Patient outcome is missing for 190 persons.

Patient demographics (i.e. age, sex, race/ethnicity) and clinical aspects of the event (i.e. initial rhythm, witness status, bystander intervention) are reported in Tables 2 and 3. The mean age at cardiac arrest was 62.8 years (standard deviation: 19.5), and 60.8% of cases occurred in males (n=21,701). The proportion of persons with an initially shockable rhythm (i.e. ventricular fibrillation or pulseless ventricular tachycardia) was 21.1%, and 50.1% of arrests were witnessed by a bystander or 911 responder (37.7% and 12.4%, respectively).

TABLE 2. Number* and percentage of persons who experienced and who survived an out-of-hospital cardiac arrest†, by selected demographic characteristics --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013

	Experienced		Survived§§	
Characteristic	**N**	**%**	**N**	**%**
Age group (yrs)				
<1	502	1.4	30	6.0
1-12	391	1.1	52	13.3
13-17	144	0.4	30	20.8
18-34	1,915	5.4	293	15.3
35-49	4,257	11.9	580	13.6
50-64	10,499	29.4	1,466	14.0
65-79	10,534	29.5	1,049	10.0
≥80	7,421	20.8	389	5.2
Total	**35,663§**	**100.0**	**3,889**	**10.9**
Sex				
Female	14,016	39.2	1,347	9.6
Male	21,701	60.8	2,554	11.8
Total	**35,717¶**	**100.0**	**3,901**	**10.9**
Race/Ethnicity				
American Indian/Alaska Native	166	0.5	18	10.8
Asian	576	1.6	60	10.4
Black/African-American	6,711	18.8	625	9.3
Hispanic/Latino	2,201	6.2	262	11.9
Native Hawaiian/Pacific Islander	255	0.7	18	7.1
Unknown	9,308	26.1	1,019	10.9
White	16,504	46.2	1,899	11.5
Total	**35,721**	**100.0**	**3,901**	**10.9**
Location of arrest				
Home/Residence	25,036	70.1	2,251	9.0
Nursing home/Assisted living facility	3,727	10.4	178	4.8
Public building	2,528	7.1	594	23.5
Street/Highway	1,621	4.5	294	18.1
Other	285	0.8	57	20.0
Healthcare facility	1,655	4.6	265	16.0
Place of recreation	594	1.7	175	29.5
Industrial place	180	0.5	47	26.1
Transport center	95	0.3	40	42.1
Total	**35,721**	**100.0**	**3,901**	**10.9**
Median household income, of home arrests**				
<$20,000	893	3.6	75	8.4
$20,000-$29,999	2,706	11.0	240	8.9
$30,000-$39,999	4,404	17.9	383	8.7
$40,000-$49,999	4,528	18.4	390	8.6
$50,000-$59,999	3,922	15.9	344	8.8
$60,000-$69,999	2,905	11.8	253	8.7
$70,000-$79,999	2,018	8.2	185	9.2
$80,000-$89,999	1,310	5.3	112	8.6
$90,000-$99,999	747	3.0	63	8.4
>$100,000	1,230	5.0	132	10.7
Total	**24,663††**	**100.0**	**2,177**	**8.8**

* N=35,721
† Defined as a cardiac arrest that occurred in the prehospital setting, had a non-traumatic cardiac etiology, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.
§ Age is missing for 58 persons.
¶ Gender is missing for 4 persons.
** Defined as median annual household income, by census tract. Analysis limited to private, home arrests.
†† Median household income Is missing for 373 home arrests.
§§ Patient outcome is missing for 190 persons.

Characteristics of event location are reported in Table 2. 70.1% of arrests occurred at a home or residence, and 10.4% occurred at a nursing home or assisted living facility. The remainder of arrests took place in public locations. Retention of incident location allows geographic information systems (GIS) to be used to map events, allowing EMS services to examine neighborhood characteristics as well as individual factors and system issues that might influence the likelihood of survival following an OHCA event.

On the basis of local EMS agency protocols, 26.9% of patients were pronounced dead after resuscitation efforts were terminated in the pre-hospital setting. Approximately 43.8% of patients were pronounced in the emergency department (ED), while the survival rate to hospital admission was 28.9%. The survival rate to hospital discharge was 10.9%. A majority of patients (82.0%) who were discharged alive had a CPC score of 1 or 2 (CPC 1 = good cerebral performance; CPC2 = moderate cerebral disability), as illustrated in Figure 2.

TABLE 3. Number* and percentage of persons who experienced and who survived an out-of-hospital cardiac arrest†, by selected clinical characteristics ---Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013

	Experienced		Survived†††	
Characteristic	**N**	**%**	**N**	**%**
Presenting arrest rhythm				
VF/VT/unknown shockable rhythm	7,548	21.1	2,218	29.4
Unknown unshockable rhythm	3,918	11.0	477	12.2
Asystole	16,556	46.4	459	2.8
Pulseless electrical activity	7,694	21.5	746	9.7
Total	**35,716§**	**100.0**	**3,900**	**10.9**
Arrest witness status				
Unwitnessed arrest	17,832	49.9	862	4.8
Witnessed by bystander	13,457	37.7	2,204	16.4
Witnessed by 911 responder	4,432	12.4	835	18.8
Total	**35,721**	**100.0**	**3,901**	**10.9**
Who first inititated CPR				
Bystander	14,121	39.6	1,769	12.5
First Responder	9,428	26.4	756	8.0
Responding EMS personnel	12,120	34.0	1,346	11.1
Total	**35,669¶**	**100.0**	**3,871**	**10.9**
Who first applied AED/monitor				
Bystander	1,586	4.4	344	21.7
First Responder	7,975	22.3	815	10.2
Responding EMS personnel	26,149	73.2	2,740	10.5
Total	**35,710****	**100.0**	**3,899**	**10.9**
Sustained ROSC in field				
Yes	11,644	32.6	3,559	30.6
No	24,044	67.4	342	1.4
Total	**35,688††**	**100.0**	**3,901**	**10.9**
Field hypothermia				
Yes	5,418	15.2	1,084	20.0
No	30,289	84.8	2,816	9.3
Total	**35,707§§**	**100.0**	**3,900**	**10.9**
In-hospital hypothermia (among admitted patients)				
Yes	5,026	50.1	1,838	36.6
No	4,999	49.9	2,001	40.0
Total	**10,025¶¶**	**100.0**	**3,839**	
Utstein events				
Witnessed by bystander and found in shockable rhythm	4,441	12.4	1,465	33.0
Witnessed by bystander, found in shockable rhythm, and received some bystander intervention (CPR by bystander and/or AED applied by bystander)	2,526	7.1	965	38.2
Resuscitation outcome				
Dead in field	9,598	26.9		
Pronounced in ED	15,662	43.8		
Admitted to hospital	10,338	28.9		
Overall survival				
Overall survival to hospital admission	10,338	28.9		
Overall survival to hospital discharge	3,901	10.9		
Home/Residence	2,415	6.8		
Rehabilitation Facility	604	1.7		
Skilled Nursing Facility/Hospice	878	2.5		
With good or moderate cerebral performance***	3,050	8.5		

Abbreviations: VF = ventricular fibrillation; VT = pulseless ventricular tachycardia; CPR = cardiopulmonary resuscitation; EMS = emer medical services; AED = automated external defibrillator; ROSC = return of spontaneous circulation; ED = emergency department

* N=35,721

† Defined as a cardiac arrest that occurred in the prehospital setting, had a non-traumatic cardiac etiology, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.

§ Presenting arrest rhythm is missing for 5 persons.

¶ Data on who initiated CPR are missing for 52 persons.

** Data on who first applied AED/monitor are missing for 11 persons.

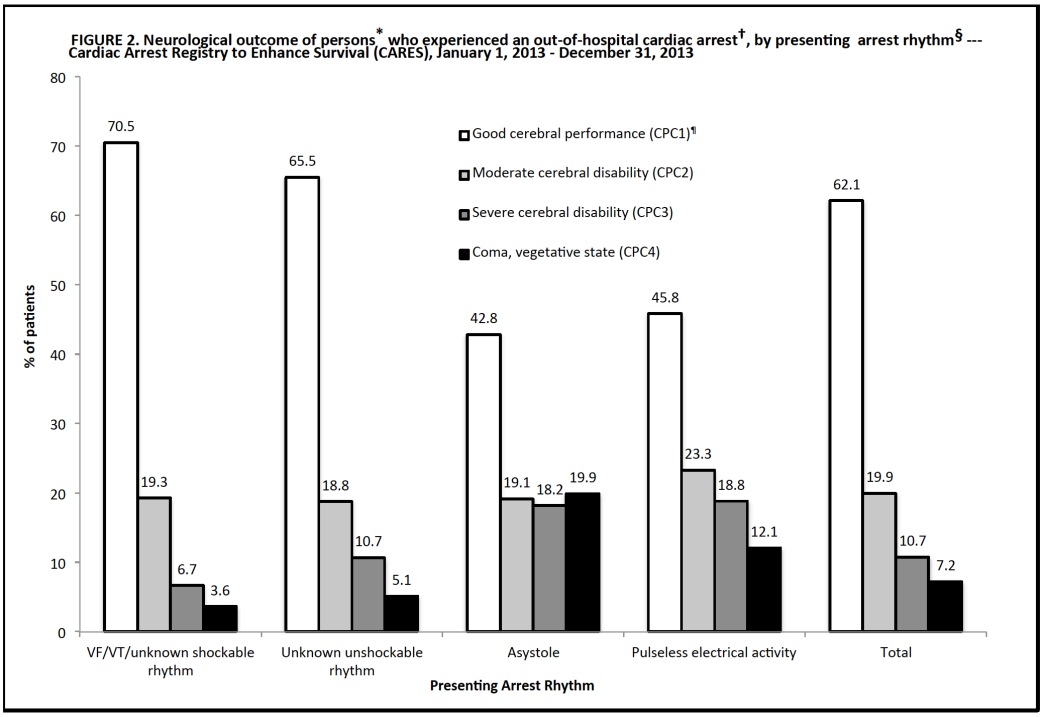
†† Sustained ROSC is missing for 33 persons.

§§ Field hypothermia is missing for 14 persons.

¶¶ In-hospital hypothermia is missing for 313 admitted persons.

*** CPC score is missing for 185 persons.

††† Patient outcome is missing for 190 persons.



Abbreviations: CPC = cerebral performance category; VF = ventricular fibrillation; VT = pulseless ventricular tachycardia
* N=35,721
† Defined as a cardiac arrest that occurred in the prehospital setting, had a non-traumatic cardiac etiology, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.
§ Presenting arrest rhythm is missing for 5 persons.
¶ CPC is missing for 185 persons.

Persons who had a bystander witnessed cardiac arrest were more likely than persons whose arrest was unwitnessed to receive bystander CPR (51.7% vs. 40.1%) or bystander AED application (6.6% vs. 3.9%) (Table 4). Patients with a bystander witnessed arrest were also more likely to be found in an initial shockable rhythm (33.0% vs. 12.2%). Overall survival to hospital discharge among patients whose arrest was bystander witnessed (16.4%) was more than three times that of patients with an unwitnessed arrest (4.8%).

TABLE 4. Number* and percentage of persons who experienced and who survived an out-of-hospital cardiac arrest†, by witness status and selected clinical characteristics --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013

	Unwitnessed				Bystander witnessed				911 responder witnessed			
	Experienced		Survived††		Experienced		Survived††		Experienced		Survived††	
Characteristic	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Presenting arrest rhythm§												
VF/VT/unknown shockable rhythm	2,174	12.2	367	16.9	4,441	33.0	1,465	33.0	933	21.1	386	41.4
Unknown unshockable rhythm	2,033	11.4	151	7.4	1,491	11.1	248	16.6	394	8.9	78	19.8
Asystole	11,015	61.8	154	1.4	4,446	33.0	185	4.2	1,095	24.7	120	11.0
Pulseless electrical activity	2,610	14.6	190	7.3	3,075	22.9	305	9.9	2,009	45.3	251	12.5
Total	**17,832**	**100.0**	**862**	**4.8**	**13,453**	**100.0**	**2,203**	**16.4**	**4,431**	**100.0**	**835**	**18.8**
Who first inititated CPR¶												
Bystander	7,147	40.1	380	5.3	6,953	51.7	1,384	19.9	--	--	--	--
First Responder	5,442	30.5	205	3.8	3,382	25.1	446	13.2	604	13.8	105	17.4
Responding EMS personnel	5,234	29.4	275	5.3	3,114	23.2	373	12.0	3,772	86.2	698	18.5
Total	**17,823**	**100.0**	**860**	**4.8**	**13,449**	**100.0**	**2,203**	**16.4**	**4,376**	**100.0**	**803**	**18.4**
Who first applied AED/monitor**												
Bystander	689	3.9	49	7.1	894	6.6	295	33.0	--	--	--	--
First Responder	4,249	23.8	179	4.2	3,450	25.6	583	16.9	276	6.2	53	19.2
Responding EMS personnel	12,889	72.3	634	4.9	9,108	67.7	1,325	14.5	4,152	93.8	781	18.8
Total	**17,827**	**100.0**	**862**	**4.8**	**13,452**	**100.0**	**2,203**	**16.4**	**4,428**	**100.0**	**834**	**18.8**

Abbreviations: VF = ventricular fibrillation; VT = pulseless ventricular tachycardia; CPR = cardiopulmonary resuscitation; EMS = emergency medical services; AED = automated external defibrillator
* N=35,721
† Defined as a cardiac arrest that occured in the prehospital setting, had a non-traumatic etiology, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.
§ Presenting arrest rhythm is missing for 5 persons.
¶ Data on who initiated CPR are missing for 52 persons.
** Data on who first applied AED/monitor are missing for 11 persons.
†† Patient outcome is missing for 190 persons.

An Utstein survival report divides arrests into three categories: unwitnessed, witnessed by bystander, and witnessed by 911 responder (Figure 3). The report then stratifies the arrests by initial cardiac arrest rhythm. This allows for interpretation of Utstein survival rate (witnessed by a bystander with an initial shockable rhythm), which was 33.0% (Table 3). Utstein bystander patients (witnessed by a bystander with an initial shockable rhythm, and received some bystander intervention [CPR and/or AED application]) had a survival rate of 38.2%.

FIGURE 3. Utstein survival report showing survival for out-of-hospital cardiac arrest, stratified by witness category --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013

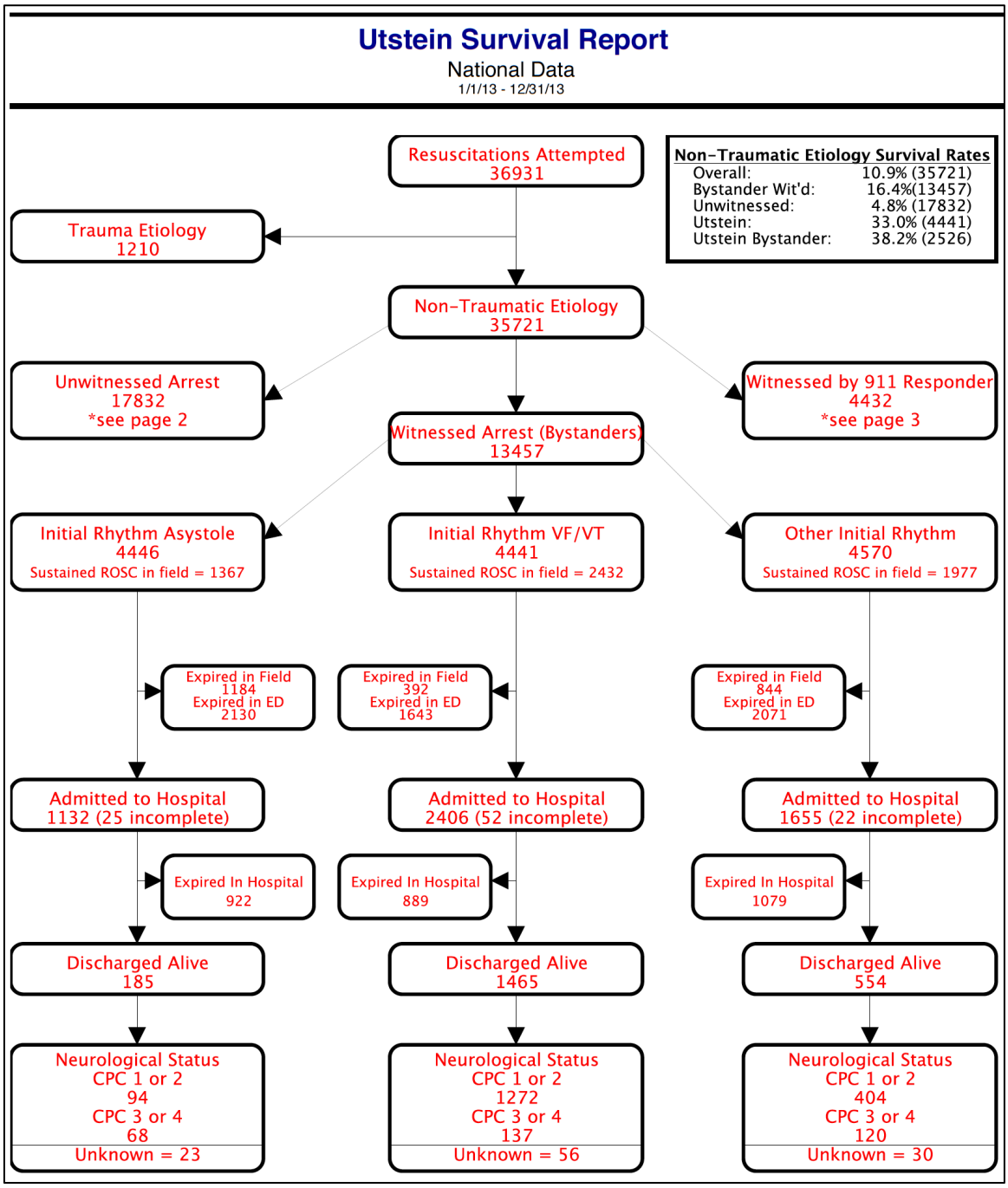
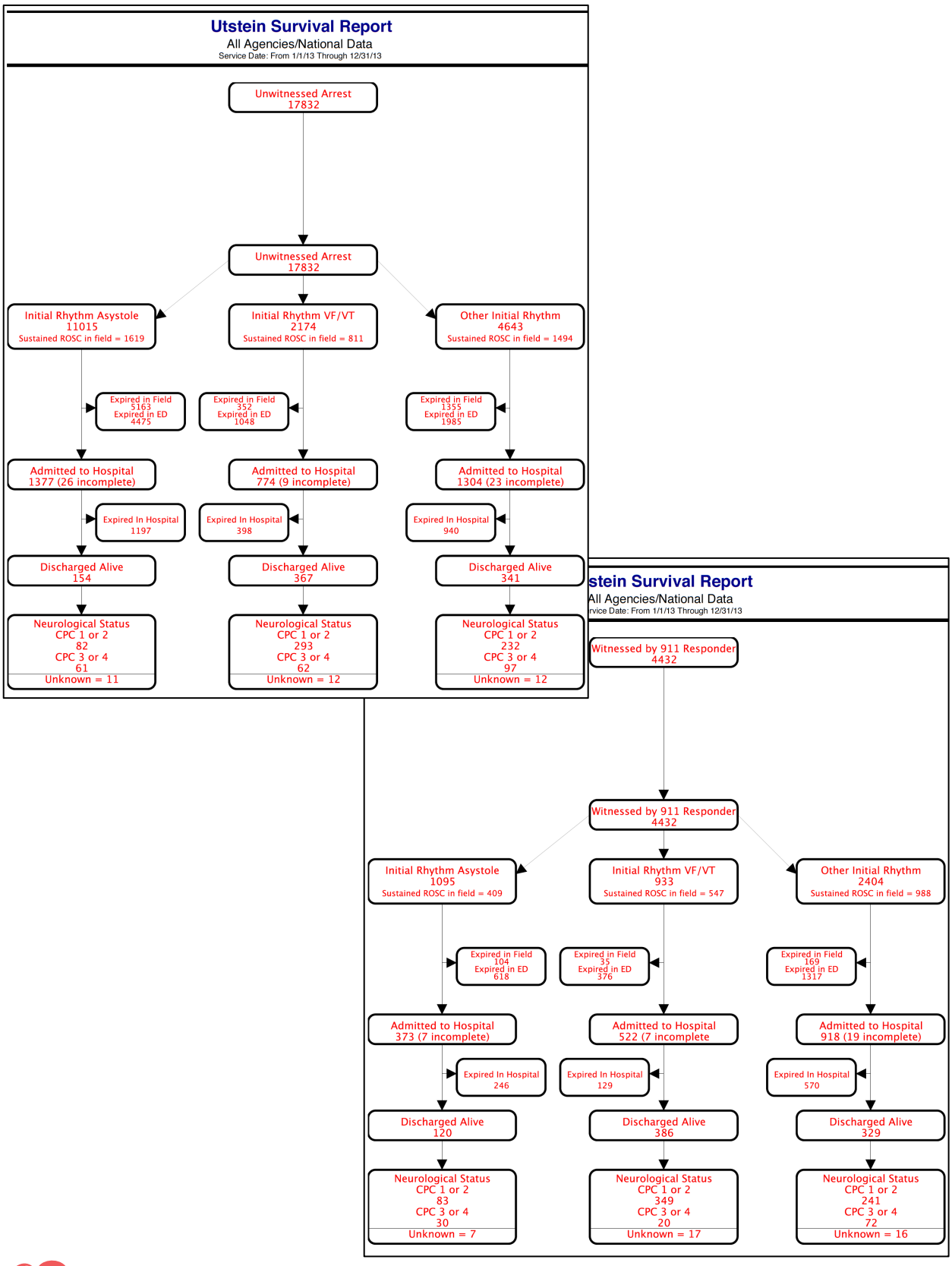
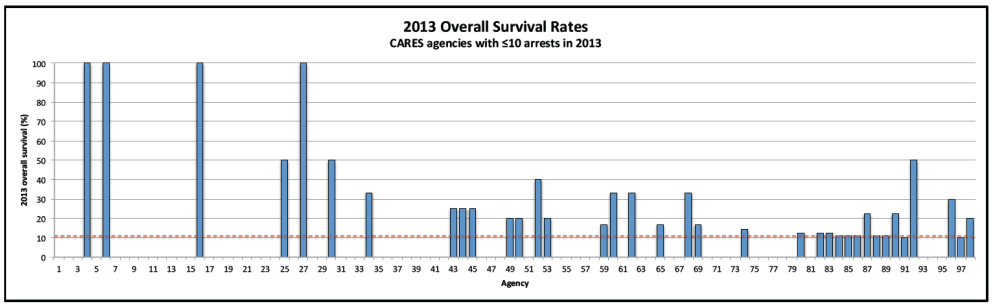


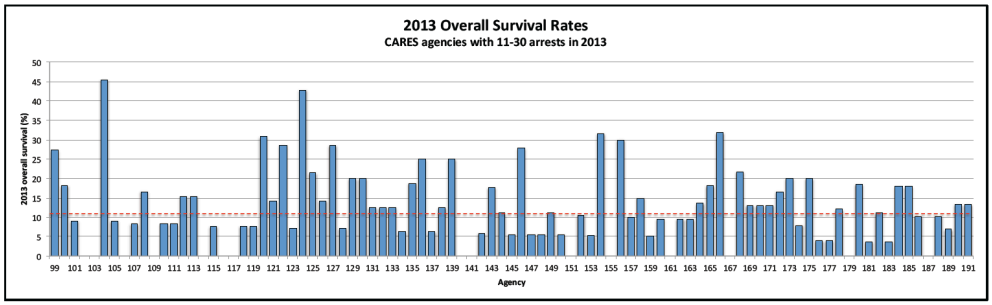
FIGURE 3 *(Cont.)*. Utstein survival report showing survival for out-of-hospital cardiac arrest, stratified by witness category --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013

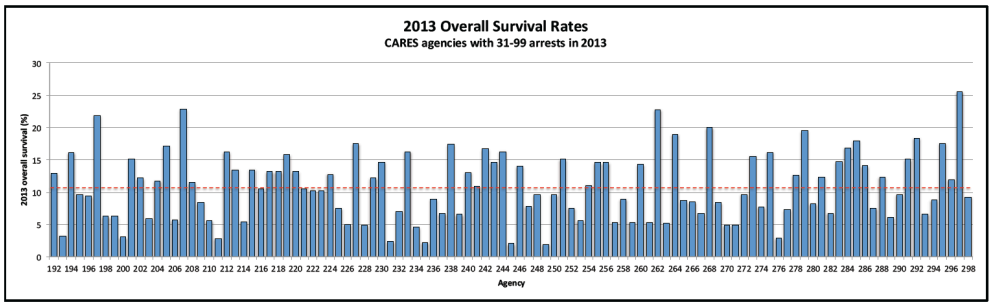


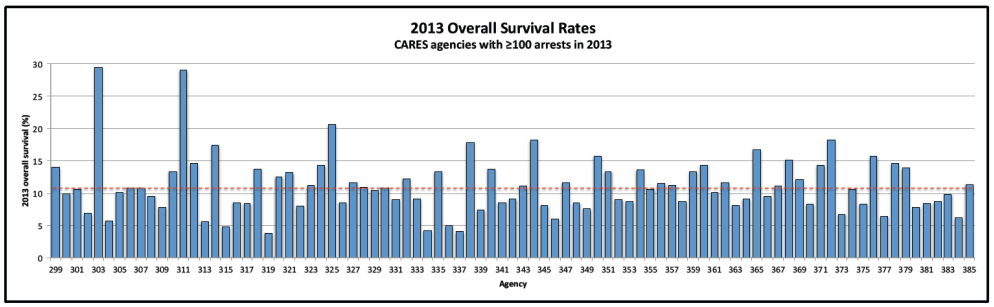
The diversity of CARES sites allows for comparison of outcome metrics among agencies of similar size. A report that compares 1) overall survival rates, 2) survival rates of witnessed arrests with an initial shockable rhythm (Utstein), and 3) bystander CPR rates by EMS agency is presented in bar graph format (Figures 4-6). This permits site-by-site comparison as well as visualization of the variability among participating agencies. Variability in rates among low-volume agencies is due to the small sample size of their annual cardiac arrests.

FIGURE 4. 2013 overall survival rates, by participating emergency medical services (EMS) agency --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013



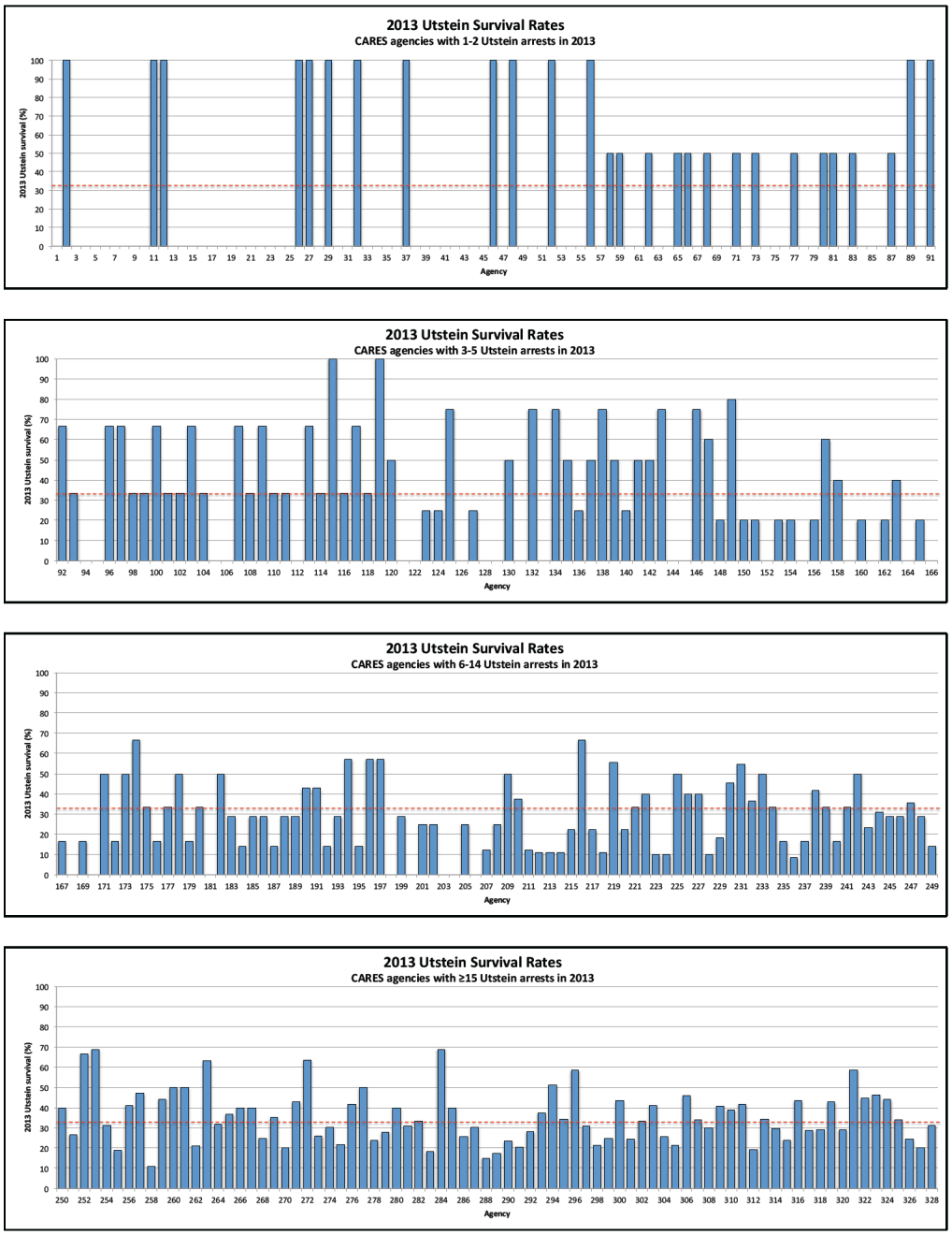






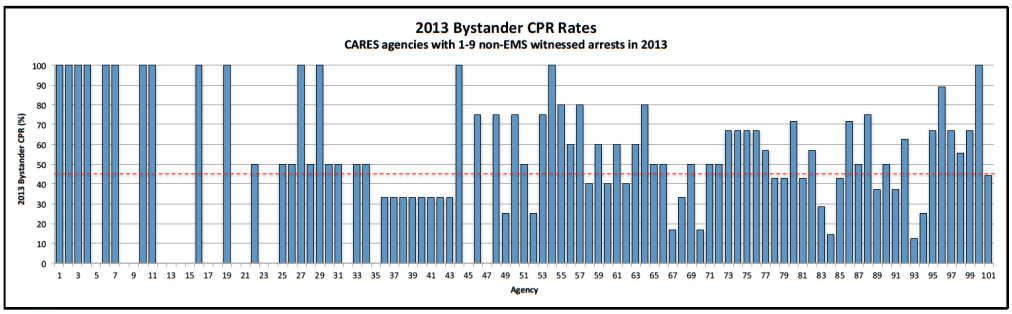
* Total N=35,721
† Inclusion criteria: cardiac arrests that occurred in the prehospital setting, had a non-traumatic cardiac etiology, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.
§ Patient outcome is missing for 190 persons.
Please note: Agency ID numbers vary across Figures 4, 5, and 6.
-------- National overall survival rate = 10.9%

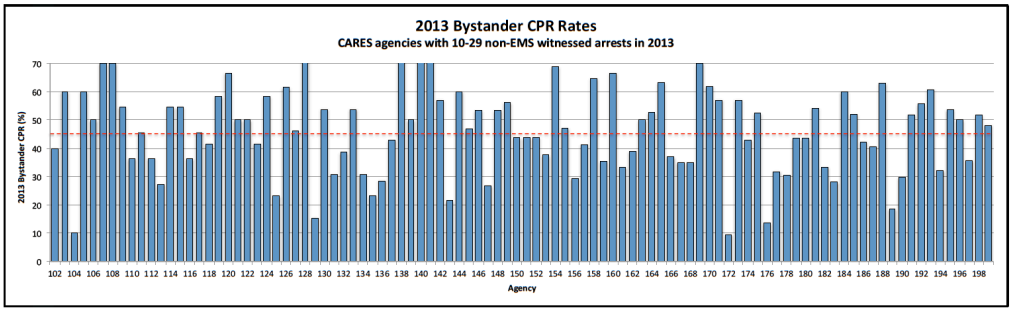
FIGURE 5. 2013 Utstein survival rates, by participating emergency medical services (EMS) agency --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013

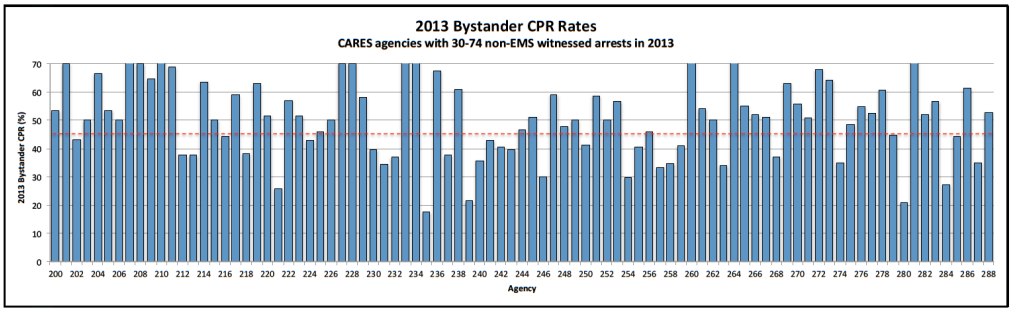


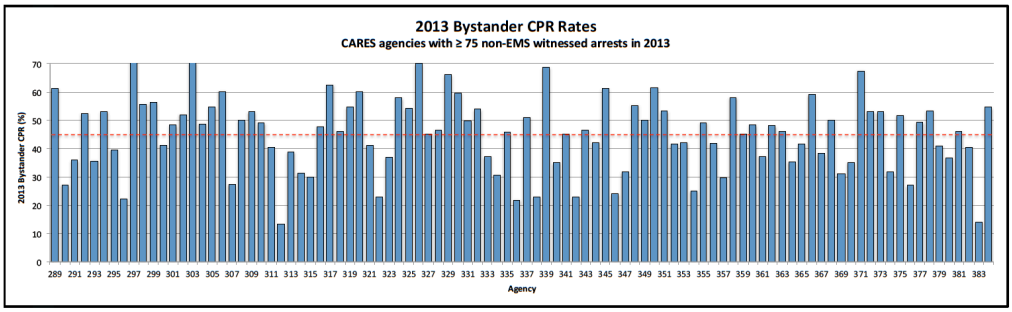
* Total N=4,441
† Inclusion criteria: cardiac arrests that were witnessed by a bystander in the prehospital setting, had a non-traumatic cardiac etiology, were found in a shockable rhythm, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.
§ Patient outcome is missing for 52 Utstein patients.
Please note: Agency ID numbers vary across Figures 4, 5, and 6.
National Utstein survival rate = 33.0%

FIGURE 6. 2013 Bystander cardiopulmonary resuscitation (CPR) rates, by participating emergency medical services (EMS) agency --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2013 - December 31, 2013





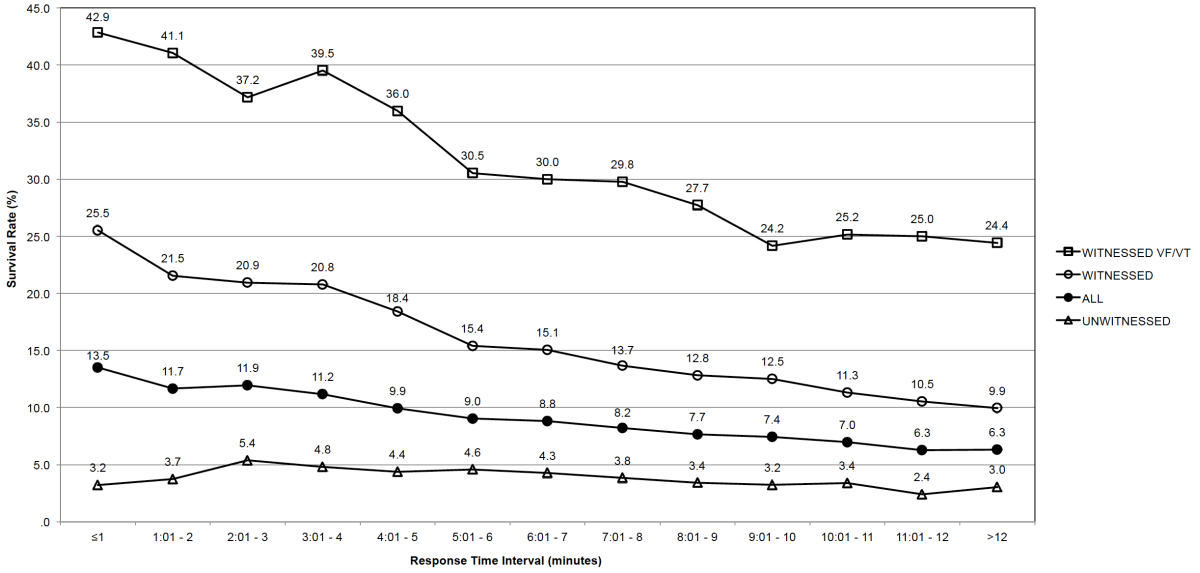




* Total N=31,289
† Inclusion criteria: cardiac arrests that occurred in the prehospital setting, had a non-traumatic cardiac etiology, were not witnessed by a 911 Responder, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.
Please note: Agency ID numbers vary across Figures 4, 5, and 6.
-------- National bystander CPR rate = 45.1%

Cumulative CARES data (October 1, 2005 – December 31, 2013) was utilized to conduct a response time analysis. The analysis was limited to arrests of presumed cardiac etiology involving attempted resuscitation by responding EMS/first responder units. There were 106,523 reported OHCA cases meeting these criteria. After excluding 11,565 cases where the arrest occurred after EMS/first responder arrival, there were 94,958 cases for review. Response time, which is an optional field in CARES, was missing for 26,276 cases. Among the remaining 68,682 cases, 310 were missing survival status data. The analyses focused on a total of 68,372 cases. Response time was measured from call receipt at dispatch center to arrival of the first 911 unit vehicle at the scene. Figure 7 graphically presents survival rates by response time interval for four groups of patients: witnessed VF/VT, witnessed, unwitnessed, and all. Patients with a witnessed VF/VT arrest experienced a significant decrease in survival after a four-minute response time. In contrast, response time had little effect on survival among unwitnessed arrests.

FIGURE 7. Survival rate of persons* who experienced an out-of-hospital cardiac arrest†, by response time§ and witness status¶ --- Cardiac Arrest Registry to Enhance Survival (CARES), October 1, 2005 - December 31, 2013



Abbreviations: VF: ventricular fibrillation; VT: ventricular tachycardia

* N=68,372

† Defined as a cardiac arrest that occurred in a prehospital setting, had a presumed cardiac etiology, was not witnessed by a 911 responder, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.

§ Response time is measured from call receipt at dispatch center to arrival of the first 911 unit vehicle at the scene.

¶ Arrest witness status missing for 5 persons.

Trend analyses were conducted using two patient subsets: the CARES 2010 cohort and cumulative data from 2005-2012. The 2010 cohort is comprised of the 69 agencies that were participating in CARES in 2010, representing 35 communities with a combined population of approximately 27 million. Year-by-year demographic and clinical characteristics of the cohort are reported in Table 5. Bystander CPR provision increased from 32.7% in 2010 to 40.0% in 2013, as did the Utstein (31.8% to 35.4%) and Utstein bystander (35.0% to 40.2%) survival rates.

TABLE 5. CARES 2010 Cohort, selected demographic and clinical characteristics of OHCA --- Cardiac Arrest Registry to Enhance Survival (CARES), January 1, 2010 - December 31, 2013

Data	2010 N=12152	2011 N=12555	2012 N=13370	2013 N=14015
Age	**N=12149**	**N=12521**	**N=13358**	**N=14004**
Mean	64.3	64.0	64.1	64.5
Median	65	65	65	65
Gender (%)	**N=12148**	**N=12551**	**N=13367**	**N=14013**
Female	4588 (37.8)	4867 (38.8)	5167 (38.7)	5375 (38.4)
Male	7560 (62.2)	7684 (61.2)	8200 (61.3)	8638 (61.6)
Race (%)	**N=12140**	**N=12512**	**N=13345**	**N=14006**
American-Indian/Alaskan	64 (0.5)	52 (0.4)	49 (0.4)	66 (0.5)
Asian	171 (1.4)	140 (1.1)	223 (1.7)	205 (1.5)
Black/African-American	3056 (25.2)	3187 (25.5)	3438 (25.8)	3626 (25.9)
Hispanic/Latino	606 (5.0)	632 (5.1)	694 (5.2)	836 (6.0)
Native Hawaiian/Pacific Islander	89 (0.7)	94 (0.8)	106 (0.8)	110 (0.8)
White	4777 (39.3)	5066 (40.5)	5931 (44.4)	6115 (43.7)
Unknown	3377 (27.8)	3341 (26.7)	2904 (21.8)	3048 (21.8)
Location of Arrest (%)	**N=12152**	**N=12555**	**N=13370**	**N=14015**
Healthcare Facility	289 (2.4)	514 (4.1)	524 (3.9)	697 (5.0)
Home/Residence	8316 (68.4)	8381 (66.8)	9178 (68.6)	9531 (68.0)
Industrial Place	60 (0.5)	62 (0.5)	64 (0.5)	80 (0.6)
Nursing Home	1568 (12.9)	1604 (12.8)	1681 (12.6)	1627 (11.6)
Other	338 (2.8)	244 (1.9)	90 (0.7)	51 (0.4)
Place of Recreation	164 (1.3)	179 (1.4)	198 (1.5)	213 (1.5)
Public/Commercial Building	793 (6.5)	887 (7.1)	893 (6.7)	1011 (7.2)
Street/Highway	569 (4.7)	635 (5.1)	683 (5.1)	749 (5.3)
Transport Center	55 (0.5)	49 (0.4)	59 (0.4)	56 (0.4)
Arrest witnessed (%)	**N=12152**	**N=12554**	**N=13370**	**N=14015**
Bystander Witnessed	4415 (36.3)	4531 (36.1)	4995 (37.4)	5205 (37.1)
Witnessed by 911 Responder	1283 (10.6)	1367 (10.9)	1434 (10.7)	1497 (10.7)
Unwitnessed	6454 (53.1)	6656 (53.0)	6941 (51.9)	7313 (52.2)
Who Initiated CPR? (%)	**N=12150**	**N=12554**	**N=13370**	**N=14015**
Not Applicable	13 (0.1)	20 (0.2)	23 (0.2)	18 (0.1)
Bystander	3979 (32.7)	4709 (37.5)	5060 (37.8)	5607 (40.0)
First Responder	4549 (37.4)	3508 (27.9)	3892 (29.1)	3866 (27.6)
Emergency Medical Services (EMS)	3609 (29.7)	4317 (34.4)	4395 (32.9)	4524 (32.3)
Was an AED applied prior to EMS arrival? (%)	**N=12151**	**N=12554**	**N=13370**	**N=14015**
Yes	2894 (23.8)	3352 (26.7)	3542 (26.5)	3440 (24.5)
No	9257 (76.2)	9202 (73.3)	9828 (73.5)	10575 (75.5)
Who first applied automated external defibrillator? (%)	**N=2876**	**N=3339**	**N=3539**	**N=3437**
Bystander	407 (14.2)	535 (16.0)	533 (15.1)	601 (17.5)
First Responder	2469 (85.8)	2804 (84.0)	3006 (84.9)	2832 (82.4)
Who first defibrillated the patient?* (%)		**N=9898**	**N=10565**	**N=12656**
Not Applicable		6407 (64.7)	6932 (65.6)	8219 (64.9)
Bystander		165 (1.7)	173 (1.6)	215 (1.7)
First Responder		786 (7.9)	816 (7.7)	820 (6.5)
Responding EMS Personnel		2540 (25.7)	2644 (25.0)	3402 (26.9)
First Arrest Rhythm (%)	**N=12148**	**N=12555**	**N=13370**	**N=14012**
VF/VT/Unknown Shockable Rhythm	2932 (24.1)	2889 (23.0)	3100 (23.2)	3173 (22.6)
Asystole	5378 (44.3)	5885 (46.9)	6388 (47.8)	6720 (48.0)
Idioventricular/PEA	2435 (20.0)	2642 (21.0)	2767 (20.7)	2919 (20.8)
Unknown Unshockable Rhythm	1403 (11.5)	1139 (9.1)	1115 (8.3)	1200 (8.6)
Sustained ROSC (%)	**N=12098**	**N=12545**	**N=13316**	**N=13998**
Yes	3419 (28.3)	3856 (30.7)	4262 (32.0)	4480 (32.0)
No	8679 (71.7)	8689 (69.3)	9054 (68.0)	9518 (68.0)
Was hypothermia care provided in the field? (%)	**N=6182**	**N=12539**	**N=13366**	**N=14009**
Yes	978 (15.8)	1798 (14.3)	2125 (15.9)	2705 (19.3)
No	5204 (84.2)	10741 (85.7)	11241 (84.1)	11304 (80.7)
Pre-hospital Outcome (%)	**N=12152**	**N=12555**	**N=13370**	**N=14015**
Pronounced in the Field	3092 (25.4)	3484 (27.7)	3863 (28.9)	4372 (31.2)
Pronounced in ED	2362 (19.4)	2428 (19.3)	2364 (17.7)	2403 (17.1)
Ongoing Resuscitation in ED	6698 (55.1)	6643 (53.0)	7143 (53.4)	7240 (51.7)
Overall Survival (%)	**N=12152**	**N=12555**	**N=13370**	**N=14015**
Overall Survival to Hospital Admission	3370 (27.7)	3399 (27.1)	3666 (27.4)	3837 (27.4)
Overall Survival to Hospital Discharge	1271 (10.5)	1357 (10.8)	1434 (10.7)	1525 (10.9)
With Good or Moderate Cerebral Performance	960 (7.9)	1001 (8.0)	1098 (8.2)	1130 (8.1)
Missing hospital outcome	81	69	75	66
Utstein Survival (%)	**N=1672**	**N=1665**	**N=1821**	**N=1900**
Witnessed by bystander and found in shockable rhythm	31.8%	32.7%	33.8%	35.4%
Utstein Bystander Survival (%)	**N=797**	**N=918**	**N=991**	**N=1086**
Witnessed by bystander, found in shockable rhythm, and received some bystander intervention (CPR by bystander and/or AED applied by bystander)	35.0%	36.5%	40.9%	40.2%

Abbreviations: OHCA = out-of-hospital cardiac arrest; CPR = cardiopulmonary resuscitation; AED = automated external defibrillator; VF = ventricular fibrillation; VT = pulseless ventricular tachycardia; PEA = pulseless electrical activity; ROSC = return of spontaneous circulation; ED = emergency department
Inclusion criteria: cardiac arrests that occurred in the prehospital setting, had a presumed cardiac etiology, and involved a person who received resuscitative efforts, including cardiopulmonary resuscitation and/or defibrillation.
*This is a new question that was introduced on the 2011 form.

An additional trend analysis, published in *Circulation*, was conducted by Chan, PS et al.[1] CARES data from October 1, 2005 – December 31, 2012 (n=70,027) was utilized to assess survival trends over time. Unadjusted rates of survival to hospital discharge increased from 5.7% in 2005-2006 to 9.8% in 2012 (Figure 8). For arrests due to ventricular fibrillation or pulseless ventricular tachycardia, the unadjusted rate of survival increased from 16.1% to 27.9%, whereas for cardiac arrests attributable to asystole or pulseless electric activity, the unadjusted rate of survival increased from 2.1% to 4.4%.

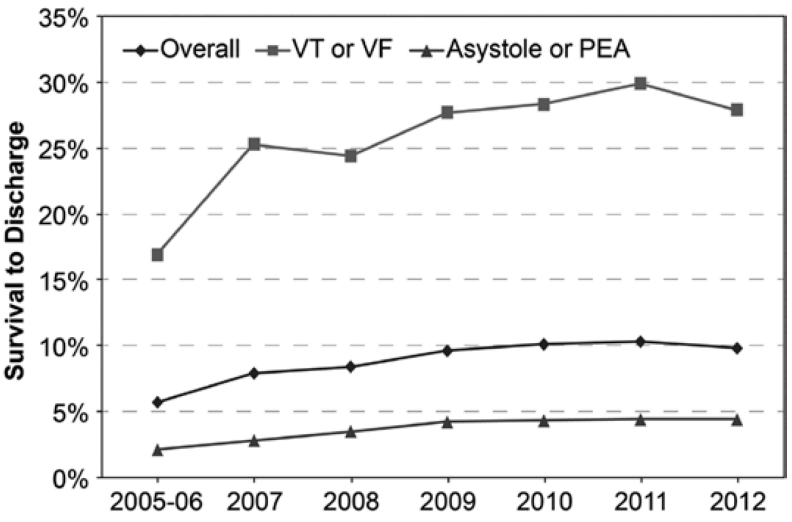


FIGURE 8. Unadjusted rates of survival to hospital discharge by calendar year

After adjusting for EMS agency and temporal trends in patient and cardiac arrest characteristics (age, sex, race/ethnicity, initial arrest rhythm, location of arrest, and witness status), risk-adjusted rates of survival improved markedly over the study period (p for trend <0.001). Compared with the 5.7% survival rate in 2005-2006, the risk-adjusted survival rate in 2008 increased to 7.2% (RR: 1.27; 95% CI: 1.12-1.43) and continued to increase more modestly thereafter (Table 6). The improved survival trends persisted when the analysis was restricted to only those EMS agencies that participated in CARES throughout the entire study period, indicating that the findings were not due to recruitment of higher-performing EMS systems in later years. The improvement in overall rates of survival was also accompanied by lower rates of neurological disability in survivors over time. These findings suggest that rates of survival from OHCA have improved among sites participating in a performance improvement registry.

TABLE 6. Model-adjusted rates of survival to discharge by calendar year

Year	Unadjusted Rate	Adjusted Rate	Adjusted Rate Ratio (95% CI)	*P* Value for Trend
2005–2006	5.7%	Reference	Reference	<0.001
2007	7.9%	6.5%	1.14 (1.06–1.22)	
2008	8.4%	7.2%	1.27 (1.12–1.43)	
2009	9.6%	7.8%	1.37 (1.18–1.59)	
2010	10.0%	8.2%	1.44 (1.22–1.69)	
2011	10.3%	8.4%	1.47 (1.25–1.73)	
2012	9.8%	8.3%	1.47 (1.26–1.70)	

Model-adjusted rates of survival to discharge were compared against the reference period, 2005 to 2006.

*Rates are adjusted for emergency medical services agency and temporal changes in age, sex, race/ethnicity, initial cardiac arrest rhythm, location of arrest, and whether the arrest was witnessed.

[1] Chan PS, et al. Recent Trends in Survival from Out-of-Hospital Cardiac Arrest in the United States. Circulation, 2014; 130:1876-1882.

V. CONCLUSION

CARES is utilized by communities to better understand OHCA metrics locally, regionally, and nationally. The data can be used to evaluate new interventions and treatments in OHCA care and can guide targeted training efforts within communities. Measuring performance longitudinally and comparing against benchmarked outcomes allows communities to identify local opportunities for improvement in an effort to increase rates of survival following an OHCA event.