
2019 Annual Report

CARES
Cardiac Arrest Registry
to Enhance Survival

A crew from Medics First of Springfield, Illinois explains their treatment plan to a patient before transport to HSHS St. John's Hospital.
*Photo courtesy of Advanced Medical Transport of Central Illinois.*

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*Cover photo courtesy of Huron Valley Ambulance; Photo credit: Rhino Media.*

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# Introduction

EMS-treated out-of-hospital cardiac arrest (OHCA) affects more than 240,000 Americans each year and is the third leading cause of disability adjusted life years (DALY) in the United States, behind cardiovascular disease and back pain. Typically, one in ten patients survives to hospital discharge, with 80% having no or moderate neurological disability. Cardiac arrest resuscitation is an important measure of a community's emergency response readiness. Successful resuscitation requires involvement by a range of individuals including bystanders, emergency medical dispatchers, first responders, paramedics, and hospital providers. Performing bystander CPR can nearly double survival and public access defibrillation results in an almost 50% survival rate for patients presenting in a shockable rhythm. It's important to remember that these impactful community-based interventions happen in advance of 911 responders arriving on the scene.

However, without data on key indicators such as patient outcomes and bystander interventions, communities and EMS leadership have no information about how they are performing relative to others, as well as whether their quality improvement efforts are succeeding. Data collection is crucial in identifying gaps and planning next steps to strengthen the chain-of-survival. OHCA registries fill this role by compiling standardized measures at the community, state, and national level. Benefits of participating in such registries include determining patient outcomes, uniform benchmarking, identifying opportunities for improvement, and assessing the effectiveness of specific interventions[1].

The Cardiac Arrest Registry to Enhance Survival (CARES) allows communities to benchmark their performance with local, state, or national metrics to better identify opportunities to improve their OHCA care. CARES offers a comprehensive understanding of where arrests are occurring, whether bystanders are providing intervention prior to EMS arrival, EMS and hospital performance, and patient outcomes. This in turn provides 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 cardiac arrest. Participating agencies are able to make decisions in their community based on real-time feedback and analysis, in order to increase survival. The culmination of CARES occurs during the national reporting process, once the dataset for the calendar year is finalized. Participating states, as well as EMS agencies, and hospitals receive their official CARES reports for the year. For 2019, over 9,000 reports were generated during the three-day reporting process, making it possible for every CARES participant to compare local, regional and national data for benchmarking and surveillance purposes with the goal of increasing survival from OHCA.

We sincerely appreciate the members of the EMS and hospital CARES communities, as well as the sponsors (American Red Cross, American Heart Association, Emory University Woodruff Health Sciences Center, and Stryker) who support our mission to save lives and improve patient care. We are pleased to present the 2019 Annual Report.


AMR Sonoma Life Support EMS crew from Santa Rosa, California stopped to catch a glimpse of the sunset over wine country.
*Photo courtesy of AMR Sonoma Life Support.*

# A Year in Review

Dear CARES Community,

2020 jolted our consciousness to consider how front-line medical providers help patients each day, often under difficult circumstances. COVID-19 highlights the fragility of life, reminds us of our own mortality and provides us with numerous examples of the dedication, sacrifice and commitment that EMS and hospital providers have for patients globally. We are honored to work with you and pray for your safety, health and well-being during this pandemic.

We are reminded of the importance of public health surveillance activities now more than ever and the need for having accurate data to understand today in an effort to improve tomorrow. CARES has made significant advances towards this goal during the past year, including participation of six additional states and strengthening collaboration nationally. A public-private partnership was announced last October between CARES, American Red Cross, American Heart Association and the Department of Health and Human Services (HHS). The additional support from the three entities will go toward HHS's national goal of expanding CARES to all 50 states in the U.S. and the District of Columbia, and, through data-driven improvements in treatment, double the survival rate from witnessed out-of-hospital cardiac arrests within five years (2021-2026). This effort has been endorsed by Admiral Brett Giroir, Assistant Secretary for Health for HHS. "This collaboration will help communities measure standard OHCA outcomes and perform local improvement activities to increase survival nationally. We also commit to dramatically reducing the longstanding racial and ethnic disparities in bystander CPR performance and survival following OHCA," stated Admiral Giroir in a recent press release.

In 2019, CARES essential data fields were harmonized with NHTSA's (National Highway Traffic and Safety Administration) NEMSIS (National EMS Information Elements) version 3.5. This coordinated effort ensures uniform data fields for out-of-hospital cardiac arrests for EMS providers nationally and minimizes the data burden to participate in CARES. Future efforts will focus on alignment of CARES supplemental data fields with NEMSIS version 3.6. We wish to thank NHTSA/NEMSIS staff and the CARES Advisory Committee in reaching consensus.

Drowning is a leading cause of preventable death; however, there is a lack of quality data that providers and policymakers can use to improve outcomes. In 2015, the International Liaison Committee on Resuscitation (ILCOR) issued an Advisory Statement on Utstein-style Recommended Guidelines of Data from Drowning Related Resuscitation. This past year, CARES developed a drowning module in response to a request from members of the American Red Cross Scientific Advisory Council - Aquatics Subcommittee to address the absence of national drowning resuscitation data. The additional 7 drowning data elements were developed, balancing data benefit and burden. The goal is to improve national surveillance and our understanding of these events to develop effective prevention strategies to save lives. Please see the article by Chief John Titchen (page 19) on how the module will be used in Hawaii, where drowning is the number one cause of death in tourists.

We recognize that the COVID-19 pandemic will continue to create challenges this year in the pre-hospital and hospital settings for both patients and providers and applaud those working on the health care front lines. We will continue to work with participating communities and states and are excited about expanding CARES nationally in collaboration with our partners, in the near future. Please be safe and stay healthy.

Respectfully,

Bryan McNally, MD, MPH
Executive Director CARES
Professor of Emergency Medicine
Emory University School of Medicine
Rollins School of Public Health
Atlanta, Georgia USA

# Why CARES Matters: A Story of Survival from OHCA

## A Twenty-Seven-Year-Old Sudden Cardiac Arrest Survivor Makes it her Life's Mission to Improve Cardiac Arrest Survival

*By Lynn Blake, Founder of Starting Hearts, Eagle-Vail, CO*

*Newlyweds Lynn & Matt Blake on their honeymoon at St. Kitts Island.*

Lynn and Matt Blake hosted a fairytale wedding in Vail, Colorado followed by a harmonious vacation to the British Virgin Islands. The furthest thing from newlyweds' minds was the thought of one of them experiencing sudden cardiac arrest (SCA). February 14, 2007 will always be etched in their brain. Not because of some fancy proposal or bouquets of roses from a special Valentine – it was the day Lynn's heart stopped beating.

At the young age of 27, she suffered sudden cardiac arrest. It was only her second day on a new job, so no one even knew who she was.

**Everyone stood stunned and unsure of how to respond. An apparently healthy young woman could not be having a life-threatening cardiac event; they first thought that she was having a seizure, but quickly realized that something more serious was happening and yelled for someone to call 9-1-1 and perform CPR.**

Her heart stopped beating, blood was not pumping, and without the help from strangers, she was dead. Fortunately, emergency responders were called, a nearby woman quickly started compressions while another man gave breaths. The Vail Fire Department was right across the street, so they ran over and continued quality CPR.

Paramedics arrived minutes later and used a defibrillator to deliver three shocks to her chest and restart her heart. She was unconscious for several days following the SCA, and when she finally awoke Lynn had an implanted pacemaker defibrillator and absolutely no recollection of what had happened. Doctors explained that she was one of the fortunate few to actually survive sudden cardiac arrest, and said that the only reason she was alive was because of bystander CPR and the use of a defibrillator.

**There was no definite reason for the arrest and the reality of her situation was perplexing. She returned home eleven days later and tried to resume a normal life.**

Sudden cardiac arrest was something that Lynn had heard of but most likely generalized as a heart attack. Taking a CPR course was something she never got around to doing. And defibrillators were something she had seen rubbed together on TV. This prompted Lynn to question why so many people are unaware of this condition that almost took her life. She began researching and found that cardiac arrest is much more common than she had ever imagined. SCA is the nation's leading cause of unexpected death, and it's on the rise.

Of the estimated 400,000 Americans that experience an out-of-hospital cardiac arrest per year, only 10% will survive. Despite its high death rate, SCA can be reversed in most cases through immediate CPR and defibrillation. A person's chances of survival decreases by 10% with every minute that passes without CPR and defibrillation, and it takes

emergency medical responders an average of 8 minutes to arrive on scene. Therefore, immediate action from family or community members is imperative for any chance at surviving.

Lynn's personal lack of knowledge about SCA, CPR and defibrillation led her to believe that much more needed to be done to properly address this preventable cause of death.

In 2010, three years after the event, Lynn made it her life's mission to help save others by establishing a nonprofit, Starting Hearts[1], dedicated to saving the lives of SCA victims. She now advocates for:

**Free accessible training:** Many people are reluctant to commit time and money for traditional certification courses. Simplified, free, accessible education is needed. Lynn coined the phrase CALL. PUSH. SHOCK. and produced a training program which teaches participants how to recognize SCA (which is a sudden collapse/not breathing) and how to perform the three steps required to save a life:

1. CALL 911
2. PUSH hard and fast on the center of the chest or perform CPR
3. SHOCK using the nearest defibrillator

Thousands of people have received this free training.


*Public defibrillator in Vail, CO.*

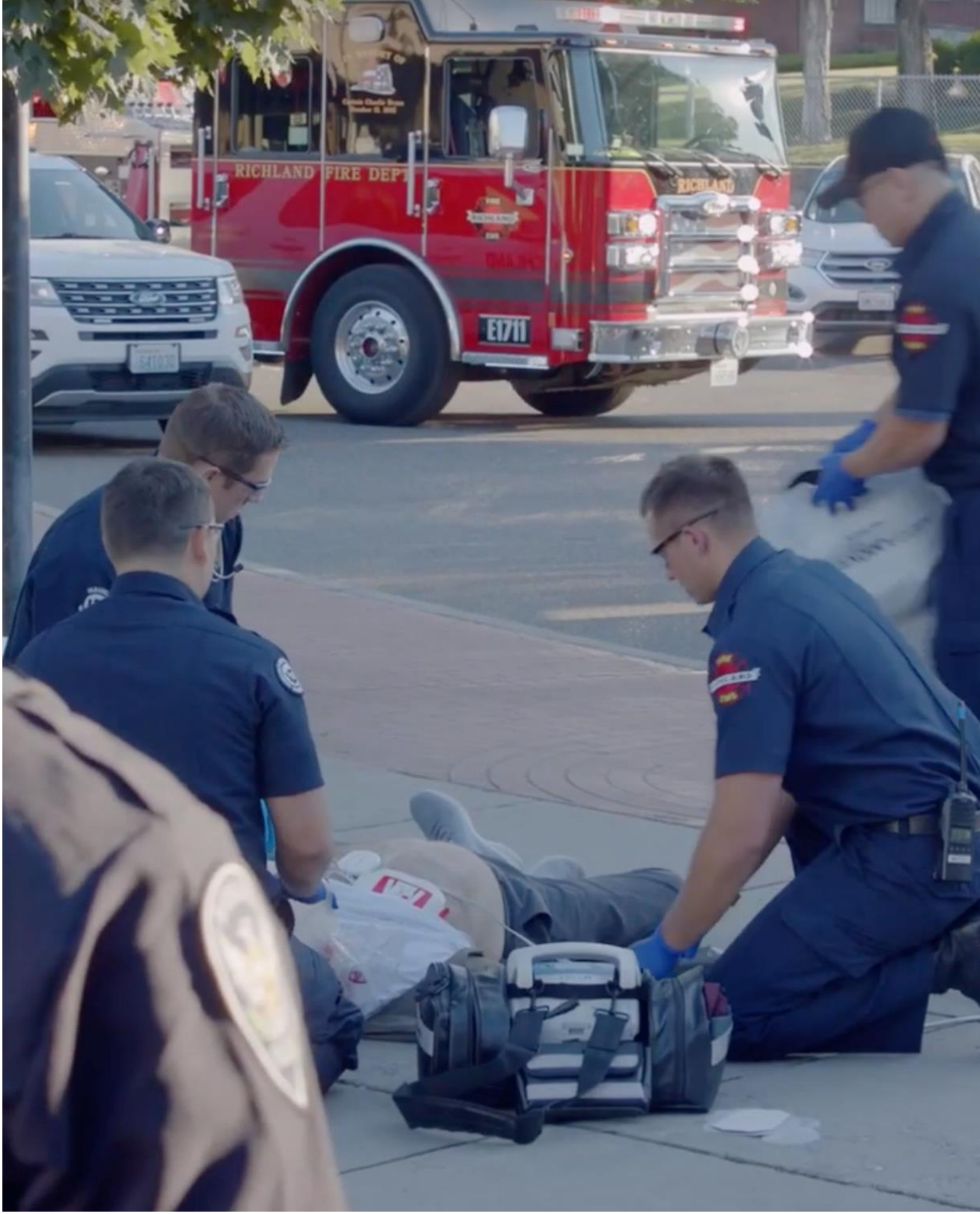
**Access to resources:** Only one in 10 citizens knows the exact location of a defibrillator. Lynn worked to secure funding to place hundreds of new defibrillators in public locations, increasing the total in her community to more than 500 for a population of 50,000, perhaps the highest per capita in the world. She also worked with legislators to advance new laws regarding defibrillators in the state of Colorado. The legislation increases immunity for anyone attempting to save a life and encourages defibrillator placement from schools to all public places.

**Nationwide tracking:** Sudden cardiac arrest is not being tracked on a national basis. Because of this, data needed for vital research and treatment options is lacking. Lynn believes that data collection is the most important factor in increasing survival rates of SCA. In 2014, she led the effort to implement CARES in her community of Eagle County, Colorado. This proved that the survival rate is 2.5 times higher than the national average. In 2019, Lynn again championed a statewide initiative to implement CARES throughout all of Colorado. Now Lynn is working with Presidential daughter and fellow SCA Survivor, Susan Ford Bales, to encourage legislators to mandate the reporting of SCA nationwide.

Lynn is extremely grateful for this second chance at life and there is no doubt that many lives have been and will continue to be saved because of her efforts. Through education, access to resources and data collection, Lynn is confident that we can stop sudden cardiac arrest in its tracks.

[1] https://www.startinghearts.org

Contact Information: Lynn Blake | lynngblake@gmail.com.

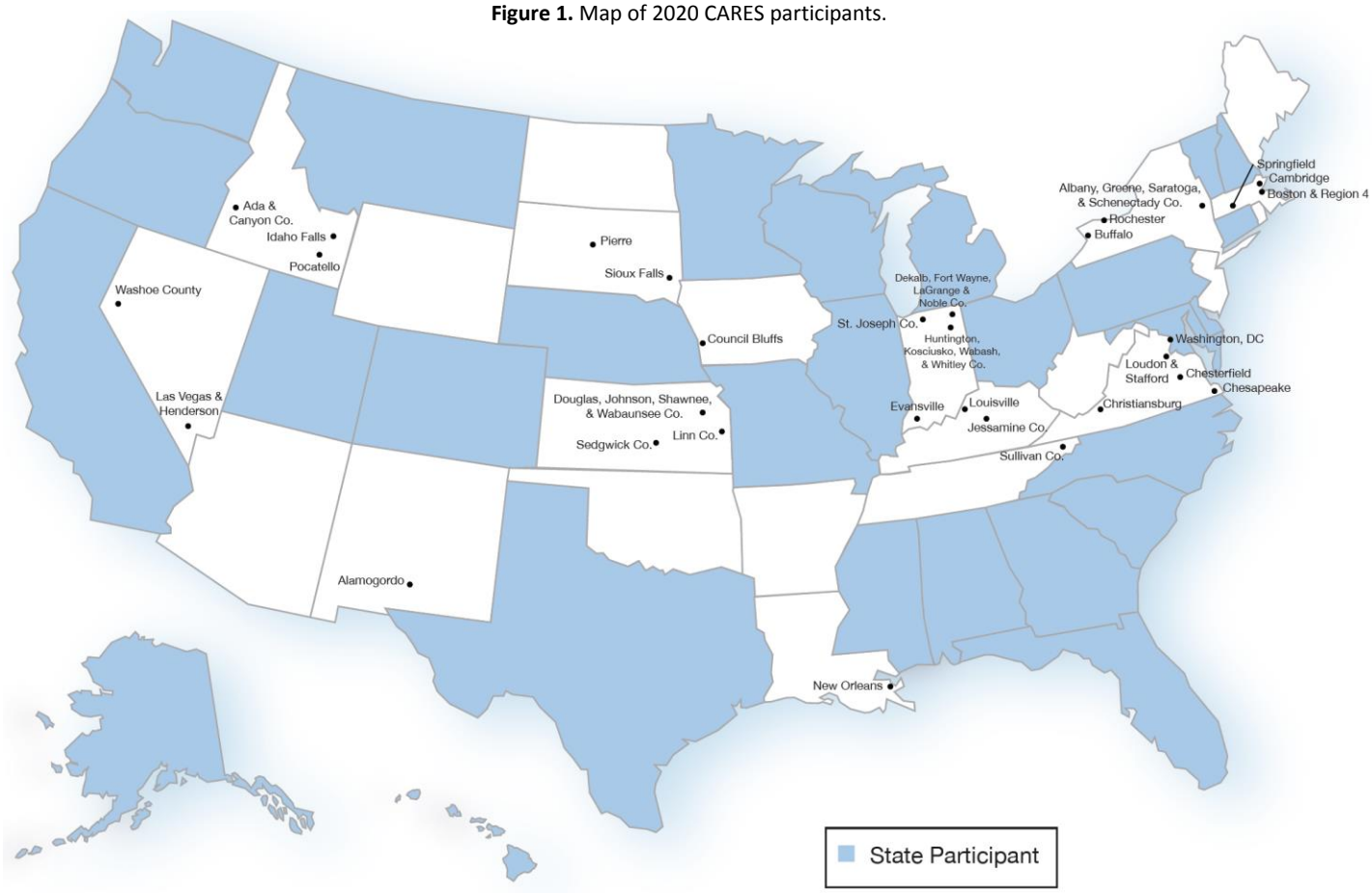



Richland Fire & Emergency Services Department providers administer resuscitation care to an out-of-hospital cardiac arrest patient.
*Photo courtesy of Richland Fire & Emergency Services Department.*

# The Cardiac Arrest Registry to Enhance Survival (CARES)

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 1,500 cases captured in 2006. The program has since expanded to include 28 state-based registries (Alabama, Alaska, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Illinois, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Texas, Utah, Vermont, Washington and Wisconsin) and the District of Columbia, with more than 45 community sites in 14 additional states. CARES represents a catchment area of almost 143 million people or approximately 44% of the US population. To date, the registry has captured over 500,000 records, with more than 1,800 EMS agencies and over 2,200 hospitals participating nationwide.

**Figure 1.** Map of 2020 CARES participants.



## Case Definition

CARES captures data on all non-traumatic out-of-hospital cardiac arrests where resuscitation is attempted by a 911 Responder (CPR and/or defibrillation). This also includes patients that receive an AED shock by a bystander prior to the arrival of 911 Responders. Inclusion and exclusion criteria are described below (Tables 1 and 2).

| Table 1. CARES inclusion criteria (all of the following) |
|---|
| • Patients of all ages who experience a non-traumatic, out-of-hospital cardiac arrest. |
| • Patients who are pulseless on arrival of 911 Responder; OR<br>• Patients who become pulseless in the presence of 911 Responder; OR<br>• Patients who have a pulse on arrival of EMS, where a successful attempt at defibrillation was undertaken by a bystander prior to arrival of 911 Responder. |

| Table 2. CARES exclusion criteria (any of the following) |
|---|
| • Unworked/untreated cardiac arrests, to include codes that are terminated immediately upon arrival of EMS because the patient is not a viable candidate for resuscitation due to:<br>○ Injuries incompatible with life.<br>○ The presence of rigor mortis or lividity.<br>○ Signs of decomposition.<br>○ Presence of a valid DNR. |
| • Private EMS transport that did not involve 911 dispatch. |
| • Cardiac arrest of clear and obvious traumatic etiology. |
| • Bystander suspected cardiac arrest, where ROSC was achieved without the need for defibrillation or 911 Responder CPR. |

## Data Collection & Elements

Data collection within CARES is based on the Utstein-style definitions – a standardized template of uniform reporting guidelines for clinical variables and patient outcomes that was developed by international resuscitation experts[2,3].

The CARES web-based software (https://mycares.net), links three sources to describe each OHCA event: 1) 911 call center data, 2) EMS data, and 3) hospital data. 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.

Data elements collected from EMS providers include demographics (i.e. name, age, date of birth, incident address, sex, and race/ethnicity), arrest circumstances (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). The CARES form includes a number of optional time elements, including estimated time of arrest, defibrillatory shock, and initial CPR. 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 coronary angiography, CABG, and stent or ICD placement.

The CARES dataset is geocoded on an annual basis, and linked to a number of census-tract level variables including: median household income, median age, race/ethnicity, unemployment rate, poverty status, urbanicity, and educational attainment.

## Reporting Capability

The CARES software includes 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 facility-specific reports, 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 data. These search results can be easily exported to Microsoft Excel for further analysis.

## 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 accuracy 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 and case ascertainment.

### *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 or 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 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.

### *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 automated 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 and error messages are 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.

### *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. 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 and case ascertainment. CARES staff and State Coordinators provide each EMS agency's geographic coverage, census population, and start date via a standardized template. This information is then linked with record volume 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.


Firefighters from Tualatin Valley Fire & Rescue in Oregon transfer a patient to an awaiting ambulance.
*Photo courtesy of Tualatin Valley Fire & Rescue.*

# CARES in Action

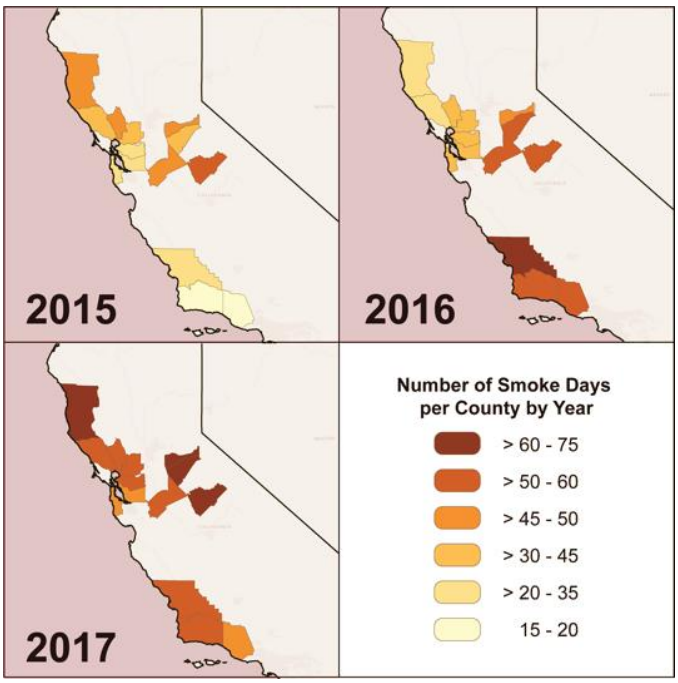
## Using CARES Data to Study Wildfire Smoke and Out-of-Hospital Cardiac Arrests in the 2015-2017 California Wildfires

*By Sumi Hoshiko, MPH, California Department of Public Health*

As the number and severity of wildfires has increased in recent years, so has scientific knowledge of the health impact of smoke from wildfires. While studies have shown increases in respiratory illnesses under smoky conditions produced by wildfires, a similar increase in cardiovascular illnesses has not been consistently seen. This has been puzzling, because decades of scientific research have linked ambient air pollution to cardiovascular problems. This prompted public health researchers in California to search for ways to investigate this question, and the CARES dataset on out-of-hospital-cardiac arrests provided just such an opportunity.

"We reasoned that because these cases often result in sudden death outside of a hospital, they may not have been captured in earlier wildfire studies of cardiovascular outcomes, as these studies typically use hospital-based datasets," explained senior author Sumi Hoshiko of the California Department of Public Health. It quickly became clear that CARES data could be invaluable in understanding the true relationship between wildfire smoke and a critical adverse cardiovascular event, and a collaborative research project was formed between CARES, the California Department of Public Health, and the United States Environmental Protection Agency.

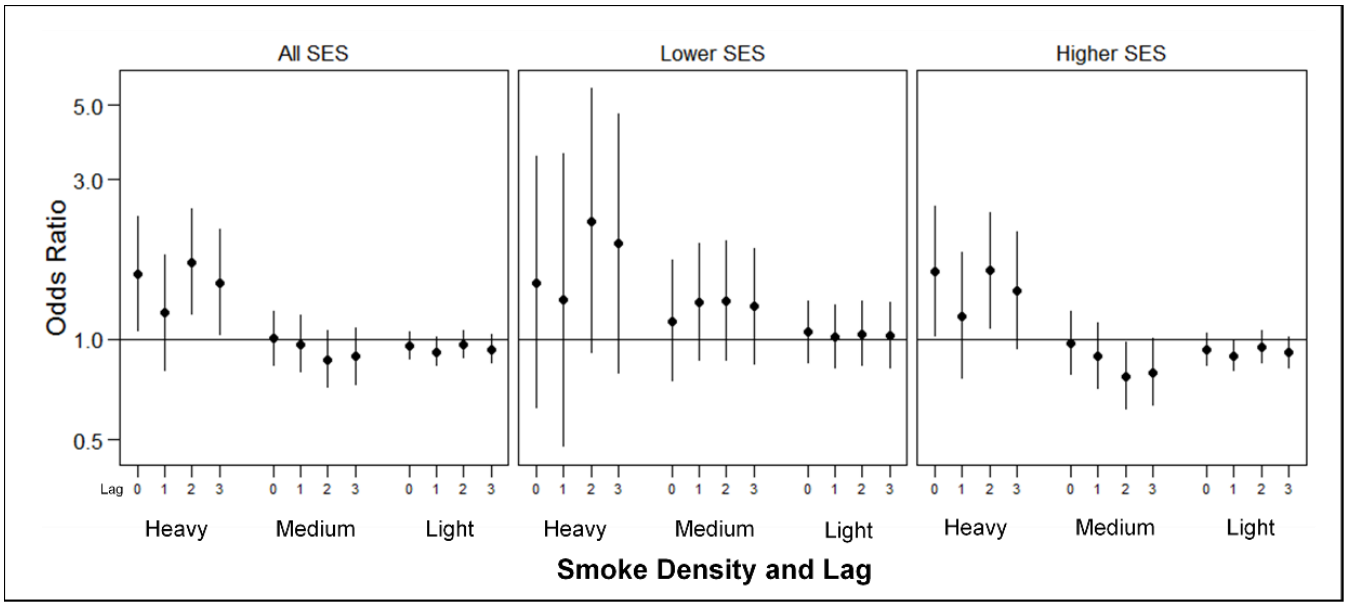
Fourteen counties in California with active CARES surveillance programs and that experienced wildfire smoke between 2015 to 2017 participated. During this time period, wildfires burned over 3 million acres across the state, exposing millions of people in different locations and points in time to wildfire smoke emissions. Satellite data from the National Oceanic and Atmospheric Association (NOAA) was used to categorize smoke plumes into none, light, medium and heavy density. By comparing exposure among cases on the day of their cardiac arrest with control days, investigators were able to study whether smoke was associated with increased numbers of cardiac arrests. The study also looked at whether those risks differed based on age, sex, and socioeconomic status. The latter was based on population income levels in the census tract where the cardiac event occurred.




*Map of the 14 California counties in the study region showing the number of smoke days in each county from 2015 – 2017, based on NOAA HMS wildfire smoke plume.*

"We saw that the number of cardiac arrests increased on days with heavy smoke exposure, but also that the risk seemed to persist for several days afterwards," explained Caitlin Jones, who led the analysis. While this was true for cases in both lower and higher socioeconomic categories on heavy smoke days, the lower socioeconomic group also appeared to be impacted on medium smoke days (Figure on page 16).

The finding that cases in lower socioeconomic areas were most affected is important to keep in mind when attempting to understand the effects of smoke exposure; in other words, there isn't a single, simple relationship between exposure and outcome – it varies depending on the vulnerability of the population exposed. There could be numerous explanations for this disparity; for example, underlying health problems may be more common and healthcare less accessible in low socioeconomic status communities. It could also be that persons in higher socioeconomic areas are better positioned to take protective action, such as leaving the area during smoky periods, staying indoors or using air filters in their home, and avoiding exertion, all of which could decrease smoke exposure and reduce the chances of a cardiac arrest during wildfires. Any single one of these factors, or a combination of these, might explain the disparity in risk based on socioeconomic status.




*Odds ratios and 95% confidence intervals for OHCA in 14 California counties, May – October, 2015-2017, by wildfire smoke exposure on the day of exposure and several following (lag) days for the whole study population and by socioeconomic status (SES). Odds ratios above 1 indicate an increased risk for OHCA for the given exposure level. For example, on the second day following a day with heavy smoke concentrations, the odds of OHCA was estimated to be 70% higher than expected.*

Both males and females, and all age groups age 35 and above were affected when exposed to heavy smoke days. Because other wildfire smoke studies have found that older adults are typically the most highly impacted, it was intriguing that this analysis also found that persons between 35 and 64 were at elevated risk. "It may be that this younger group is not aware that they could be at risk, causing them to continue activities involving exertion and exposure during wildfire smoke episodes, whereas older persons may be more likely to make changes to reduce exposure to protect their health," suggested Jones.

By using CARES data to investigate this critical cardiovascular outcome, researchers were able to show that smoke from wildfires likely has the potential to trigger fatal and near-fatal cardiac arrest. "Studying out-of-hospital cardiac arrests proved invaluable in furthering our scientific understanding of the cardiovascular risks from exposures to wildfire smoke," said Hoshiko. "We are grateful to the CARES Surveillance Group and also the individual EMS agencies and organizations that chose to include their data in this research."

The last few years have awakened the world to more frequent, intense and large-scale wildfires and the smoke plumes they emit, and climate models predict that the weather conditions which create these fires will continue. Researchers anticipate that in addition to these forces, health effects from wildfire emissions will also be affected by the aging American population, as the proportion and number of persons with underlying cardiopulmonary disease increases. Coauthor and cardiologist Dr. Wayne Cascio, Director of the Center for Public Health and Environmental Assessment at the US Environmental Protection Agency emphasized, "Because of this, it is especially important to protect persons with cardiopulmonary disease who may be at greatest risk, namely patients with ischemic heart disease, heart failure, cerebrovascular disease, arrhythmia, COPD, and asthma."

An expert panel convened by the American Heart Association and others recommends advising patients with cardiovascular disease about risks from air pollution. The US EPA, in partnership with the Centers for Disease Control and Prevention, offers continuing education for health care providers on wildfire smoke on the EPA website.[2]

[2] https://www.epa.gov/wildfire-smoke-course

Reference: Hoshiko S, Jones C, Rappold A, Vargo J, Cascio W, Kharrazi M, McNally B. Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015–2017 California Wildfires. *JAHA*. 2020;9:e014125.

Press Release: https://newsroom.heart.org/news/breathing-heavy-wildfire-smoke-may-increase-risk-of-out-of-hospital-cardiac-arrest

## Using CARES Data to Influence Survivability in the Hospital Setting

*By Andrea Kiogima, MSN, RN, Chest Pain Coordinator at the University of Michigan Health, Wyoming, MI*

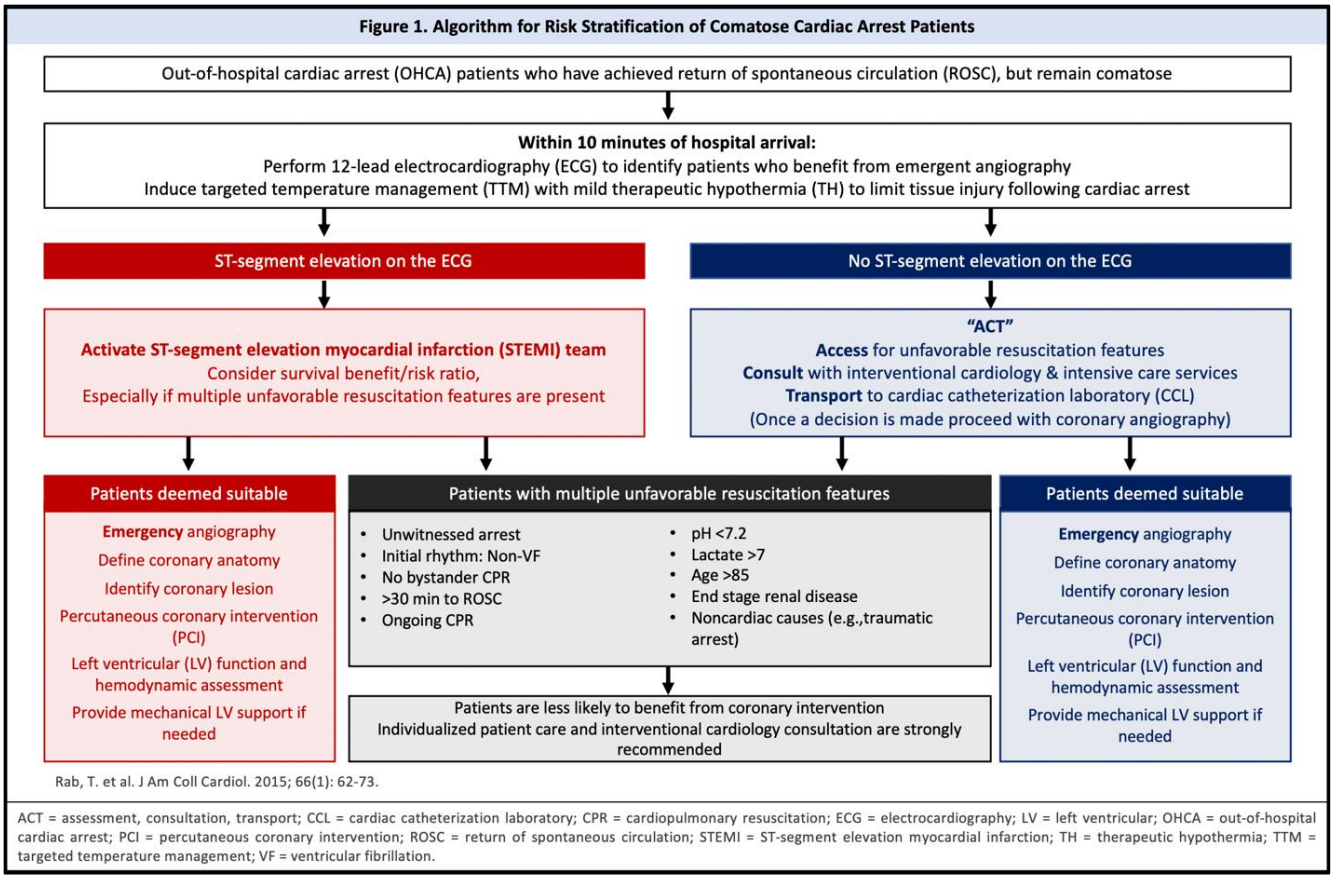
In early 2018, the finalized 2017 CARES National Reports were made available to individual EMS and hospital facilities. It was a time of discovery for the Metro Health-University of Michigan Health organization as survivability following an out-of-hospital cardiac arrest (OHCA) was not a subset of patients that had specifically been tracked.

One metric that stood out was in-hospital mortality. This represents patients who experienced an OHCA, survived to hospital admission, but do not survive to discharge. At the time the data was first presented, the organization was faring worse than state and national averages at a 70% in-hospital mortality rate, while the state average was 66.4% and national average was 62.8%.

It quickly drew the attention of the organization's leadership and interdisciplinary Chest Pain Committee. What we understood, without the ability to control, was the fact that our hospital remains the most rural of the three major health systems in our region (Grand Rapids area). Metro Health regionally serves a large span of rural West Michigan around Grand Rapids. Often, our cardiac arrest patients had longer distances in transport, adding precious minutes to a critical situation. However, there were other factors that Metro had control over, one of those being Emergency Department (ED) disposition. There was no identifiable or standardized decision-making process as to where the patient should go following their care in the ED. Often times, patients went emergently to the Cardiovascular Catheterization Lab (CCL) and other times to the Intensive Care Unit (ICU). This was subjectively determined by individual physicians, case-by-case.

An article published in the Journal of the American College of Cardiology (JACC) in 2015[3] offered an algorithm to provide guidance for the management of patients who have achieved return of spontaneous circulation (ROSC), but remain comatose. ST-elevation on a 12-lead electrocardiogram was a direct indication for emergent transfer to CCL. CCL versus ICU disposition should be based on a number of considerations as shown in the figure below.

**Figure 1. Algorithm for Risk Stratification of Comatose Cardiac Arrest Patients**

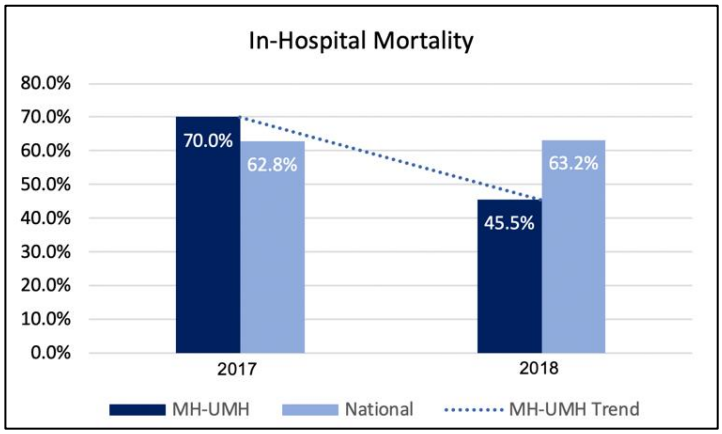



Rab, T. et al. J Am Coll Cardiol. 2015; 66(1): 62-73.

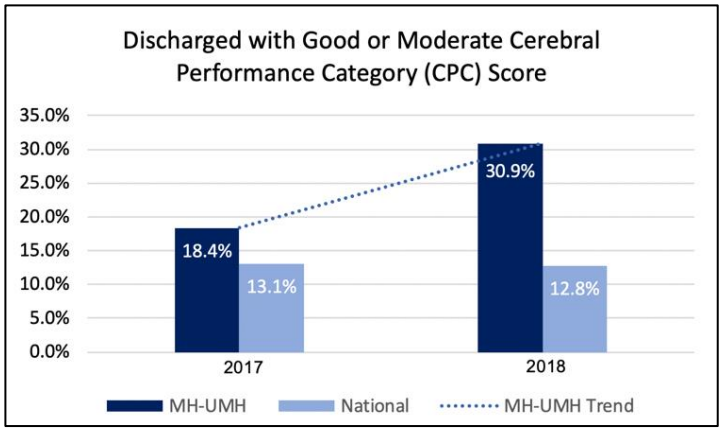
ACT = assessment, consultation, transport; CCL = cardiac catheterization laboratory; CPR = cardiopulmonary resuscitation; ECG = electrocardiography; LV = left ventricular; OHCA = out-of-hospital cardiac arrest; PCI = percutaneous coronary intervention; ROSC = return of spontaneous circulation; STEMI = ST-segment elevation myocardial infarction; TH = therapeutic hypothermia; TTM = targeted temperature management; VF = ventricular fibrillation.

[3] Rab, T, Kern KB, Tamis-Holland JE, et al. Cardiac arrest: a treatment algorithm for emergent invasive cardiac procedures in the resuscitated comatose patient. *J Am Coll Cardio 2015;66:62-73 (Figure 1 reproduced with permission)*

Our Chest Pain Committee, which is comprised of pre-hospital and hospital/departmental senior leaders, physician champions, and front-line staff, all supported the adoption of a standardized care model and it was accepted into practice almost immediately. Shifting to an increased focus on metabolic stabilization following cardiac arrest directly correlated to a higher percentage of OHCA patients transferred to ICU rather than to CCL for diagnostic cardiac angiography. Often times this delayed, but not eliminated, a heart catheterization to explore potential causes for the arrest. Targeted-temperature management remained a priority as well for eligible patients, as it had been prior to implementation.




To assess compliance with this care pathway, every admitted OHCA patient was tracked and evaluated quarterly by our interdisciplinary team for appropriate disposition. Any outliers were referred to and discussed by a peer review committee. When 2018 finalized data became available, a drastic improvement was seen in reduction of in-hospital mortality for our OHCA patient population as tracked by CARES. A previous 70% mortality rate had fallen to approximately 45%. Furthermore, the number of patients discharged with a Cerebral Performance Category (CPC) Score of 1 or 2 had also risen from 18.4% to 30.9%, indicating that more people who survived remained neurologically intact.




Success of this project is credited to the engagement and actions of a multi-disciplinary team that spans the full spectrum of representation including EMS, ED, CCL, ICU and beyond. Utilization of a pathway supported standardization of care and minimized deviation between providers and specialties adding consistency to how we treated our patients, and ultimately was associated with a decrease in in-hospital mortality. A thorough review and feedback process ensured accountability and helped to drastically reshape and simplify the decision-making process for continued treatment of the OHCA patient. As a result, more patients are returning to their families with optimal neurological functioning.


*Metro Health – University of Michigan Health is an integrated healthcare system located in Wyoming, Michigan that includes a 208-bed general acute-care osteopathic teaching hospital. Metro Health Hospital is a primary PCI center with a fully staffed CCL 24/7 and nationally recognized heart and vascular services. Other hospital certifications include Level 2 Trauma and Comprehensive Stroke care.*

## 2020 CARES Drowning Module: Highlight on Hawaii

*John Kamalei Titchen, JD, Chief of Ocean Safety, City and County of Honolulu, Hawaii*

In January 2020, CARES announced the addition of a drowning module to supplement the core CARES dataset that includes 7 questions to better understand drowning related cardiac arrest events. There is nowhere in the United States that this data is more critical than in the state of Hawaii. The state's coastline expands over 750 miles, attracting over 10 million tourists annually in addition to its 1.4 million residents. Drowning is the leading cause of deaths for tourists visiting Hawaii and is the fifth leading cause of death for residents, accounting for approximately 50-60 deaths annually. Therefore collecting, measuring and tracking drowning data both locally and statewide is crucial. The state of Hawaii has been a CARES participant since 2011. Its participation is unique in that all of the transporting EMS providers are on the same electronic patient care reporting system, allowing for 100% state population coverage. According to CARES data (2013-2018), drowning causes are attributed to an average of 5% of the total cardiac arrest cases annually in Hawaii, which is far above the national average drowning rate of 0.5%. Dr. Libby Char, a Medical Director for several first responder and ocean safety agencies in Hawaii, who was instrumental in bringing CARES to the state and in developing the drowning module explains how important this information is for the state, "Drowning is one of the most important challenges we face in EMS and we need more data to be able to fully understand the problem, improve our EMS response and to create prevention programs with the goal of saving lives." John Titchen, the Chief of Ocean Safety for the city and county of Honolulu, is responsible for all beach and water safety on the island of Oahu, Hawaii's most populous island. Chief Titchen manages the daunting task of overseeing 16 mobile and 41 tower patrol/rescue services, a total of 250 employees and a budget of $19 million. "Drowning statistics are essential for the deployment of personnel, review of budget requests and the majority of administrative decisions for my department", Chief Titchen explains. Although Hawaii Department of Health compiles drowning data for the state, only the aggregate metrics are shared annually. This makes it difficult to utilize the data quickly and effectively. CARES will compliment and improve the existing drowning data in terms of the ability to monitor real-time metrics. The information pertaining to the location of the drowning, age of the patient, the activity at the time of submersion and lifeguard response collected by CARES will be invaluable to the Department of Ocean Safety, the Oahu community and state as a whole.

The changing ecological environment in Hawaii, and in the tourist population, adds to the complexity in planning for ocean safety and EMS response. The rising ocean tides are moving people from the once most populated beaches to other areas of the island. The traditional lifeguard towers are cemented into the ground but now there is a need to consider mobile towers that can be moved based on the data CARES can provide. In addition, the influence of new, emerging vacation rental methods is impacting the type of tourist coming to Hawaii and therefore the recreational activities people are engaging in. "The need for ongoing data collection to modernize our approach to ocean safety and innovate drowning prevention programs has never been greater" explains Chief Titchen. Hawaii has numerous drowning prevention programs targeted to the various audiences that are engaging in water activity: tourists, triathletes, surfers and school-aged children to name a few. CARES data will allow prevention campaigns and trainings to be better tailored to each group, maximizing effectiveness and ensuring the strategic allocation of valuable resources. Hawaii EMS and Ocean Safety Officials hope that the new drowning dataset will allow for quicker analysis of real-time trends to better respond to and treat drowning patients across the state. Dr. Libby Char summarizes, "The utilization of CARES drowning data is the next step to decrease the number of drowning arrests statewide and to hopefully put us in a position to prevent drownings. It will make the islands as safe as possible for tourists, residents and the responders that risk their lives to save these patients."

*Ocean Safety Honolulu personnel conduct a search for a missing 20-year-old swimmer, suspected of drowning, at Waimea Bay on the North Shore of Oahu.*

## Using CARES Data for Performance Improvement in Texas

*By Micah Panczyk, Texas CARES State Coordinator*

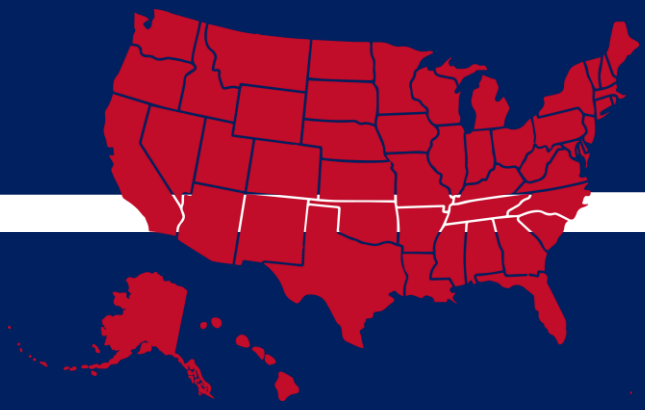
Texas became a CARES state participant in mid-2019 with support from McGovern Medical School at UTHealth. Texas-CARES leadership looked not only to expand registry participation, but also to increase rates of bystander CPR and to improve in-hospital care after out-of-hospital cardiac arrest (OHCA). Quality improvement efforts aim to strengthen the links in the "chain of survival": access to care, early CPR, early defibrillation, EMS High-Performance CPR, and standardized post-arrest care. Community-based interventions such as bystander CPR and public access defibrillation, if initiated before first responders arrive, can significantly improve OHCA survival. "The CARES registry is a vital source of information for improving patient outcomes by identifying weak links in the chain of survival," said Jeff Jarvis, Medical Director for Williamson County EMS and Marble Falls Area EMS in Texas. "Our 2018 CARES data showed that the bystander CPR rate in Texas was 45.5%, which is higher than the national average, but we didn't want to stop there."

Texas-CARES has partnered with National Two Step CPR to track and increase rates of bystander CPR. Two Step, an alliance of medical students, along with national non-profits HealthCorps and First Impact, trained roughly a thousand community members in compression-only CPR at 25 sites across Texas during its annual "Save a Life Campaign" in February. "Nearly 1,000 people daily in the US will suffer an out-of-hospital cardiac arrest," said Ashley Cohen, a Two Step board member and M.D. candidate at Chicago Medical School at Rosalind Franklin University of Medicine and Science. "Survival for these individuals has been shown to improve dramatically with prompt CPR. With community-focused training events we hope to empower our neighbors and community members to bridge the gap from witnessed cardiac arrest to EMS arrival. Together we can improve the survival statistics." During 5-minute training sessions, participants learned the importance of acting quickly in incidents of suspected OHCA by following two simple steps: calling 911, and pushing hard and fast in the center of the chest until professional rescuers assume care. Texas-CARES will complement Two Steps' efforts by measuring rates and types of bystander CPR and linking these with patient outcomes over time. Texas-CARES hopes to help grow Two Step community training by engaging the participation of EMS agencies and fire departments statewide.

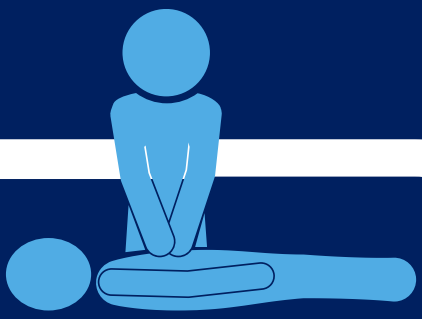

*Two Step volunteer teaches a young student compression-only CPR during a recent community-based training event in Texas.*

Texas-CARES has also partnered with Penn Medicine's TTM Academy to present a workshop titled "Optimizing Cardiac Arrest Survival with State-of-the-Art Post-Arrest Care" at the MD Anderson Simulation Center in Houston. During the one-day workshop, experts trained new hospital staff in Targeted Temperature Management (TTM), a critical cooling intervention believed to improve outcomes from cardiac arrest and among patients with neuro-critical injury. About 70 nurses, paramedics, and physicians learned cutting-edge strategies from TTM Academy staff and local critical care resuscitation experts through a series of lectures, breakout sessions, and panel discussions. Dr. Ben Bobrow, Chair of the McGovern Medical School Department of Emergency Medicine at UTHealth, explains, "The CARES registry will continue to provide valuable insight into the effectiveness of such trainings by measuring trends in the use of TTM and associated outcomes that can inform future strategies to achieve optimal use of this therapy in Texas."

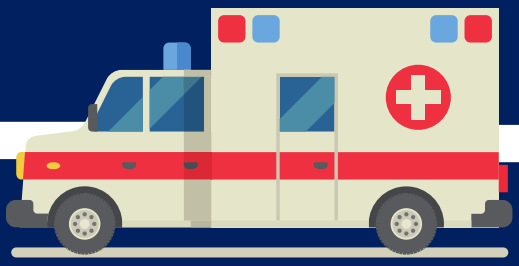
Through the help of program sponsors, partners, and participants, Texas-CARES is working diligently to improve cardiac arrest survival in Texas.



100,956 non-traumatic, worked OHCAs reported to CARES in 2019



41.2% of patients received bystander CPR



Median EMS response time:
7.2 minutes
30.7% of patients achieved sustained ROSC in the field

12.2% of patients who arrested in public had a bystander applied AED


27.9% of patients survived to hospital admission

45.8% of admitted patients received hypothermia care

10.5% of patients survived to hospital discharge

80.5% of discharged patients had a positive neurological outcome (CPC 1 or 2)

# Incidence & Demographics

## 2019 Dataset and Incidence of OHCA Events

This report describes CARES data from the most recent calendar year, January 1 to December 31, 2019. CARES requires that an EMS Agency enter at least one complete calendar year of data and meet a patient lost to follow-up threshold of less than 1% to be included in the Annual National Report. The CARES 2019 National Reports can be viewed at: https://mycares.net/sitepages/reports2019.jsp.

Descriptive statistics in this report are presented as frequencies or proportions for categorical variables, and median and interquartile ranges for continuous variables. Comparison of proportions were conducted using the chi-square test.

The 2019 dataset includes 1,604 EMS Agencies and 1,765 Hospitals, and represents a population of 131.9 million, approximately 40% of the U.S. population. In 2019, 100,956 OHCA events were reported to CARES. The crude incidence of non-traumatic, worked arrests was 76.5 per 100,000, slightly above the incidence rate observed in 2018 of 74.3. Using 2019 census data to extrapolate to the U.S. population[4], CARES estimates that there were approximately 251,000 EMS-treated, non-traumatic OHCAs in the United States last year.

## Demographics

In 2019, CARES patients were predominately male (62.2%). Of the reported OHCA events, 97.3% (n=98,159) were adults and 2.7% (n=2,761) were children, 18 years and younger. The median age of OHCA patients was 65.0 years (mean: 62.4; SD: 19.1). The age distribution varied significantly across the sexes (Figure 2), with females having a higher median age of arrest (66.0 vs. 64.0 years, p<.0001).

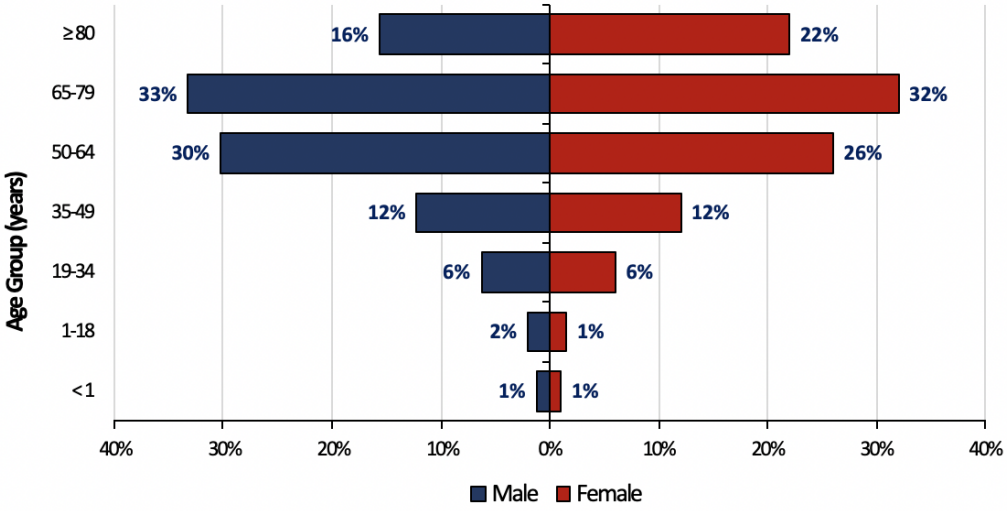



**Figure 2.** Age distribution of OHCA events.

## Etiology

In alignment with the most recent ILCOR guidelines[3], CARES requires that all EMS-treated, non-traumatic cardiac arrests be entered into the registry. The etiology of arrest is identified by field providers and recorded in the patient care record. Per the Ustein guidelines, an arrest is presumed to be of cardiac etiology unless it is clearly documented otherwise.

In 2019, 82.9% of adult (>18 years of age) OHCAs were presumed to be of a cardiac cause. Other causes of adult OHCA were: respiratory/asphyxia (9.1%), drug overdose (5.7%), exsanguination/hemorrhage (0.8%), drowning/submersion (0.5%), and other medical (0.9%) (Figure 3).

The etiology of arrest for pediatric patients (≤18 years of age) differed substantially from that of adults. In 2019, 40.7% of pediatric arrests were presumed to be of a cardiac etiology. Other causes of pediatric OHCA were: respiratory/asphyxia (38.5%), drowning/submersion (9.1%), SIDS/SUID (5.3%), drug overdose (3.3%), and other medical (3.0%) (Figure 4).

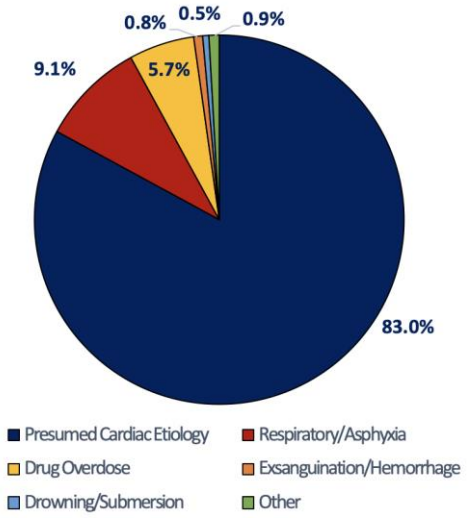



**Figure 3.** Etiology of arrest for adults.

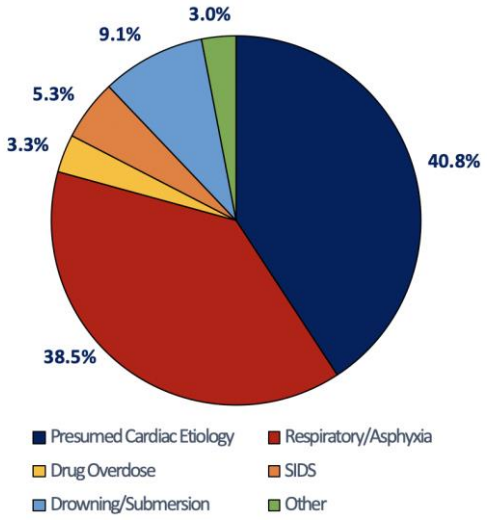



**Figure 4.** Etiology of arrest for pediatric patients.

Figure 5 further highlights the relationship between arrest etiology and patient age. Presumed cardiac cause was the most predominant etiology for all age groups, with the proportion of arrests attributable to this cause increasing with patient age. However, pediatric patients were much more likely than adults to experience an arrest due to respiratory cause. Drug overdose accounted for 37% of arrests in the 19-34 age group and 16% of arrests in the 35-49 age group, highlighting the impact of the current opioid epidemic in the United States.

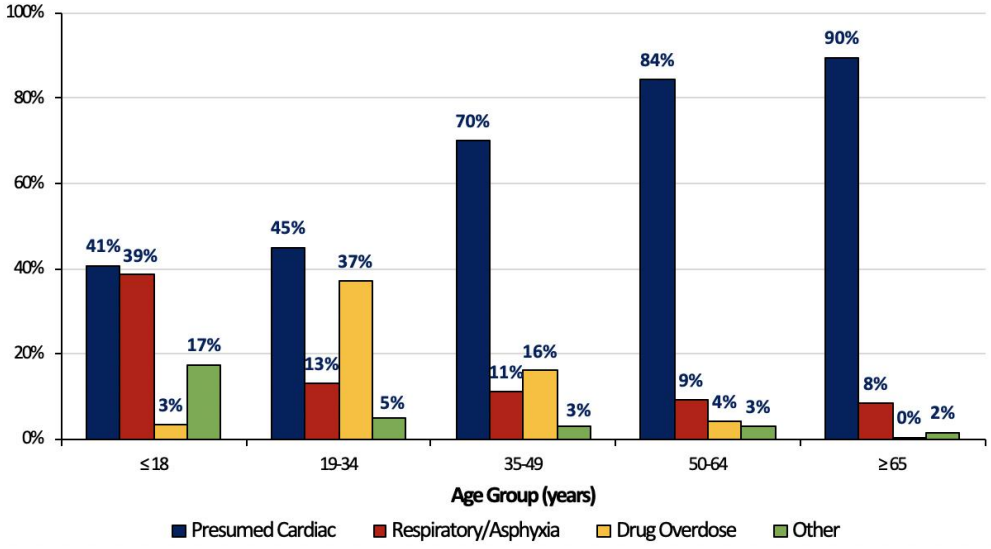



**Figure 5.** Etiology of arrest by age group.

## Location of Arrest

The most common place for an OHCA to occur is in a residential setting, with 70.4% of events occurring in a home. Other common arrest locations were nursing home (10.9%), public or commercial building (7.6%), street or highway (5.0%), and healthcare facility (3.5%) (Figure 6).

The location of an OHCA is highly correlated with bystander intervention and patient outcome. In comparison to residential arrests, patients who arrested in a public setting were far more likely to have a bystander witnessed event and receive bystander CPR prior to EMS arrival (Figure 7). Patient outcomes were also significantly different across incident locations, with public arrests having a 2.7-fold rate of survival to hospital discharge compared to residential arrests (23.3% vs 8.6%, respectively; p< .0001).

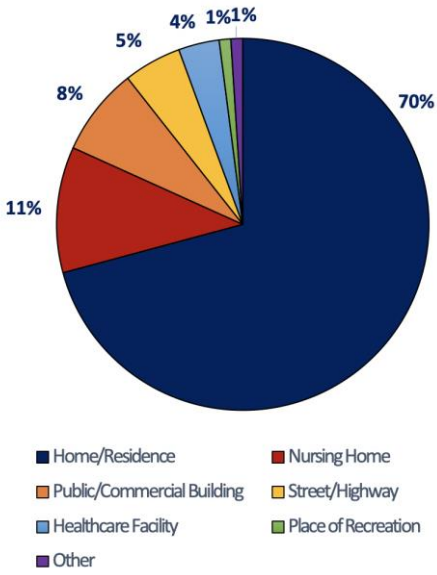



**Figure 6.** Location of arrest.

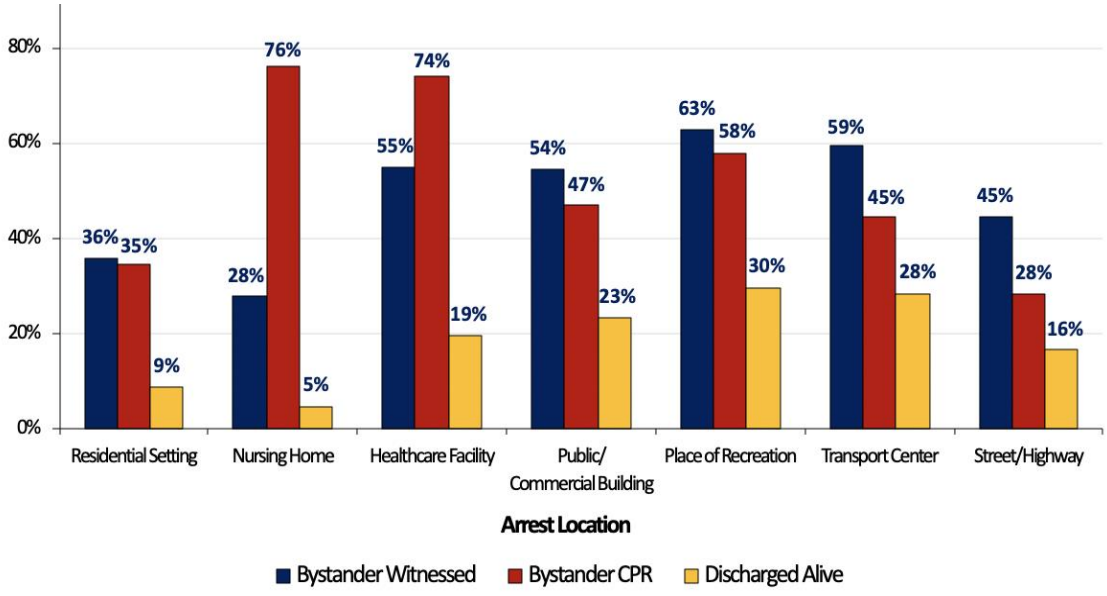



**Figure 7.** Percentage of events that are bystander witnessed, receive bystander CPR, and survive to hospital discharge by arrest location.

## Witness Status

Arrest witness status has significant implications for patient outcomes, as witnessed arrests have more opportunity for bystander intervention and early delivery of care.

Approximately half of arrests were unwitnessed (49.5%), while 38.0% were bystander witnessed and 12.5% were witnessed by a 911 Responder (Figure 8). Patients with a bystander witnessed arrest were more than 3 times as likely to survive their event compared with unwitnessed arrests (16.0% vs 4.4%, respectively; p<.0001), while patients with a 911 Responder witnessed arrest were more than 4 times as likely to survive compared with unwitnessed arrests (18.2% vs 4.4%, respectively; p<.0001).

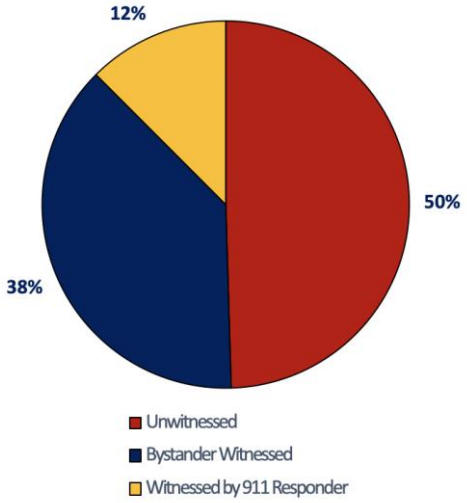



**Figure 8.** Arrest witness status.

## Initial Rhythm

When the cardiac rhythm is first monitored after OHCA, a patient may present in a shockable rhythm (ventricular fibrillation or ventricular tachycardia) or non-shockable rhythm (asystole or idioventricular/pulseless electrical activity (PEA)). Treatment and prognosis depend on presenting rhythm, with better survival after OHCA among patients with a shockable rhythm (29.0% vs. 6.2%, p<.0001).

18.9% of patients presented with an initial shockable rhythm of ventricular fibrillation (VF) or ventricular tachycardia (VT), while 81.1% of patients presented in an unshockable rhythm, with asystole being the most common (49.8%). Presenting rhythm differed markedly by arrest witness status, with bystander witnessed patients being much more likely to present in a shockable rhythm than unwitnessed patients (29.9% vs 10.6%, respectively; p<.0001) (Figure 9).

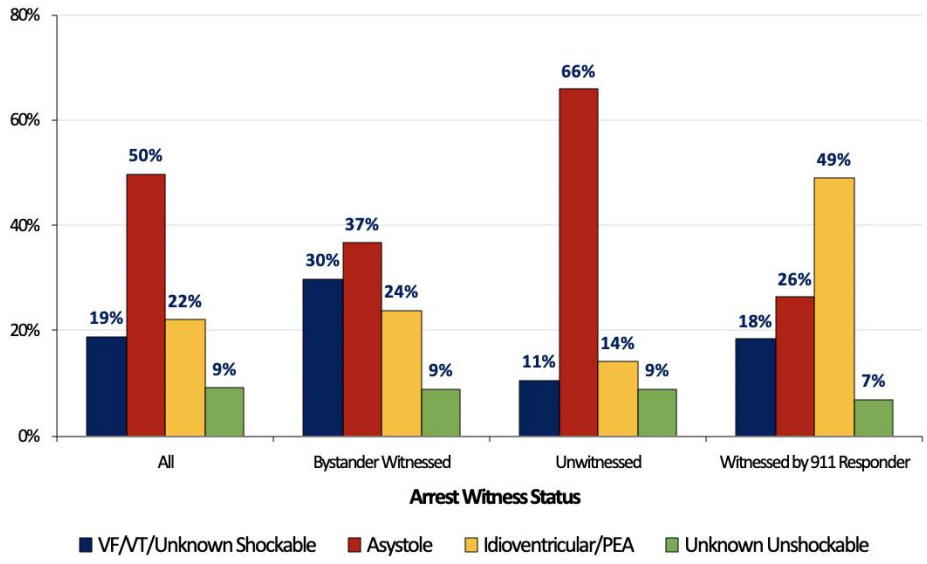



**Figure 9.** Presenting arrest rhythm by arrest witness status.


Early access to care

Early CPR

Early defibrillation

Rapid delivery of EMS care

# Chain of Survival

The chain of survival refers to a series of actions intended to maximize the chances of survival following cardiac arrest. The five links in the chain of survival are early access to care, early CPR, early defibrillation, rapid delivery of EMS care, and early post-resuscitative care. For every minute of cardiac arrest without CPR or defibrillation, a patient's chance of survival falls by 7-10%[5]. This means that the community and bystander response are integral to survival from OHCA.

## Early Access to Care

The first step in the chain of survival is recognition of cardiac arrest and activation of the emergency response system by calling 911. The next crucial time period is the interval between call receipt at the dispatch center to arrival on scene, or "response time". The distribution of First Responder and EMS response times are presented in Figure 10.

Response and treatment times are supplemental elements in CARES; however, participants are encouraged to measure response times in order to identify local opportunities for improvement. Records with missing response times (18.4%) as well as those that were witnessed by a 911 Responder (12.5%), have been excluded from response time analyses.

In 2019, median response time by First Responders was 6.2 minutes (IQR: 4.5 - 8.4 minutes) and median response time by EMS was 7.2 minutes (IQR: 5.2 - 10.0 minutes). First Responders arrived on scene in ≤ 5 minutes for 30.5% of arrests, while EMS arrived on scene in ≤ 9 minutes for 67.7% of arrests.

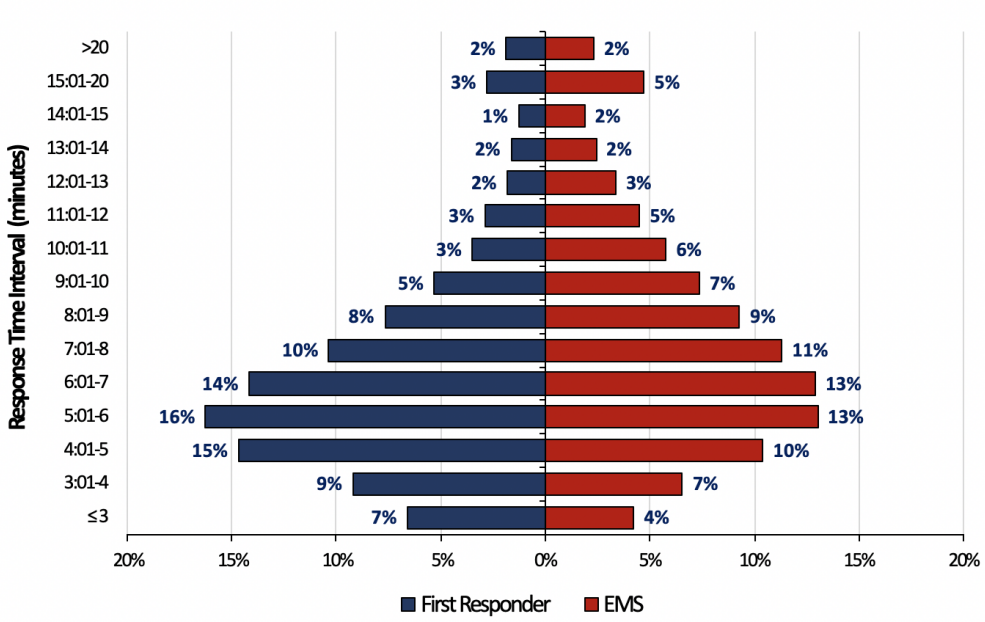



**Figure 10.** Distribution of First Responder and EMS response times (time interval from 911 call to arrival on scene).

Figure 11 is a bivariate analysis of survival to hospital discharge rate by EMS response time (measured from call receipt at dispatch center to arrival of the ambulance at the scene) for all OHCA patients as well as three subsets: bystander witnessed, bystander witnessed VF/VT (Utstein), and unwitnessed. Patients with a witnessed VF/VT arrest experienced a significant decrease in survival with increasing EMS response time. In contrast, response time had little effect on survival among unwitnessed arrests.

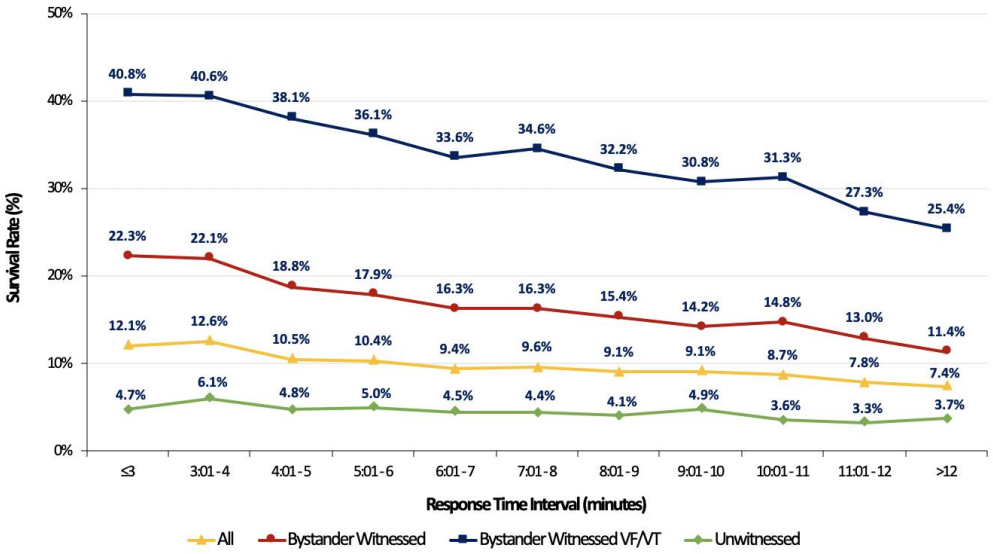



**Figure 11.** Survival rate by EMS response time and arrest witness status.

Figure 12 illustrates the interdependence between the links in the chain of survival, by highlighting how rapid 911 response and bystander CPR (bCPR) work in tandem to improve patient survival. Bystander CPR helps provide critical and timely intervention while 911 vehicles are in transit to the scene. By comparing the same patient subgroups in Figure 11 and Figure 12, one can see how survival is elevated when bystander CPR is performed.

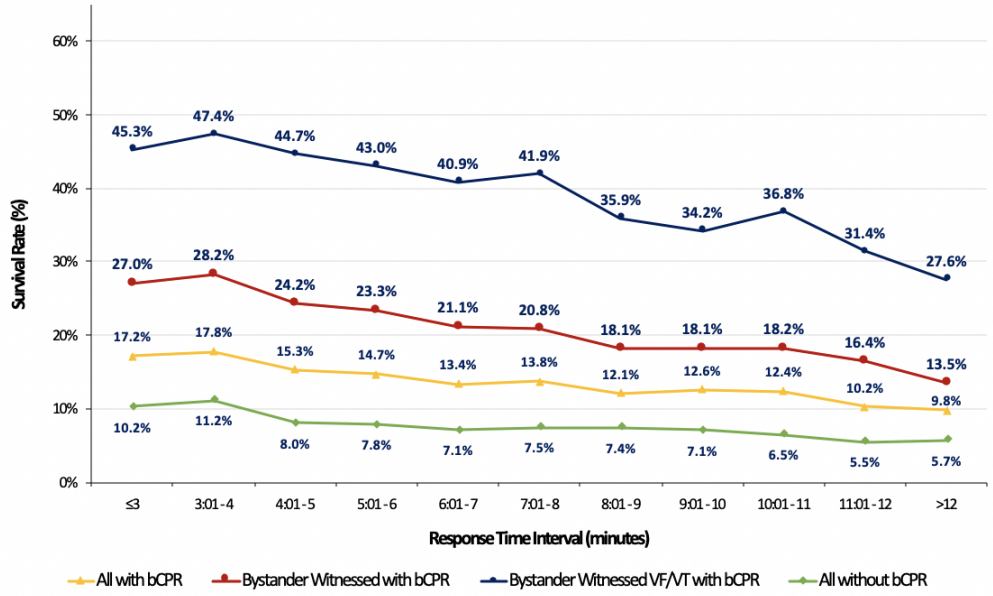



**Figure 12.** Survival rate by EMS response time and arrest witness status, among patients who received bystander CPR.

A 911 dispatcher from MedStar Mobile Healthcare in Fort Worth, TX uses call taking software to quickly identify high priority medical calls and provide pre-arrival medical instructions for condition such as cardiac arrest. *Photo courtesy of MedStar Mobile Healthcare*.

## Early CPR

One of the critical interventions to achieving successful resuscitation is early CPR. If CPR is started before an ambulance arrives, the patient's chances of survival dramatically increase. In 2019, bystander CPR was initiated on 41.2% of CARES patients. Of note, CARES excludes 911 Responder witnessed events as well as those that occurred in a nursing home or healthcare facility from our bystander CPR rate, as these are scenarios where we would expect CPR to be performed by a trained medical provider.

Bystander CPR provision was strongly correlated with arrest witness status (Figure 13). Bystander CPR was initiated after 49.6% of bystander witnessed events, compared with 34.4% of unwitnessed events (p<.0001).

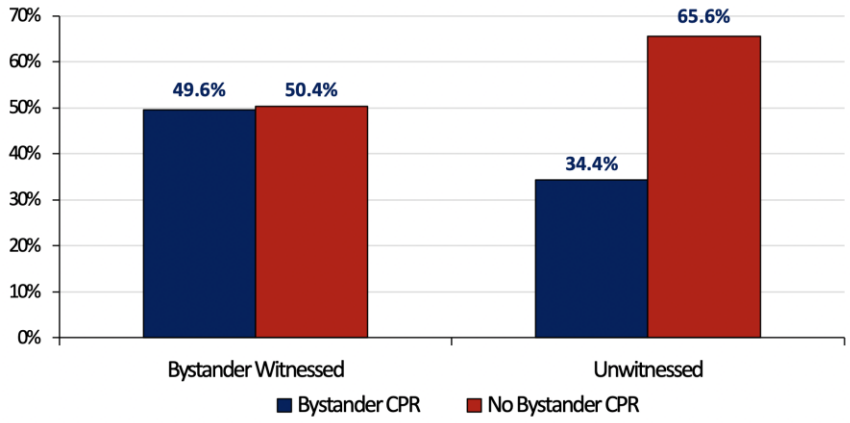



**Figure 13.** Bystander CPR provision by arrest witness status.

Return of spontaneous circulation (ROSC) in the field, survival to hospital admission, and survival to hospital discharge were all strongly associated with receipt of bystander CPR (Figure 14). The survival to discharge rate for patients receiving bystander CPR (13.1%) was significantly (p<.0001) higher than that of patients who did not receive bystander CPR (7.4%).

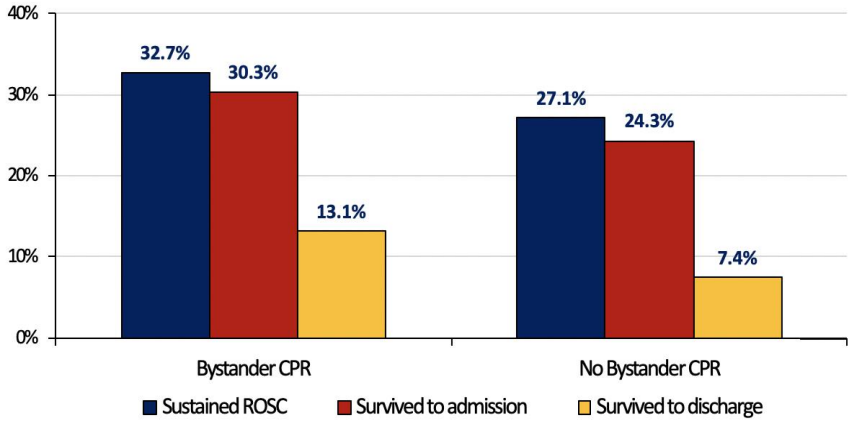



**Figure 14.** Unadjusted survival outcomes after bystander CPR.

## Early Defibrillation

More than 15% of OHCAs occur in a public location; therefore, public access AEDs and community training have a large role to play in early defibrillation. However, the number of patients who have an AED applied by a bystander remains low, occurring after only 12.2% of public arrests.

In 2019, 31.2% (n=31,530) of CARES patients were defibrillated in the field. The proportion of patients first defibrillated by a bystander was 5.6%, whereas 19.6% and 74.8% were first defibrillated by a First Responder or EMS personnel, respectively.

Reducing delays to defibrillation leads to better outcomes for patients in a shockable rhythm. Unadjusted outcomes for this subset of patients vary according to who performed the first defibrillation (Figure 15). The proportion of OHCA patients surviving to hospital discharge when first defibrillated by a bystander with an AED was 48%, compared with 28% of patients first shocked by First Responders and 27% of patients first shocked by responding EMS personnel.

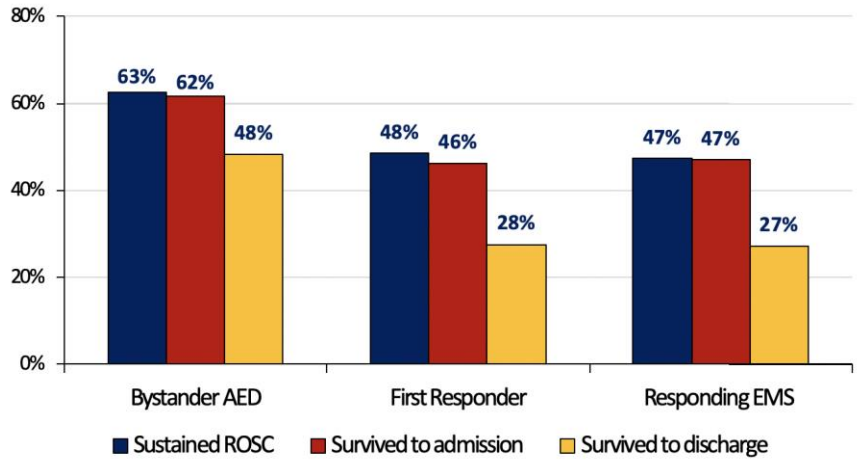



**Figure 15.** Unadjusted survival outcomes by who performed first defibrillation in the population with a shockable presenting rhythm.

# Survival Outcomes

## Patient Outcomes

On the basis of local EMS agency protocols, 36.4% of patients were pronounced on scene after resuscitative efforts were terminated in the pre-hospital setting (Figure 16). A successful attempt at resuscitation in the field is often defined by a patient's return of spontaneous circulation (ROSC). In 2019, sustained ROSC (20 consecutive minutes of ROSC, or present at transfer of care to a receiving hospital) was achieved by 30.7% of CARES patients.

The rate of survival to hospital admission was 27.9% (ED outcome missing for 156 cases; 0.2%), and the rate of survival to hospital discharge was 10.5% (hospital outcome missing for 174 cases; 0.2%). A majority of patients who were discharged alive had a neurologically favorable outcome, a Cerebral Performance Category (CPC) score of 1 or 2 (Table 3).

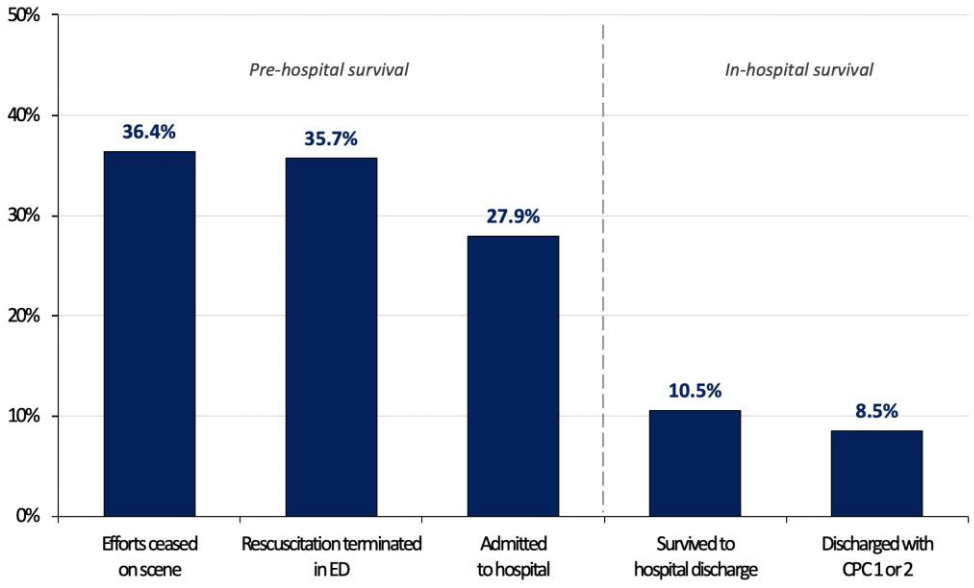



**Figure 16.** Unadjusted pre-hospital and in-hospital OHCA patient outcomes.

**Table 3. Cerebral Performance Category (CPC) scores**

| CPC Score | Description |
|---|---|
| CPC 1 | Good Cerebral Performance<br>Conscious, alert, able to work and lead a normal life. |
| CPC 2 | Moderate Cerebral Disability<br>Conscious and able to function independently (dress, travel, prepare food), but may have hemiplegia, seizures, or permanent memory or mental changes. |
| CPC 3 | Severe Cerebral Disability<br>Conscious, dependent on others for daily support because of impaired brain function (in an institution or at home with exceptional family effort). |
| CPC 4 | Coma, Vegetative State<br>Not conscious. Unaware of surroundings, no cognition. No verbal or psychological interactions with environment. |
| CPC 5 | Death |

## Arrest Characteristics and Outcomes

Survival outcomes differed markedly across etiology, presenting rhythm, and witness status categories.

Patients with an arrest of presumed cardiac etiology had an unadjusted survival rate to hospital discharge of 9.8%. Survival among patients with an arrest caused by a respiratory mechanism or drowning was slightly higher (12.7 and 12.4%, respectively), whereas patients with an overdose-related arrest had a survival rate of 17.4%. Survival was lowest among patients with an arrest due to exsanguination or hemorrhage (4.2%) (Figure 17).

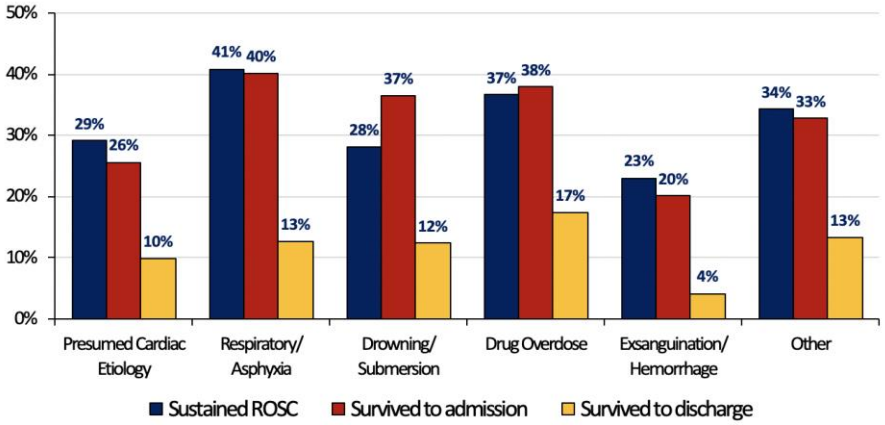



**Figure 17**. Unadjusted survival outcomes by arrest etiology.

Patients that present with an initial shockable rhythm of ventricular fibrillation (VF) or ventricular tachycardia (VT) have a much higher chance of survival than patients who present with a non-shockable rhythm such as asystole or pulseless electrical activity (PEA) (Figure 18). Patients who presented in a shockable rhythm had a survival to hospital admission rate of 48.0%, compared with 34.2% for those in PEA and 16.6% for those in asystole. Similarly, patients presenting in a shockable rhythm had a greater chance of being discharged alive (29.0%), compared with 10.3% of patients presenting in PEA and 2.5% of patients in asystole.

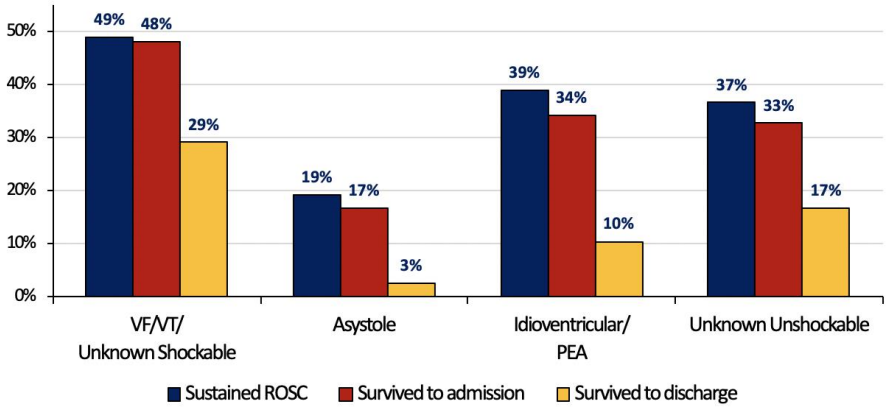



**Figure 18**. Unadjusted survival outcomes by presenting arrest rhythm.

Arrest witness status also has a significant impact on patient outcomes, as witnessed arrests have more opportunity for bystander intervention and early delivery of care. OHCA patients with a 911 Responder witnessed arrest had the highest chance of survival to hospital discharge (18.2%), followed closely by those with a bystander witnessed arrest (16.0%). In contrast, unwitnessed events had a survival rate of 4.4% (Figure 19).

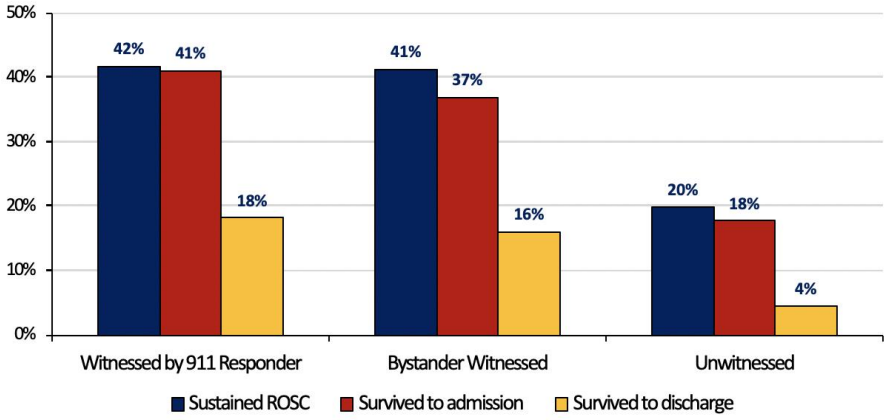



**Figure 19**. Unadjusted survival outcomes by arrest witness status.

## Utstein Survival

The Utstein template was developed by international resuscitation experts to promote uniform reporting guidelines for clinical variables and patient outcomes[2,3]. These guidelines define core data fields to ensure consistency in terminology and make recommendations on the data elements to be recorded for each OHCA event.

Patients who have a bystander witnessed OHCA and present in a shockable rhythm are the most likely to survive their arrest, and are referred to as the "Utstein" subgroup. This subset of arrests is an important measure of system efficacy, allowing for comparison of patient outcomes between systems and time periods, despite the wide variation of cardiac arrest circumstances and patient characteristics.

Figure 20 shows the National CARES Utstein Survival Report for 2019. This report stratifies arrests by witness status and presenting rhythm. In 2019, the survival to hospital discharge rate for the Utstein subgroup was 33.2%. Utstein bystander patients (arrest witnessed by a bystander, presented in a shockable rhythm, and received some bystander intervention [CPR and/or AED application]) had a survival rate of 37.3%.

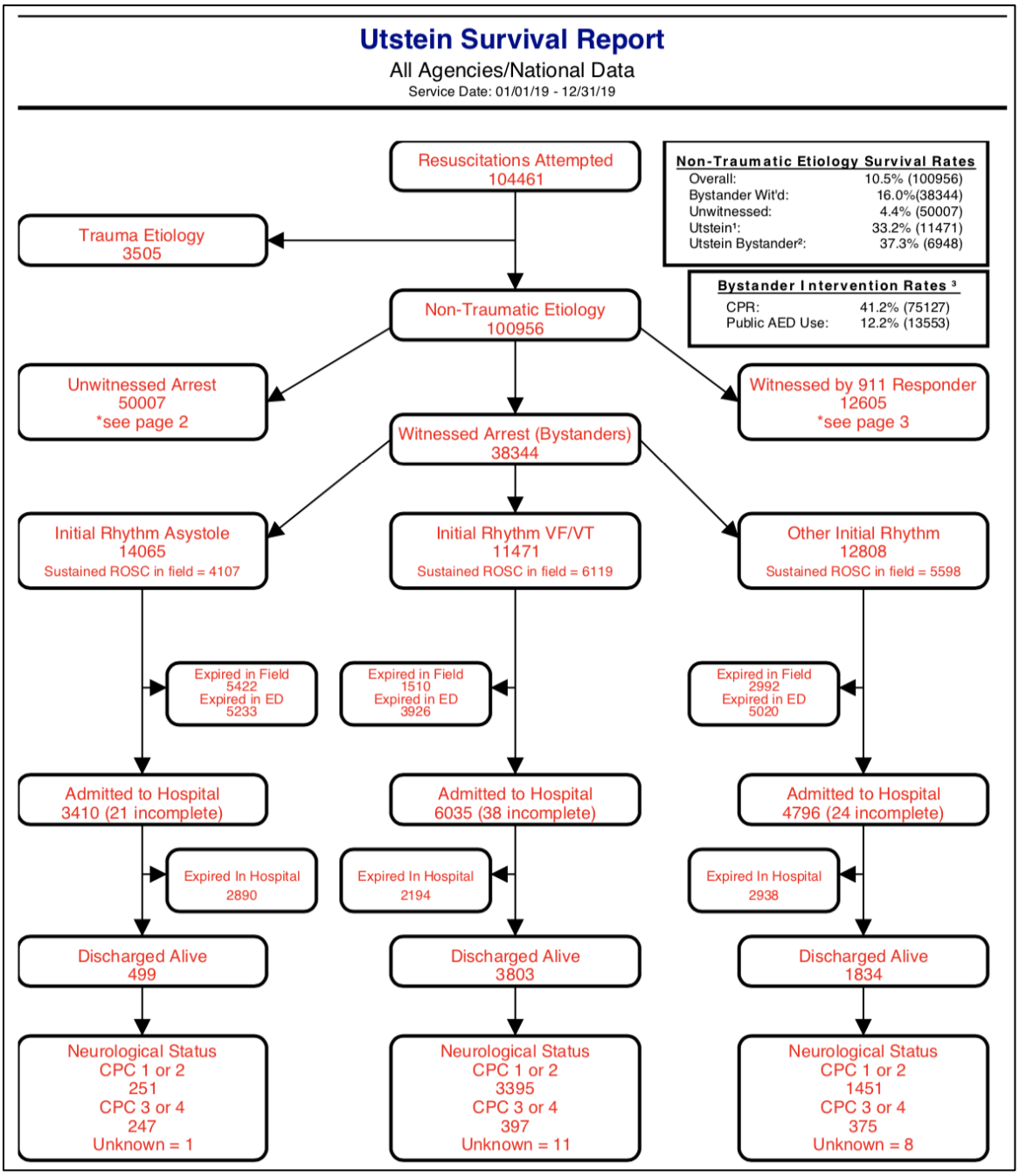



**Figure 20.** 2019 CARES Non-Traumatic Etiology Utstein Survival Report.

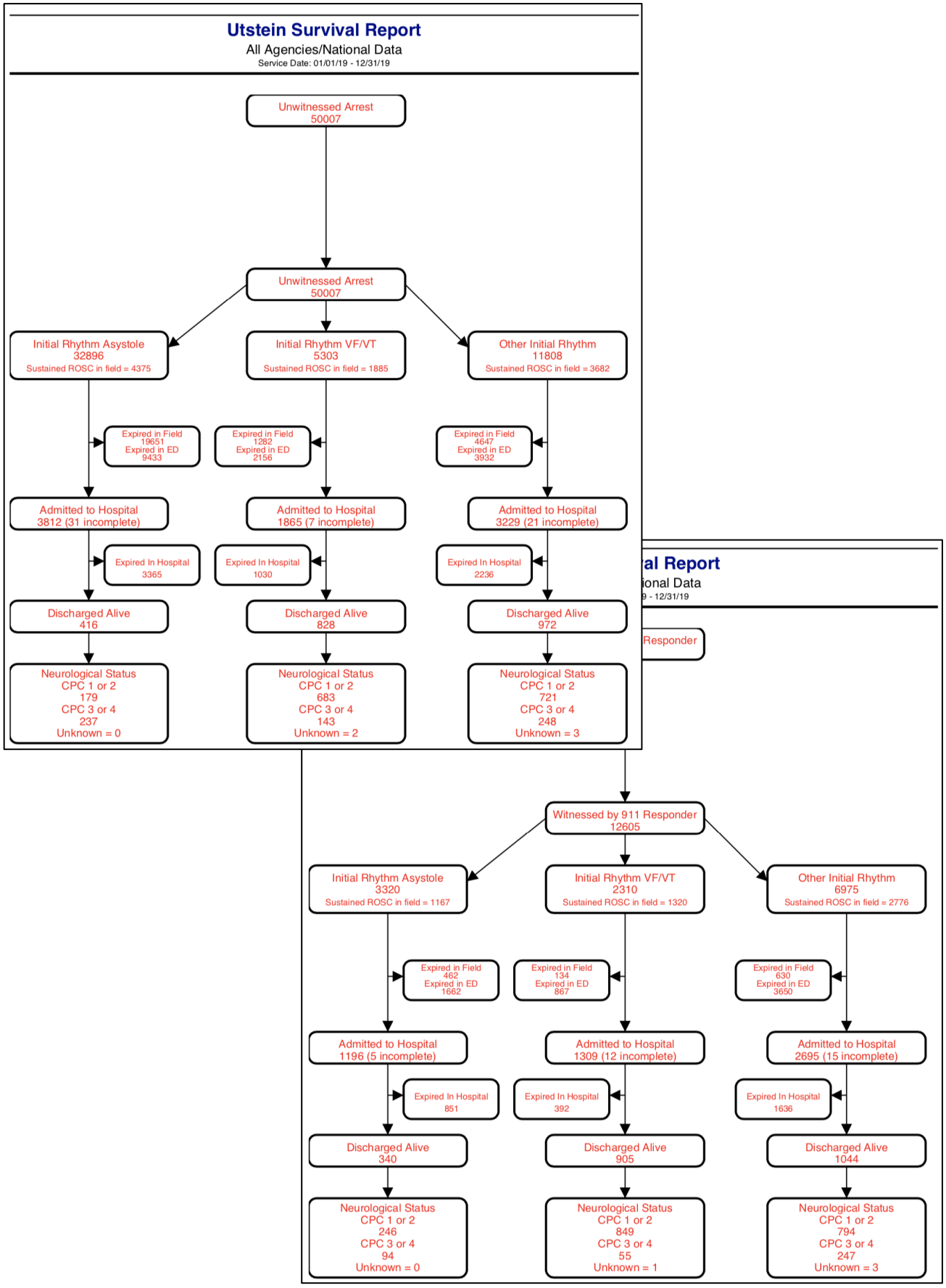



**Figure 20.** 2019 CARES Non-Traumatic Etiology Utstein Survival Report.


Physicians and medical staff at Emory University Hospital in Atlanta provide compassionate emergency care.
*Photo courtesy of Emory University Hospital; Photo credit: Jack Kearse, Health Sciences Photography*.

## Hospital Survival

The CARES Hospital Survival Report allows receiving centers to view summary metrics for their patient population. The report follows a flow diagram format, categorizing arrests by sustained ROSC in the field, initial rhythm, and patient outcome, and also allows for filtering of patients by whether they were transported by EMS or transferred from another acute care facility. Figure 21 shows the National CARES Hospital Survival Report for 2019.

Among all patients transported to a hospital, the survival to admission rate was 43.9% and the survival to discharge rate was 16.6%. Survival to hospital discharge was substantially higher among those who achieved sustained ROSC in the field (31.9%) compared with those who did not (2.5%), and among those who were transferred from another facility (44.5%) compared with patients who were transported directly by EMS (15.0%).

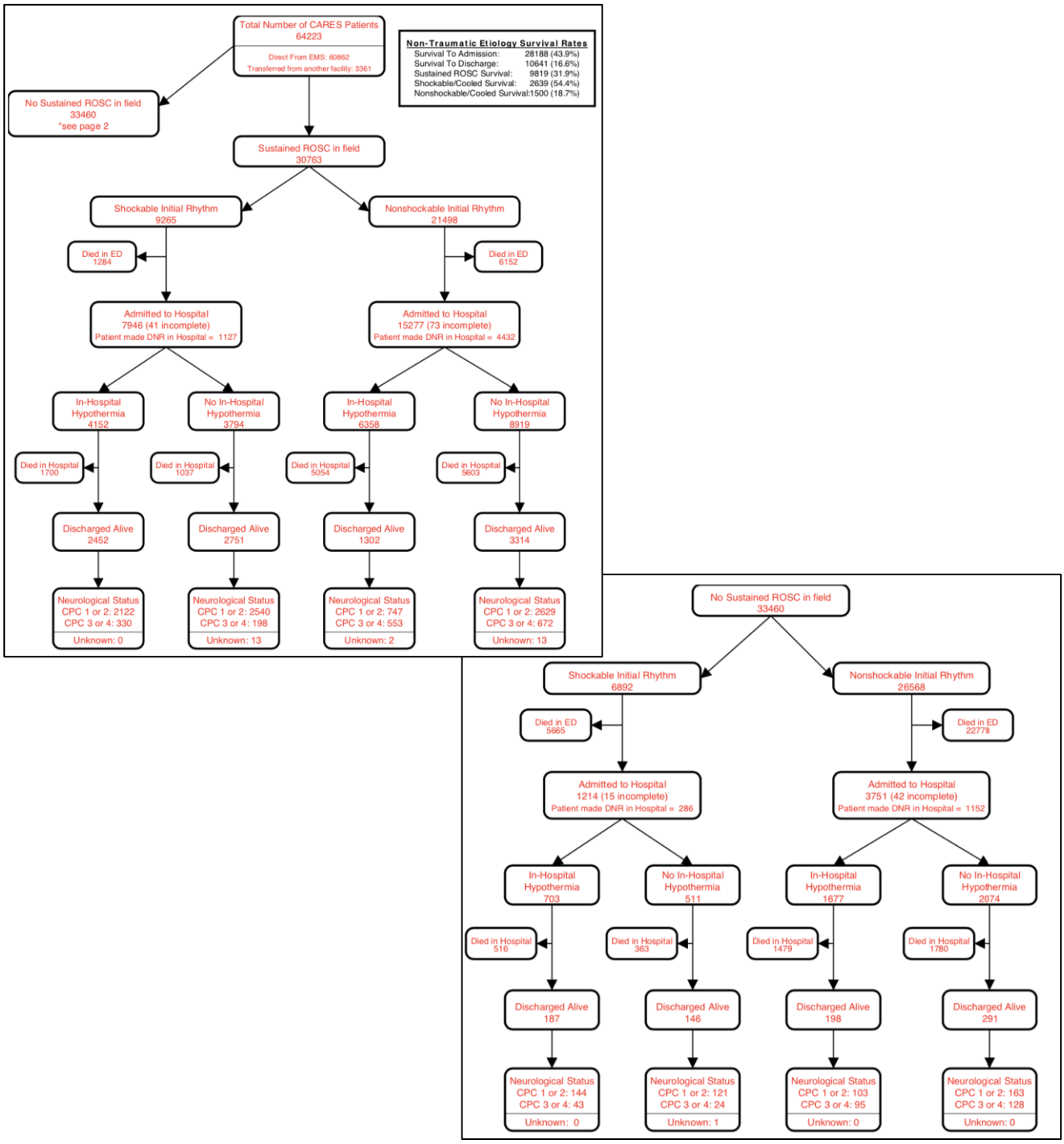



**Figure 21.** 2019 CARES Non-Traumatic Etiology Hospital Survival Report.

## Regional Variation in OHCA Outcomes

There is marked regional variation in OHCA patient outcomes and bystander intervention rates. The diversity of CARES communities allows for comparison of system performance and outcome metrics. The figures below compare overall survival rates (Figure 22), Utstein survival rates (Figure 23), and bystander CPR rates (Figure 24) among the 165 EMS agencies with ≥150 CARES cases in 2019. These figures highlight the significant variability among participating agencies (ranges: overall survival 2.5–21.1% (8-fold difference); Utstein survival 7.7–64.0% (8-fold difference); bystander CPR 14.6–77.8% (5-fold difference). The bars in each figure represent communities with an underlying population ranging from 100,000 to over 2 million. The red dotted line denotes the national average for benchmarking purposes (overall survival: 10.5%; Utstein survival: 33.2%; bystander CPR 41.2%), while the grey vertical lines indicate quartile cutpoints.

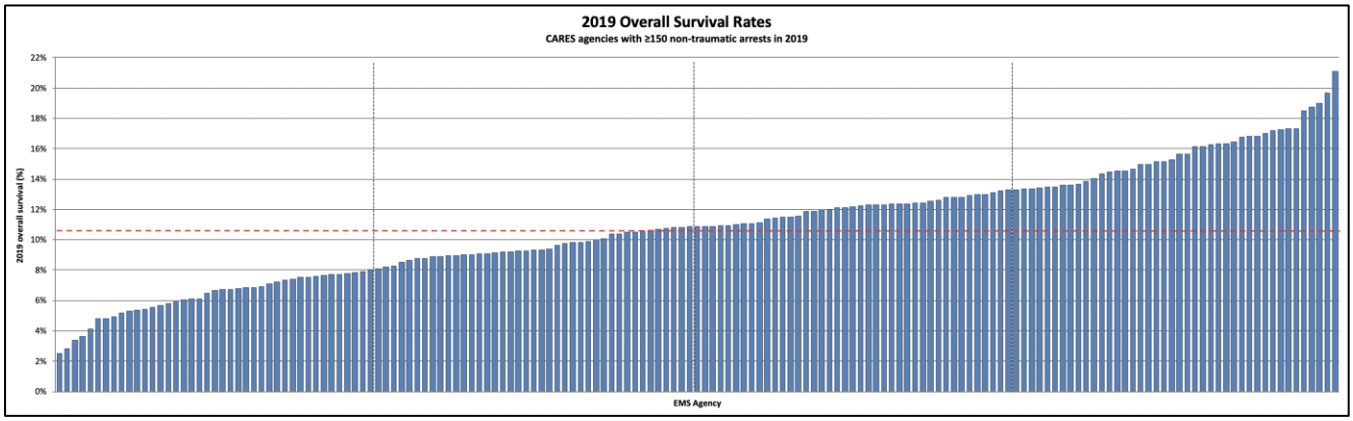



**Figure 22.** Variability in overall survival rates, among EMS agencies with ≥150 CARES cases in 2019.

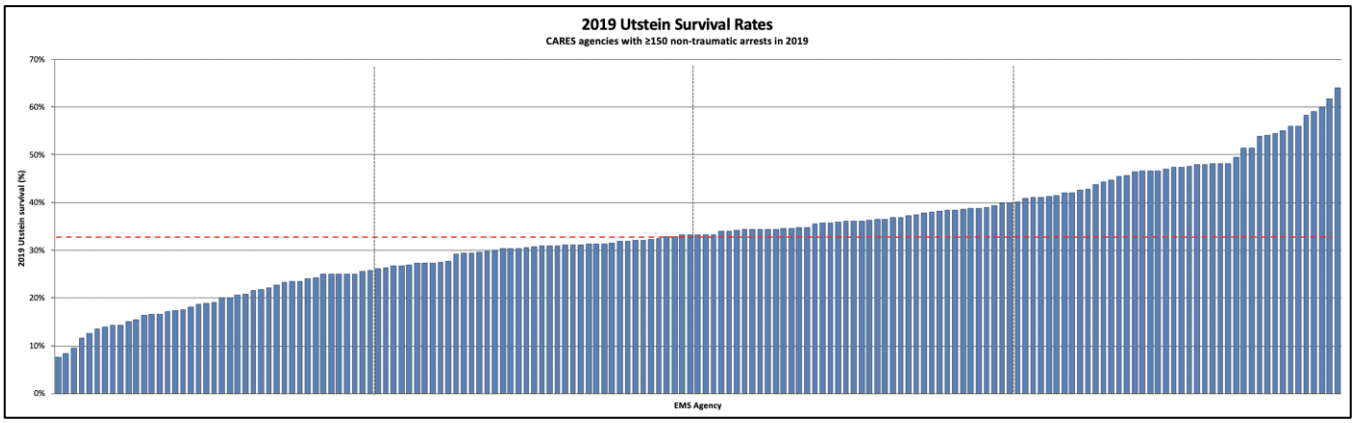



**Figure 23.** Variability in Utstein survival rates, among EMS agencies with ≥150 CARES cases in 2019.

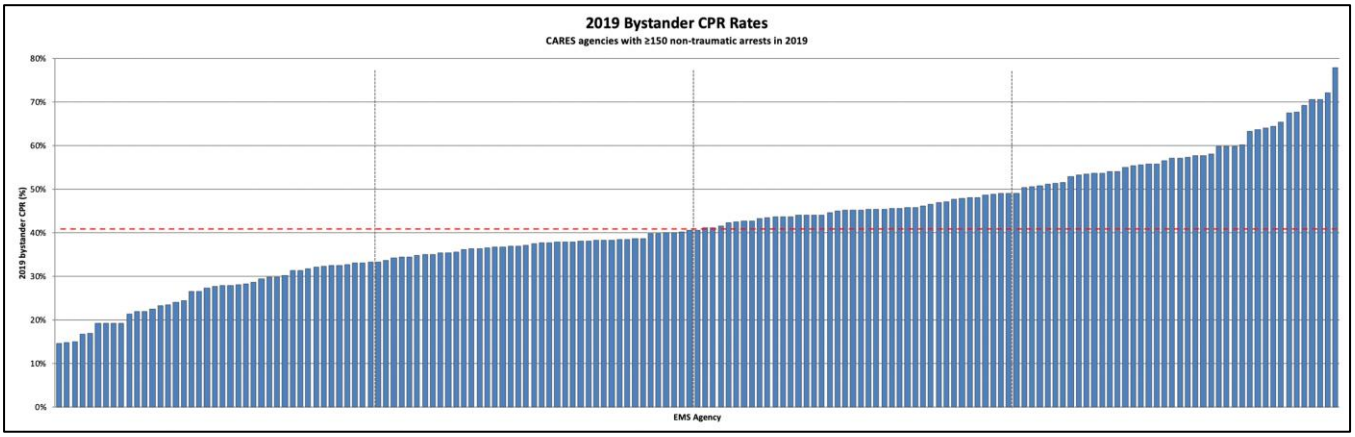



**Figure 24.** Variability in bystander CPR rates, among EMS agencies with ≥150 CARES cases in 2019.

## Public Reporting of State Aggregate Metrics

Survival after out-of-hospital cardiac arrest varies between regions in the United States. With the growing number of CARES state participants, there is a unique opportunity to present aggregate metrics by state to better understand OHCA incidence, survival outcomes, and bystander intervention rates nationwide. The table below shows aggregate metrics for state participants that had at least 50% population catchment in 2019. 17 states and the District of Columbia voluntarily agreed to participate in reporting these metrics.

The included states have a wide range of both population catchment (611,330 to over 24 million) as well as incidence rate (41.8–126.1 per 100,000; 3-fold difference). There was also marked variability in community interventions, with bystander CPR rates ranging from 33.6–73.3% (a 2-fold difference) and public AED use rates ranging from 2.7–15.1% (a more than 5-fold difference), as well as patient outcomes (overall survival: 6.0–16.0%; Utstein survival: 22.1–44.1%).

**Table 4. Public Reporting of State Aggregate Metrics, 2019**

| | OHCA Incidence | | | | | Non-Traumatic Etiology Survival Rates | | Bystander Intervention Rates | |
|---|---|---|---|---|---|---|---|---|---|
| | CARES Cases Reported | 2019 CARES Population Catchment | 2019 Total State Population | % Population Covered | Incidence Rate (per 100,000) | Overall Survival to Hospital Discharge (%) | Utstein Survival (%) | CPR (%) | Public AED Use (%) |
| **National** | 100,956 | 131,905,913 | 328,239,523 | 40.1% | 76.5 | 10.5 | 33.2 | 41.2 | 12.2 |
| **State** | | | | | | | | | |
| **Alaska** | 394 | 611,330 | 731,545 | 83.6% | 64.4 | 16.0 | 44.1 | 73.3 | 2.7 |
| **California** | 16100 | 24,681,023 | 39,512,223 | 62.5% | 65.2 | 9.0 | 32.1 | 43.5 | 12.0 |
| **Colorado** | 2074 | 3,616,495 | 5,758,736 | 62.8% | 57.4 | 12.3 | 39.4 | 41.7 | 15.1 |
| **Delaware** | 1165 | 967,171 | 973,764 | 99.3% | 120.5 | 11.8 | 30.4 | 36.2 | 6.5 |
| **Hawaii** | 1321 | 1,415,872 | 1,415,872 | 100.0% | 93.3 | 11.3 | 31.4 | 49.2 | 13.2 |
| **Michigan** | 7727 | 7,896,597 | 9,986,857 | 79.1% | 97.9 | 8.7 | 30.3 | 40.2 | 13.9 |
| **Minnesota** | 2537 | 4,887,375 | 5,639,632 | 86.7% | 51.9 | 13.5 | 38.5 | 37.5 | 14.1 |
| **Mississippi** | 1825 | 1,778,516 | 2,976,149 | 59.8% | 102.6 | 6.0 | 22.1 | 36.5 | 10.1 |
| **Montana** | 507 | 642,348 | 1,068,778 | 60.1% | 78.9 | 11.2 | 36.8 | 48.5 | 5.2 |
| **New Hampshire** | 1059 | 1,359,711 | 1,359,711 | 100.0% | 77.9 | 10.2 | 28.2 | 53.5 | 14.4 |
| **North Carolina** | 5965 | 7,114,453 | 10,488,084 | 67.8% | 83.8 | 12.6 | 32.4 | 37.1 | 13.6 |
| **Oregon** | 2410 | 3,895,582 | 4,217,737 | 92.4% | 61.9 | 14.7 | 35.6 | 57.4 | 13.9 |
| **Pennsylvania** | 8013 | 9,973,687 | 12,801,989 | 77.9% | 80.3 | 9.5 | 31.4 | 36.4 | 10.0 |
| **South Carolina** | 2551 | 2,760,590 | 5,148,714 | 53.6% | 92.4 | 11.8 | 28.2 | 37.4 | 10.9 |
| **Utah** | 1321 | 3,161,105 | 3,205,958 | 98.6% | 41.8 | 8.6 | 26.8 | 36.9 | 10.2 |
| **Vermont** | 481 | 623,989 | 623,989 | 100.0% | 77.1 | 10.2 | 36.0 | 43.0 | 6.6 |
| **Washington** | 4210 | 7,273,113 | 7,614,893 | 95.5% | 57.9 | 15.0 | 42.5 | 57.3 | 12.2 |
| **District of Columbia** | 886 | 702,455 | 705,749 | 99.5% | 126.1 | 7.7 | 31.0 | 33.6 | 6.9 |

CARES sincerely appreciates the willingness of state participants to voluntarily share this information. Reporting of state variations in OHCA outcomes validates the importance of data collection for OHCA, promotes the sharing of best practices and helps facilitate system improvements to save lives nationwide.

## Healthy People 2020

Every decade, the Healthy People initiative develops a set of objectives to improve the health of all Americans. The topic of "Preparedness" was added to the 2020 objectives, with the goal of strengthening and sustaining communities' abilities to prevent, protect against, mitigate the effects of, respond to, and recover from incidents with negative health effects[6]. Community resilience, the ability of a community to use its assets to strengthen public health and healthcare systems, is a cornerstone of preparedness. CARES is partnering with Healthy People 2020 to focus on and promote bystander response, with the goal of increasing the rates of:

- Bystander CPR for all non-traumatic cardiac arrests.
- Bystander AED use for non-traumatic cardiac arrests occurring in public locations.
- Survival to hospital discharge for patients who receive bystander intervention (through CPR and/or AED application).
- Survival to hospital discharge for Utstein bystander patients (those with a bystander witnessed non-traumatic cardiac arrest that present in a shockable rhythm and receive bystander intervention through CPR and/or AED application).

CARES is utilizing the stable 2015 cohort, comprised of the more than 500 EMS agencies that participated in the registry in 2015 and serve a population of approximately 85 million, to track these metrics longitudinally over a 5-year period (2015 through 2020). The unadjusted 2019 rates for this cohort are listed in Table 5.

An adjusted trend analysis will be performed this year on the four Healthy People 2020 objectives over 5 years (2015-2019). Sociodemographic measures will also be assessed to determine if they influence targeted goals. We expect to share this report once it is published in Morbidity and Mortality Weekly Report (MMWR).

| Table 5. CARES Healthy People Metrics, 2019 | |
|---|---|
| Bystander CPR | 41.9% |
| Bystander AED use in public locations | 12.1% |
| Survival to discharge among patients who received bystander CPR and/or AED application | 13.6% |
| Survival to discharge among Utstein bystander patients | 38.5% |


A Lower Providence EMS unit having its pre-shift check completed.
*Photo courtesy of Lower Providence EMS; Photo Credit: EVT Photography.*

# 2019 Research Highlights

*A comprehensive list of CARES publications to-date can be viewed at: https://mycares.net/sitepages/publications.jsp.*

## Peer-Reviewed Publications

- Pun PH, Dupre ME, Starks MA, Tyson C, Vellano K, Svetkey LP, Hansen S, Frizzelle BG, McNally B, Jollis JG, Al-Khatib SM, Granger CB; CARES Surveillance Group. **Outcomes for Hemodialysis Patients Given Cardiopulmonary Resuscitation for Cardiac Arrest at Outpatient Dialysis Clinics.** *J Am Soc Nephrol.* 30(3):461-70.
- Amen A, Karabon P, Bartram C, Irwin K, Dunne R, Wolff M, Daya MR, Vellano K, McNally B, Jacobsen RC, Swor R, Cares Surveillance Group. **Disparity in Receipt and Utilization of Telecommunicator CPR Instruction.** *Prehosp Emerg Care.* 13:1-6.
- Del Rios M, Weber J, Pugach O, Nguyen H, Campbell T, Islam S, Stein Spencer L, Markul E, Bunney EB, Vanden Hoek T. **Large urban center improves out-of-hospital cardiac arrest survival.** *Resuscitation*. 139:234-240.
- Cone DC, Burns K, Maciejewski K, Dziura J, McNally B, Vellano K; CARES Surveillance Group. **Sudden cardiac arrest survival in HEARTSafe communities.** *Resuscitation*. 146:13-18.
- Griffis H, Wu L, Naim MY, Bradley R, Tobin J, McNally B, Vellano K, Quan L, Markenson D, Rossano JW; CARES Surveillance Group. **Characteristics and outcomes of AED use in pediatric cardiac arrest in public settings: The influence of neighborhood characteristics.** *Resuscitation*. 146:126-131.
- Chen J, Seetharam K, Reginauld S, Lerakis S; CARES Surveillance Group**. Higher Walk Score is associated with higher rates of bystander automated external defibrillator use in street-level cardiac arrest from Cardiac Arrest Registry to Enhance Survival registry.** *J Cardiovasc Med*. 20(12):859-860.
- Glober NK, Tainter CR, Abramson TM, Staats K, Gilbert G, Kim D. **A simple decision rule predicts futile resuscitation of out-of-hospital cardiac arrest.** *Resuscitation*. 142:8-13.
- Naim MY, Griffis HM, Burke RV, McNally BF, Song L, Berg RA, Nadkarni VM, Vellano K, Markenson D, Bradley RN, Rossano JW. **Race/Ethnicity and Neighborhood Characteristics Are Associated With Bystander Cardiopulmonary Resuscitation in Pediatric Out-of-Hospital Cardiac Arrest in the United States: A Study From CARES.** *J Am Heart Assoc. 8*(14): e012637.
- Coute RA, Nathanson BH, Panchal AR, Kurz MC, Haas NL, McNally B, Neumar RW, Mader TJ. **Disability-Adjusted Life Years Following Adult Out-of-Hospital Cardiac Arrest in the United States.** *Circ Cardiovasc Qual Outcomes*. 12(3):e004677.
- Balian S, Buckler DG, Blewer AL, Bhardwaj A, Abella BS; CARES Surveillance Group. **Variability in survival and post-cardiac arrest care following successful resuscitation from out-of-hospital cardiac arrest.** *Resuscitation*. 137:78-86.
- Harford S, Darabi H, Del Rios M, Majumdar S, Karim F, Hoek T, Erwin K, Watson D. **A machine learning based model for Out of Hospital cardiac arrest outcome classification and sensitivity analysis.** *Resuscitation*. 138:134-140.

## Abstracts

- Ryan A Coute, Brian Nathanson, Michael C Kurz, Nathan L Haas, Bryan McNally, Timothy J Mader. **National Institutes Of Health Research Investment For The Leading Causes Of Disability-Adjusted Life Years In The United States.** American Heart Association Resuscitation Science Symposium; 2019 November 16-17; Philadelphia, PA.
- Pavitra Kotini-Shah, Oksana Pugach, Ruizhe Chen, Marina Del Rios, Kimberly Vellano, Bryan Francis McNally, Terry L Vanden Hoek, Paul Chan. **Sex Differences In Outcomes For Out-Of-Hospital Cardiac Arrest.** American Heart Association Resuscitation Science Symposium; 2019 November 16-17; Philadelphia, PA.

- Sidsel Moeller, Carolina Malta Hansen, Matthew Dupre, Tom Rea, Sean Van Diepen, Lisa Monk, Clark Tyson, Bryan McNally, Monique AnNderson Starks, Christopher Fordyce, Jenny Shin, Fredrik Folke Folke, Christian Torp-pedersen, James Jollis, Christopher Bull Granger. **Higher Mortality From Cardiac Arrest In North Carolina Versus Washington State And Denmark: Implications For Improving Systems Of Care.** American Heart Association Resuscitation Science Symposium; 2019 November 16-17; Philadelphia, PA.

- Shobi Mathew, James H Paxton, Brian Reed, Joseph B Miller, Howard Klausner, Robert Dunne, Brian O'Neil. **Factors Contributing To Out-Of-Hospital Cardiac Arrest Mortality Trends In The City Of Detroit (2014-2018).** American Heart Association Resuscitation Science Symposium; 2019 November 16-17; Philadelphia, PA.

- David A Berger, Nai-Wei Chen, Joseph B Miller, Robert Dean Welch, Joshua C Reynolds, James M PRIBBLE, Robert A Swor. **Variation Of Post Arrest Survival To Discharge And Cerebral Performance Category 1/2 In State Of Michigan.** American Heart Association Resuscitation Science Symposium; 2019 November 16-17; Philadelphia, PA.

- Julie Tram, Andrew Pressman, Nai-Wei Chen, David Berger, Joseph B Miller, Robert Dean Welch, Joshua C Reynolds, James M Pribble, Ronny Otero, Robert A Swor. **Ventricular Assist Device Association In Improving Outcomes In Patients Resuscitated From Out Of Hospital Cardiac Arrest.** American Heart Association Resuscitation Science Symposium; 2019 November 16-17; Philadelphia, PA.

- Alyssa Vermeulen, Marina Del Rios, Teri Lynn Campbell, Hai Nguyen, Hoang H Nguyen. **Forecasting Out-Of-Hospital Cardiac Arrest In The Young Using Generalized Additive Model: A Network Analysis Of The Cardiac Arrest Registry For Enhanced Survival In Chicago.** American Heart Association Resuscitation Science Symposium; 2019 November 16-17; Philadelphia, PA.

- Christopher Berry, Douglas Kupas, Mark Olaf, Anne Knorr, Andrea Berger, Division of EM, Geisinger Health System. **In Out-Of-Hospital Cardiac Arrest, Longer On Scene Times Are Associated With Higher Survival Rates: "Scoop And Run" May Be Deadly.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Mark Pinchalk, Adam Palmer, James Dlutowski, John Mooney, Adam Studebaker, Simon Taxel, Jeff Reim, Jr., Phillips Frank, City of Pittsburgh EMS. **Utility Of A Prehospital "Crashing Patient" Care Bundle In Reducing The Incidence Of Post Ems Contact Cardiac Arrest Of Critically Ill Medical Patients.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Amanda Amen, Patrick Karabon, Cherie Bartram, Kevin Irwin, Robert Dunne, Margaret Wolff, Mohamud Daya, Kimberly Vellano, Bryan McNally, Robert Swor, Oakland University William Beaumont School of Medicine. **Disparities In Receipt And Utilization Of Telecommunicator Cpr Instruction.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- David Cone, Kevin Burns, Kimberly Vellano, Bryan McNally, Yale University School of Medicine. **Sudden Cardiac Arrest Survival In Heartsafe Communities.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Mark Lehman, Douglas Kupas, Anne Knorr, Andrea Berger, Division of EMS, Geisinger Health System**. Comparison Of Survival Outcomes And Factors Associated With Out-Of-Hospital Cardiac Arrest From Presumed Overdose Etiology In Pennsylvania.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Douglas Kupas, Mark Olaf, Anne Knorr, Andrea Berger, Division of EMS, Geisinger Health System. **Preliminary Evaluation Of The American Heart Association Termination Of Resuscitation Criteria In The Pediatric Population Using The Cardiac Arrest Registry To Enhance Survival.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Mark Olaf, Douglas Kupas, Anne Knorr, Andrea Berger, CARES Surveillance Group, Geisinger Health System Validation Of American Heart Association. **Termination Of Resuscitation Criteria And Comparison To Shibahashi Criteria In A United States Out-Of-Hospital Cardiac Arrest Population.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Ryan Overberger, Arun Thomas, Kamran Mohiuddin, Einstein Medical Center Philadelphia. **A Comparison Of Outcomes Following A Change From Therapeutic Hypothermia To Targeted Normothermia In Patients Suffering Out-Of-Hospital Cardiac Arrest**. National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Ryan Coute, Brian Nathanson, Michael Kurz, Bryan McNally, Timothy Mader, University of Alabama at Birmingham. **Association Between Scene Time Interval And Neurologic Outcome Following Adult Out-Of-Hospital Cardiac Arrest In The United States.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- John France, Joseph Miller, Ronny Otero, Brian O'Neil, Christina Brent, Howard Klausner, Henry Ford Health System. **Improving Survival From Out-Of-Hospital Cardiac Arrest In Detroit.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Kevin Seaman, Bryan McNally, Melanie Gertner, Karen O'Connell, Jennifer Anders, Medical Director. **Statewide Survival After Pediatric Out-Of-Hospital Cardiac Arrest.** National Association of EMS Physicians Annual Meeting; 2019 January 07-12; Austin, TX.

- Joseph Miller, MD, MS, Mohamed Hamam, MD, John France, BS, Ronny Otero, MD, Robert Swor, DO, James Paxton, MD, Brian O'Neil, MD, Christina Brent, MD, Robert Neumar, MD, PhD, Robert Dunne, MD, Howard A. Klausner, MD, and the CARES Surveillance Group. **Intraosseous Route of Drug Administration is Associated with Lower Survival in Out of Hospital Cardiac Arrest.** Society for Academic Emergency Medicine Annual Meeting; 2019 May 14-17; Las Vegas, NV.

- Bob Swor, D Berger, J Reynolds, R Otero, J Miller, N Chen, J Pribble, R Welch **Statewide Variation in Post Cardiac Arrest Hospital Care in Michigan.** Society for Academic Emergency Medicine Annual Meeting; 2019 May 14-17; Las Vegas, NV.

- Rama Salhi, Jessica Lehrich, Christine Brent, Christopher Nelson, Michael D. Fetters, Timothy Guetterman, Peter Mendel, Robert Swor, Bill Forbush, Brian O'Neil, Brahmajee K. Nallamothu, Mahshid Abir. **Exploring the Role of Police in Out-of-Hospital Cardiac Arrest Response.** Society for Academic Emergency Medicine Annual Meeting; 2019 May 14-17; Las Vegas, NV.

- Pavitra Kotini et al. **Differential Survival to Hospital Admission in Men and Women with Out-of-Hospital Cardiac Arrests.** Society for Academic Emergency Medicine Annual Meeting; 2019 May 14-17; Las Vegas, NV.

- Mahshid Abir, Rama Salhi, Jason Goldstick, Jesse Lehrich, Sydney Fouche, Claude Setodji, Bill Forbush, Robert Neumar, Steve Kronick, Teri Shields, Erin Brennan, Robert A. Swor, Brian O'Neil, CARES Surveillance Group, Brahmajee K. Nallamothu. **Evaluating Variation in Return of Spontaneous Circulation Rates Across EMS Agencies in Michigan.** Society for Academic Emergency Medicine Annual Meeting; 2019 May 14-17; Las Vegas, NV.

- Caitlin G. Jones, Ana G. Rappold, Jason Vargo, Sumi Hoshiko, and the CARES Surveillance Group. **Out-of-Hospital Cardiac Arrests and Fine Particulate Matter (PM2.5) during 2015-2017 California Wildfires.** Western Regional Epidemiology Network; 2019 April 02-04; Ashland, OR.

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- Samuel A. Hofacker, Matthew Dupre, Kimberly Vellano, Bryan McNally, Laura Svetkey, and Patrick H. Pun. **Racial Differences Among Recipients of Staff-Initiated CPR in Outpatient Dialysis Clinics.** American Society of Nephrology; 2019 November 16-17; Washington, District of Columbia.

- Caitlin G. Jones, Ana G. Rappold, Jason Vargo, Wayne E. Cascio, the CARES Surveillance Group, and Sumi Hoshiko**. Wildfire smoke and risk of out-of-hospital cardiac arrests using a spatially derived exposure metric for 2015-2017 California wildfires.** GeoVet; 2019 October 08; Davis, CA.

# List of Abbreviations & Definitions

| | |
|---|---|
| AED | Automated External Defibrillator |
| CARES | Cardiac Arrest Registry to Enhance Survival |
| CPC | Cerebral Performance Category |
| CPR | Cardiopulmonary Resuscitation |
| DNR | Do Not Resuscitate |
| ED | Emergency Department |
| EMS | Emergency Medical Services |
| OHCA | Out-Of-Hospital Cardiac Arrest |
| PEA | Pulseless Electrical Activity |
| ROSC | Return of Spontaneous Circulation |
| SIDS/SUID | Sudden infant death syndrome/Sudden unexpected infant death |
| VF | Ventricular Fibrillation |
| VT | Ventricular Tachycardia |

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