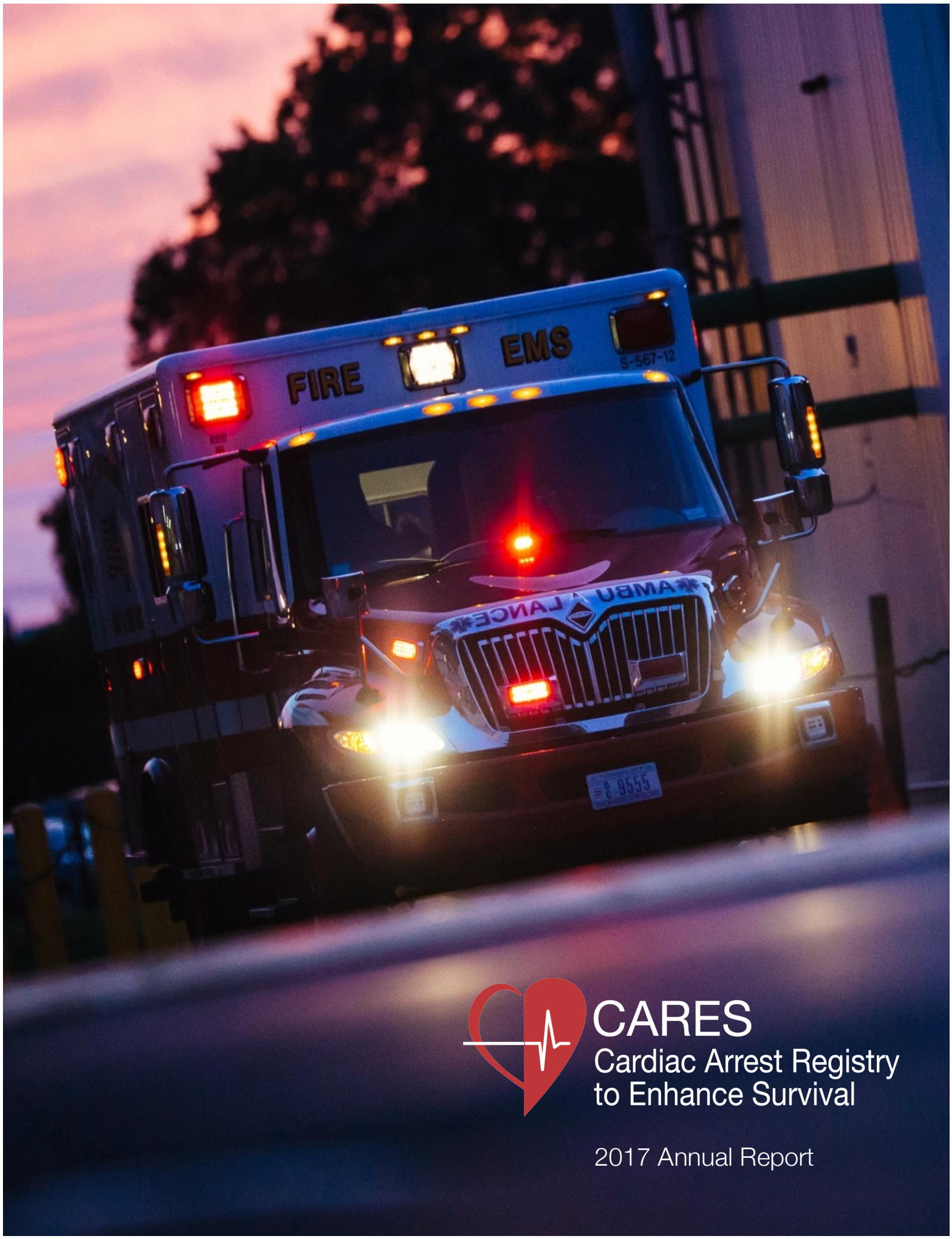

CARES

Cardiac Arrest Registry to Enhance Survival

2017 Annual Report

Members of the Columbus Division of Fire teach Hands-Only CPR outside of Nationwide Stadium during EMS Week.
Photo courtesy of the Columbus Division of Fire; Photo credit: James Miller.

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Introduction

Out-of-hospital cardiac arrest (OHCA) is a significant public health issue and leading cause of death in the United States. More than 200,000 patients each year will have resuscitation attempted after an out-of-hospital cardiac arrest, but only 10% will survive to hospital discharge. 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.

Measurement is key to improving quality of care and patient outcomes. In 2015, the Institute of Medicine released "Strategies to Improve Cardiac Arrest Survival: A Time to Act," which recommended the establishment of a national cardiac arrest registry to monitor performance in terms of both success and failure, identify problems, and track progress[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.

We sincerely appreciate the members of the EMS and hospital CARES communities, as well as the sponsors (American Red Cross, American Heart Association, The Heart Rescue Project, Physio-Control) who support our mission to save lives and improve patient care. We are pleased to present the 2017 Annual Report.

Why CARES Matters: A Story of Survival from OHCA

At CARES, we focus on systemized data collection to measure and benchmark out-of-hospital cardiac arrest outcomes to improve care and survival. The data are crucial in helping create more human stories like this one. Rick and Jennifer Chap from Orlando, Florida, share their inspiring story of survival and put the human face on our mission. Their story illustrates the importance of each link in the "Chain of Survival"– early recognition and access to care, early CPR, early defibrillation, rapid delivery of EMS care, and early post-resuscitative care.

A Perfect (or "Purrfect") Chain of Survival

The Chain of Survival has five parts. But, Rick's chain had a 6th link, the Chap family's beloved cat Buddy.

It's February 27, 2012 and a typical Monday morning. Rick and Jennifer Chap work from their home in Orlando. Rick is in the kitchen getting coffee, and Jennifer is in her home office with Buddy. She's on a conference call with a client, so the door is closed. Suddenly Buddy begins meowing, jumping and scratching unusually to get Jennifer's attention. Fortunately, he does.

Jennifer picks up Buddy and takes him out of the room only to find the source of Buddy's concern. Rick is collapsed on the kitchen floor, unresponsive and gasping for air as if in a seizure.

Phone still in hand, Jennifer immediately dials 911, opening a life-line to dispatcher Kevin Sealey of the Orlando Fire Department. Kevin is diagnostician, communicator, coach and will become Jennifer's hero. They instantly become a team. Kevin works quickly to get the facts and help on the way. Jennifer doesn't know it yet, but Rick is in sudden cardiac arrest. His heart is not beating. He is not breathing. He is clinically dead.

"I'm losing him, I'm losing him!" Jennifer yells. And to her horror, Rick takes his final agonizing breath in her arms. As fear turns to dread, she realizes Rick needs CPR. Kevin immediately tells Jennifer what to do, where to press, how deep to press and how fast to press. And, he says one more thing that she will never forget, "You need to be prepared to do 600 compressions."

Jennifer takes a deep breath and begins to push hard and fast in the center of Rick's chest to the beat of Bee Gees "Stayin' Alive"—a surrealistic musical trip through time, when time is all that matters.

She pushes and pushes until her body almost abandons her will, losing count after 300 compressions. Throughout, Kevin is on the other end of the line calmly empowering Jennifer to keep going. For what seemed like forever but was only minutes, Jennifer was Rick's heartbeat, helping to buy precious time until EMS could get there to restore life. At the brink of exhaustion, the six-man crew of OFD Station 6, shift B led by Lt. Trent Johnston arrives. EMS takes over in perfect harmony, each performing a focused and specific task to help save Rick.

Jennifer backs away as if in a faraway dream-state, her eyes not comprehending what she is seeing. Rick is blue. They continue CPR and quickly place their AED pads. It is as if she is watching a movie, but this is far from make believe. This is horribly real. Jennifer hears, "Clear!" Silence. Then miraculously, "We got a heartbeat." Rick is alive.

Still unconscious, pulseless and not breathing, Rick is intubated and whisked away. OFD fire-based transport provides continuity of care all the way to Orlando Regional Medical Center (ORMC), a level 1 trauma hospital.

At the ORMC Emergency Department, Rick is attended by a 20+ person team all focused on saving his life. Jennifer is told he is in critical condition and the next 24 hours are crucial. Rick is put into therapeutic hypothermia to protect his brain and moved to the ICU. He receives amazing advanced medical care from an incredible and compassionate team of doctors, nurses and support staff. And Jennifer receives support from hospital clergy, family and friends. The wait is almost unbearable, but the medical team is hopeful.

On day 3 Rick is warmed, and on day 4 he is awake and extubated. And Jennifer gets her first kiss! Rick has survived OHCA and is one of the less than 10% who survive. A stent in his left anterior descending artery, 11 days in the hospital and a year of cardiac rehab, Rick is alive to share his side of the story.

Life After OHCA—The Chain of Survival Goes Full Circle

Undoubtedly sudden cardiac arrest (SCA) has changed both Rick and Jennifer. On that fateful morning, they were completely unaware of SCA and that it can happen to a seemingly healthy person. Thankfully Rick survived. But as they now know, 9 out of 10 OHCA victims do not survive and will never come home. The impact on their families is devastating.

For Rick, it all came down to a "purrfect" chain of survival starting with one hero, a cat named Buddy. Today the Chaps are driven by a mission to help save more lives from SCA in whatever way they can.

- Within months of Rick's SCA, the Chaps shared their story at an Orlando City Council meeting to thank and advocate for the Orlando Fire Department. This helped inspire the city's "Take Heart Orlando" program, which has the goal of training every Orlando citizen in CPR. The program is now in its 5th year and the Chaps volunteer as CPR instructors.
- They founded BuddyCPR to encourage everyone to "learn CPR with a buddy" since most sudden cardiac arrests happen at home. You need a buddy—there's no such thing as do-it-yourself CPR.
- They are volunteers and advisors with Sudden Cardiac Arrest Foundation where they use their marketing experience to conduct national public awareness and messaging studies, and created a "Together We Can Save More Lives" PSA video.
- And they participate in Telephone CPR workshops, sharing the caller's perspective with EMS providers.

The Chaps are filled with incomprehensible gratitude and are thankful to live in a community that recognizes the importance of a complete system of care for OHCA from highly trained EMS, to CPR programs, to hospitals with advanced post cardiac arrest care. And because of this, they're able to "make memories that may not have been."

Rick is living proof that CPR and an integrated system of care works.

Rick Chap, SCA survivor, Jennifer Chap TCPR lay rescuer, and Buddy the hero cat, who alerted Jennifer that Rick was in cardiac arrest. Seated in Orlando Fire Department's Tower 6, which was on scene for Rick's code save on 2/27/12. *(Photo by Dan Beckmann)*

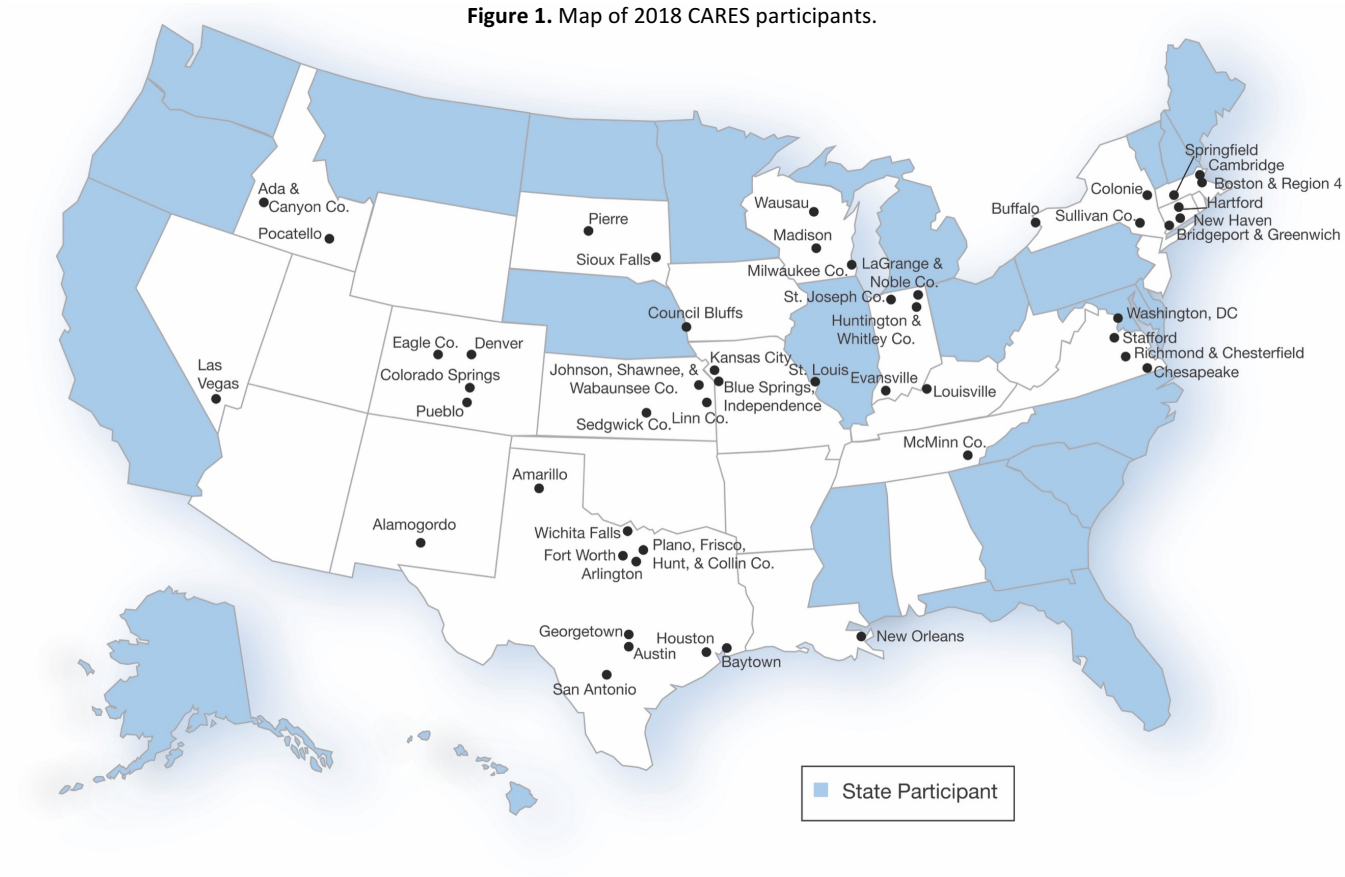
Firefighter paramedics from Tualatin Valley Fire & Rescue in Oregon participate in a training exercise on the provision of post-resuscitative care.
Photo courtesy of Tualatin Valley Fire & Rescue.

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. At present, the registry now captures that same number of records weekly. The program has expanded to include 23 state-based registries (Alaska, California, Delaware, Florida, Georgia, Hawaii, Illinois, Maine, Maryland, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Carolina, Vermont, and Washington) and the District of Columbia, with more than 60 community sites in 19 additional states. CARES represents a catchment area of almost 115 million people or approximately one-third of the US population. To date, the registry has captured over 350,000 records, with more than 1,400 EMS agencies and over 1,900 hospitals participating nationwide.

Figure 1. Map of 2018 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 • Patients who become pulseless in the presence of 911 Responder; OR • 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: ○ Injuries incompatible with life. ○ The presence of rigor mortis or lividity. ○ Signs of decomposition. ○ 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, unemployment rate, average household size, population density, 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.

CARES in Action

SaveMiHeart in Michigan

By Teri Shields, Michigan CARES Coordinator

In 2014, Michigan partnered with CARES as a statewide effort to report data on out-of-hospital cardiac arrest. The same year ***SaveMiHeart***[1], a non-profit initiative, was formed to unite the community, dispatch, first responders, EMS and hospital systems to improve cardiac arrest survival. Currently, the CARES registry covers approximately 7.9 million of the total 9.9 million Michigan residents. In 2017, there were 136 Michigan EMS agencies and 110 hospitals actively entering data into CARES. The goal is to have the entire state covered by 2020.

CARES has provided valuable data to identify areas for improvement. Recognizing cardiac arrest immediately and acting quickly has been shown to have the greatest impact on survival. ***SaveMiHeart*** aims to increase community awareness and education of sudden cardiac arrest and increase bystander compression-only CPR and AED use rates. The bystander CPR rate in Michigan has stayed between 36% and 40% over the past 4 years. The percentage of cardiac arrest patients who had an AED applied prior to EMS arrival was 32% in 2014 and 34.7% in 2017. A current project, *Hands on the Heart of Detroit*, focuses on populations located in neighborhoods with high incidence of cardiac arrest and low rates of bystander response. Programs such as this working together with community, faith-based and school organizations will help create measurable change in improving survival. ***SaveMiHeart*** has collaborated with the University of Michigan athletics program to provide CPR and AED training during football pregame tailgating and also shows a PSA video[2] in the stadium to over 100,000 spectators. The fun yet educational video has gained popularity and has been shown at other sporting events throughout the year.

CARES has allowed Michigan communities, which range from remote rural to suburban and urban populations, to address areas for improvement by providing a user-friendly tool to measure performance and provide meaningful feedback to continually improve their system of care. ***SaveMiHeart*** works with EMS agencies to recognize and reunite survivors with their rescuers. Bystander intervention along with an excellent system of care often means the difference between a life SAVED and one lost. Utilizing CARES as a strategy to accomplish the mission of ***SaveMiHeart*** to double survival in our state by 2020 has already helped save additional lives.

Incident Command for Cardiac Arrest in Chicago

By Dr. Joseph Weber, EMS Medical Director, Chicago EMS System

Until recently, Chicago has been known as a city with one of the lowest published cardiac arrest survival rates and therefore, a place you did not want to have a cardiac arrest. But in 2011, the Chicago EMS System and the Chicago Fire Department (CFD) decided to take on out-of-hospital cardiac arrest. This new quality assurance initiative started with a focus on CFD and their EMS response to cardiac arrest. The department created new protocols that focused on high quality on scene resuscitation with team-based care. However, in an EMS system the size of Chicago with more than 1,500 paramedics and 3,000 EMTs, protocol change is not easily achieved. The CFD simulation training center was central to their success. They took on the herculean task of putting all of their providers through a hands-on simulation based course in their new approach to cardiac arrest, termed “Incident Command for Cardiac Arrest”. The training continues today for all new providers as well as refresher courses for those who have previously completed the training.

With their new protocols on the streets, CFD needed data to see if their initiatives were improving survival. In 2013, they joined a multi-institutional collaborative group from the state of Illinois, Illinois Heart Rescue, that applied for and was awarded the Medtronic Foundation Heart Rescue Grant. As part of this grant, CFD began using the CARES Registry to collect outcome data on all of their cardiac arrest patients. In September of 2013, the first data reports from the CARES

[1] https://www.savemiheart.org/about
[2] https://www.youtube.com/watch?v=QLyxKFSwX5M

registry showed that their efforts thus far had already made significant improvements in cardiac arrest survival rates in the City of Chicago and their 2013-2016 data show a more than four-fold increase in survival over previously published rates.

CARES registry data and collaboration with Illinois Heart Rescue also helped identify other areas for out-of-hospital cardiac arrest quality improvement. New dispatch CPR protocols and training were initiated, as well as a more formalized quality assurance call review process. Bystander CPR training initiatives were led by the Illinois Heart Rescue Community Sphere, which focused efforts on medically underserved areas of the city with a high incidence of cardiac arrest. Both of these initiatives have led to a more than doubling of bystander CPR rates in Chicago. Finally, new EMS protocols were developed requiring that resuscitated cardiac arrest patients be transported only to hospitals able to perform 24/7 percutaneous coronary intervention (PCI) and targeted temperature management (TTM). Hospital based CARES data is additionally used to give feedback to these hospitals on the quality of care they deliver to these patients.

Chicago has made great strides in their approach to cardiac arrest over the past several years. Their basic approach and use of CARES data to measure and improve is now an example for communities of any size, that improving cardiac arrest survival is possible anywhere.

Criteria Based Dispatch in Anchorage

By Dr. Mike Levy, EMS Medical Director, Anchorage Fire Department

Imagine you work as a Telecommunicator (aka Dispatcher) at your local public safety access point (PSAP) taking calls for the fire-based EMS system. It is a pretty busy place that processes 80,000 calls for service in a year that may include EMS, Fire and requests from other agencies for help. The callers could be reporting the smell of smoke in a structure, a psychological emergency, a gunshot wound, a heart attack...the potential is almost endless. As an added twist, the callers will cover an immense gamut of communication skills and primary languages. Anchorage, Alaska is by some accounts the most diverse city in the US[3] . The local school district reports that there are 99 languages besides English spoken by its student body. Those who call may, of course, be very emotional in response to the incident. How do emergency telecommunicators rapidly process calls to identify a life-threatening emergency?

Anchorage Fire Department uses a system called Criteria Based Dispatch (CBD) which was developed at King County EMS. Once basic location information is obtained, the dispatchers ask two key questions on all calls:

1) "Is the person awake and alert?"
2) "Is (s)he breathing normally?"

If the answer to those questions is "no" then the dispatcher tells them to start CPR and gives instructions. This is the so-called "No-No-Go" method that was pioneered in Seattle/King County. This method is likely the fastest means of initiating CPR with lay rescuers and has resulted in significant improvement in the time to first CPR as well as the number of times that CPR is performed in the Anchorage system. Using the CARES Dispatcher Assisted CPR module, Anchorage FD was able to track numerous time intervals as well as monitor barriers encountered by the dispatcher. After implementing CBD in the spring of 2014 (and using the CARES Dispatcher Module when it became available in late 2015), the table below shows how Anchorage FD has been able to far exceed the national standards in Telephone CPR[4].

	Call receipt to CPR recognition	Call receipt to first compression
National Standard: High Performance	60 seconds	120 seconds
National Standard: Minimum	120 seconds	180 seconds
Anchorage FD 2016	44 seconds	100 seconds
Anchorage FD 2017	52 seconds	111 seconds

[3] https://www.cnn.com/2015/06/12/us/most-diverse-place-in-america/index.html.
[4] http://cpr.heart.org/idc/groups/heart-public/@wcm/@ecc/documents/downloadable/ucm_493303.pdf

CBD is unique in that the dispatchers are encouraged to use their verbal and experiential dispatch skills to quickly get to the right answer. For example, if the caller is unable to determine if the person is breathing normally, this system encourages the dispatcher to have the caller move the phone to the patient. Many times, this allows the dispatcher to identify the ineffective breathing pattern of cardiac arrest known as agonal respirations and with that information they immediately have the caller start CPR. This is only effective in dispatch centers that have been trained and in which the dispatchers are given the latitude to draw these conclusions. In other words, some systems are very rigid and do not allow any variations from a set algorithm.

With the CARES Dispatcher Assisted CPR Module, the Anchorage Fire Department has found that when the telecommunicators/dispatchers are trained in CBD AND enabled to add flexibility to the call taking AND rewarded with feedback on the cardiac arrest "saves", we saw significant improvements in our time to first compressions and frequency of CPR being performed prior to EMS arrival. This process is "easy but not simple" as it often requires confronting an established dispatch culture but it has paid immense dividends for Anchorage FD and the community it serves.

Hilton Head Island Fire Rescue's Flight Plan for Survival

By Battalion Chief of EMS Tom Bouthillet, Hilton Head Island Fire Rescue

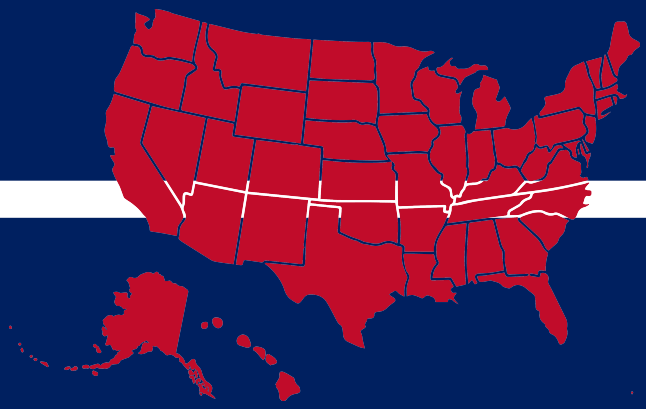
Hilton Head Island Fire Rescue joined the Cardiac Arrest Registry to Enhance Survival (CARES) in 2010. At the time, they had no idea how they were performing with sudden cardiac arrest.

"We felt some anxiety because we didn't know what the data would show," says Battalion Chief of EMS Tom Bouthillet. "But we also knew that we needed the data to move forward." The turning point was the Miracle on the Hudson when Capt. Chesley "Sully" Sullenberger and his crew saved 150 passengers aboard US Airways Flight 1549. "The event captured the imagination of the nation," says Bouthillet. "I felt instinctively that if we could develop a parallel to cardiac arrest survival that it would inspire the decision makers to move forward." Bouthillet, a line firefighter/paramedic at the time, presented a plan to save 150 lives from out-of-hospital cardiac arrest to the senior staff, inspiring the organization to take action.

Over the years, Hilton Head Island Fire Rescue implemented many system improvements for sudden cardiac arrest, starting with a more robust initial assignment including an ambulance, two fire engines, and a battalion chief. Instead of sending 4 or 5 people to a cardiac arrest, they now send 7 to 11. All personnel were trained in Pit Crew CPR and dispatchers received additional training in Telecommunicator CPR. They developed a checklist for on-scene care including post-resuscitation care. They started having meetings with Hilton Head Hospital. Feedback was provided to crews after a resuscitation attempt. It was a complete change of culture and the staff rose to the occasion.

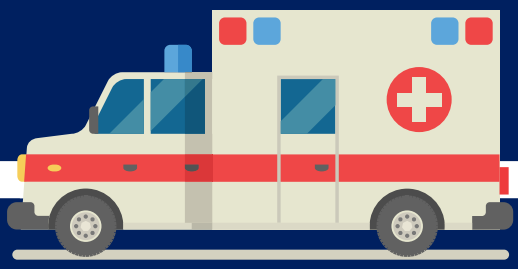
There were some bumps along the way. "We won a national award in 2012, but our performance slumped in 2013 and 2014. It taught us that excellence requires sustained effort over time. It's always a work in progress." After re-training the entire department in Seattle's High Performance CPR they clawed their way back to success. "I wanted to prove that 2012 wasn't a fluke," says Bouthillet. Hilton Head Island Fire Rescue had their best year ever in 2017, when 11 of 16 witnessed VF/VT patients survived to hospital discharge with a CPC score of 1 or 2 – a survival rate of 68% for this group of patients. In an effort to engage with and acknowledge the community, Hilton Head Fire Rescue keeps in contact with their cardiac arrest survivors and the citizens who perform bystander CPR or deploy publicly available AEDs.

Bouthillet credits the CARES registry for arming his organization with knowledge. "It's like Deming said, without data you're just another person with an opinion." This year Hilton Head Island Fire Rescue hung a diagram of a Boeing 737 with 150 seats in the lobby of their main building to help measure their progress. "We're making a public commitment to our citizens and visitors to save 150 lives and we're right on track."



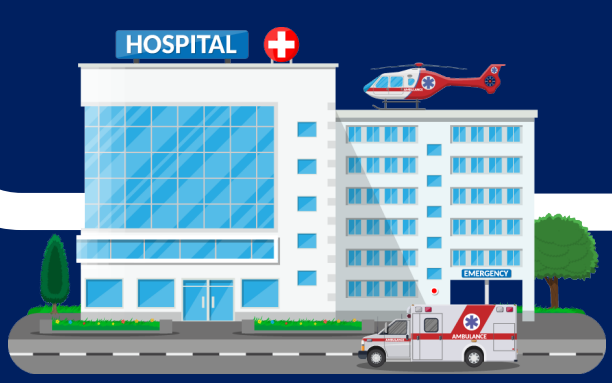
76,215 non-traumatic, worked OHCAs reported to CARES in 2017

38.2% of patients received bystander CPR



Median EMS response time:
7.3 minutes
31.8% of patients achieved sustained ROSC in the field

11.4% of patients who arrested in public had a bystander applied AED



28.1% of patients survived to hospital admission

45.2% of admitted patients received hypothermia care

10.4% of patients survived to hospital discharge

80.4% of discharged patients had a positive neurological outcome (CPC 1 or 2)

Incidence & Demographics

2017 Dataset and Incidence of OHCA Events

This report describes CARES data from the most recent calendar year, January 1 to December 31, 2017. 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 2017 National Reports can be viewed at: https://mycares.net/sitepages/reports2017.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 2017 dataset includes 1,156 EMS Agencies and 1,304 Hospitals, and represents a population of 102.6 million, approximately 32% of the U.S. population. In 2017, 76,215 OHCA events were reported to CARES. The crude incidence of non-traumatic, worked arrests was 74.3 per 100,000, higher than the rate of 68.9 per 100,000 observed in 2016. Using 2017 census data to extrapolate to the U.S. population[4], CARES estimates that there were approximately 242,000 EMS-treated, non-traumatic OHCAs in the United States last year.

Demographics

In 2017, CARES patients were predominately male (62.0%). Of the reported OHCA events, 97.2% (n=74,058) were adults and 2.8% (n=2,113) were children, 18 years and younger. The median age of OHCA patients was 64.0 years (mean: 62.0; SD: 19.5). The age distribution varied significantly across the sexes (Figure 2), with females having a higher median age of arrest (66.0 vs. 63.0 years, p<.0001).

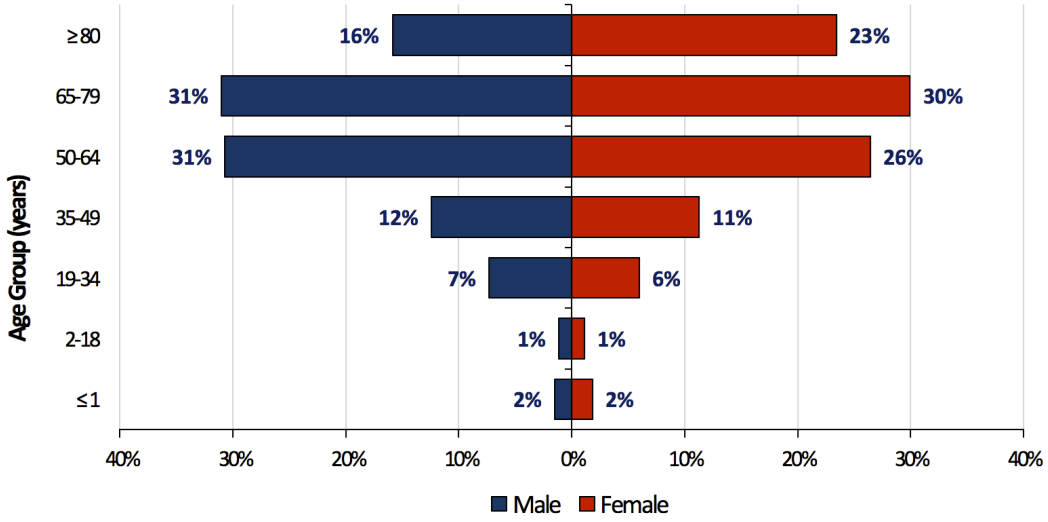


Figure 2. Age distribution of OHCA events.

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 2017, 82.7% 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 (6.1%), exsanguination/hemorrhage (0.7%), 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 2017, 43.5% of pediatric arrests were presumed to be of a cardiac etiology. Other causes of pediatric OHCA were: respiratory/asphyxia (34.9%), drowning/submersion (7.8%), SIDS/SUID (7.5%), drug overdose (2.7%), and other medical (3.6%) (Figure 4).

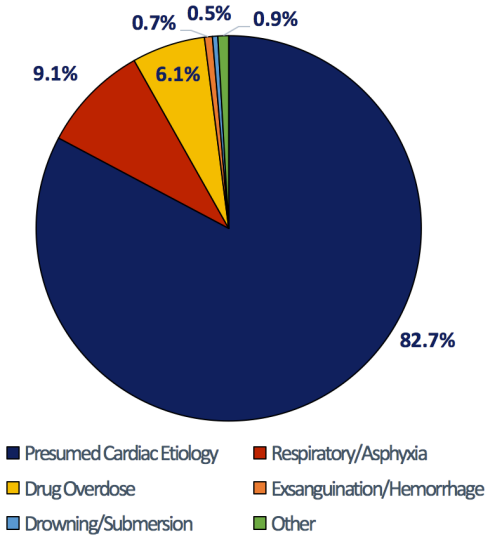


Figure 3. Etiology of arrest for adults.

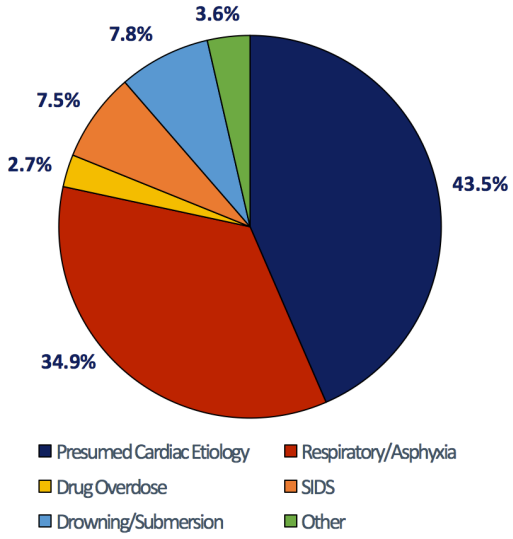


Figure 4. Etiology of arrest for pediatric patients.

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 39% of arrests in the 19-34 age group and 17% of arrests in the 35-49 age group, which is concerning due to the current opioid epidemic in the United States.

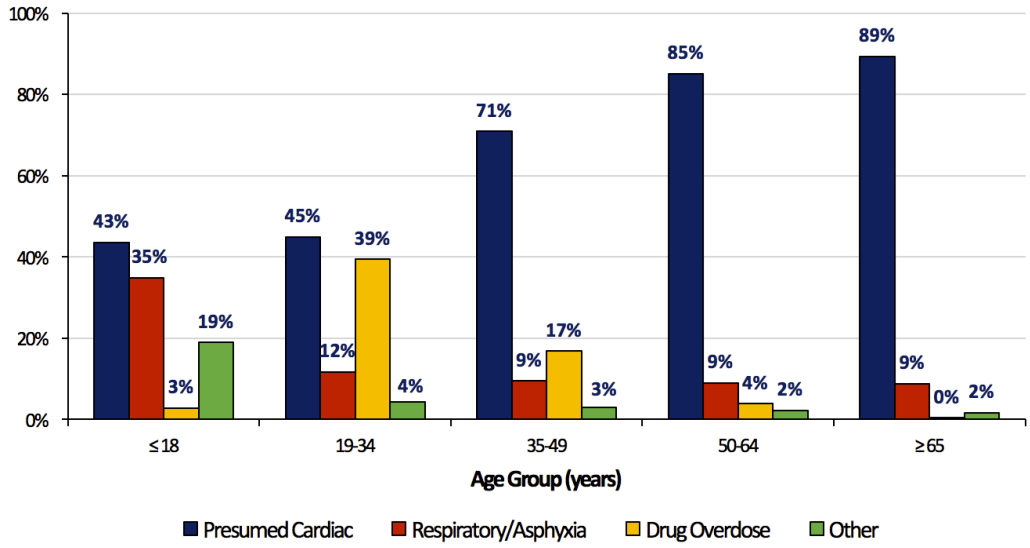


Figure 5. Etiology of arrest by age group.

Location of Arrest

The most common place for an OHCA to occur is in a residential setting, with 69.9% of events occurring in a home. Other common arrest locations were nursing home (11.4%), public or commercial building (7.2%), street or highway (5.4%), 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 nearly 2.5-fold rate of survival to hospital discharge compared to residential arrests (21.5% vs 8.7%, respectively; p< .0001).

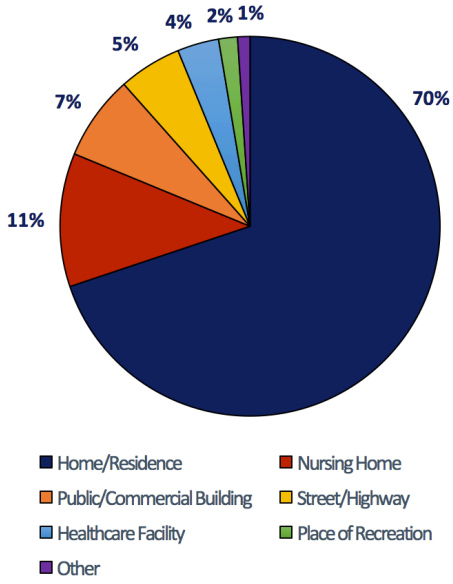


Figure 6. Location of arrest.

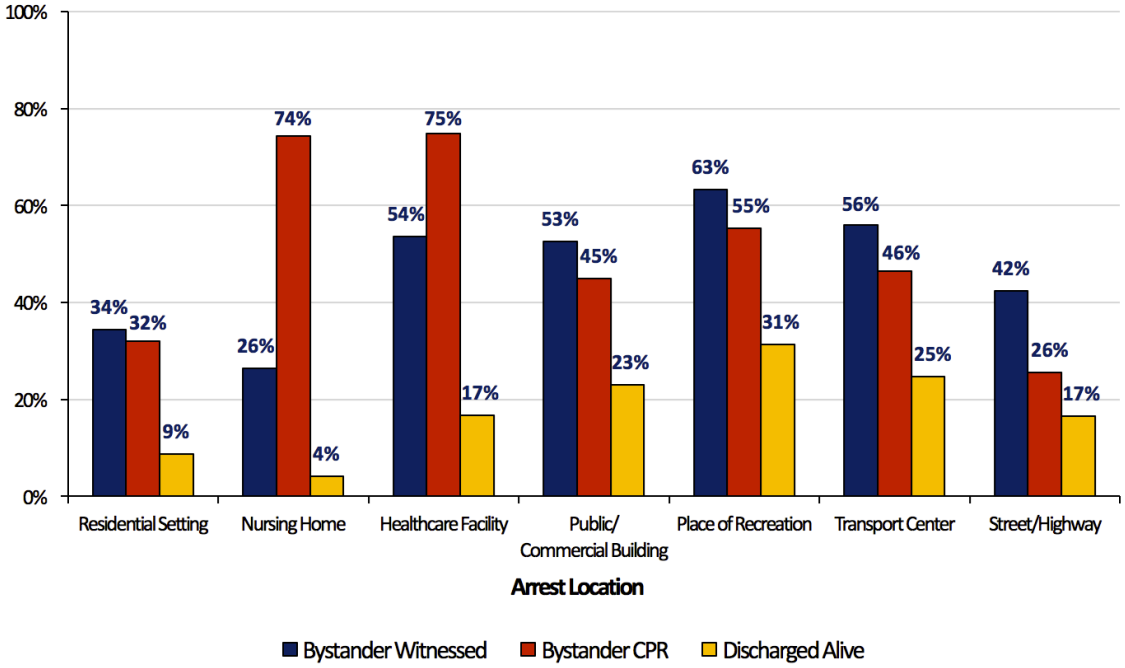


Figure 7. Percentage of events that are bystander witnessed, receive bystander CPR, and survive to hospital discharge by arrest location.

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 (51.1%), while 36.6% were bystander witnessed and 12.3% 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 4.6%, respectively; p<.0001), while patients with a 911 Responder witnessed arrest were nearly 4 times as likely to survive compared with unwitnessed arrests (18.1% vs 4.6%, respectively; p<.0001).

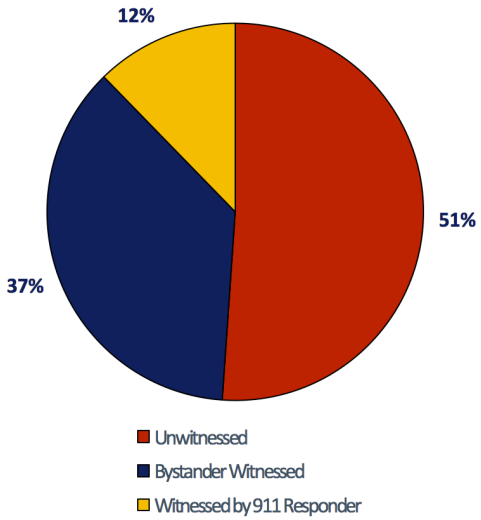


Figure 8. Arrest witness status.

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 (29.1% vs. 6.2%, p<.0001).

18.4% of patients presented with an initial shockable rhythm of ventricular fibrillation (VF) or ventricular tachycardia (VT), while 81.6% of patients presented in an unshockable rhythm, with asystole being the most common (50.2%). 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 (30.1% vs 10.0%, respectively; p<.0001) (Figure 9).

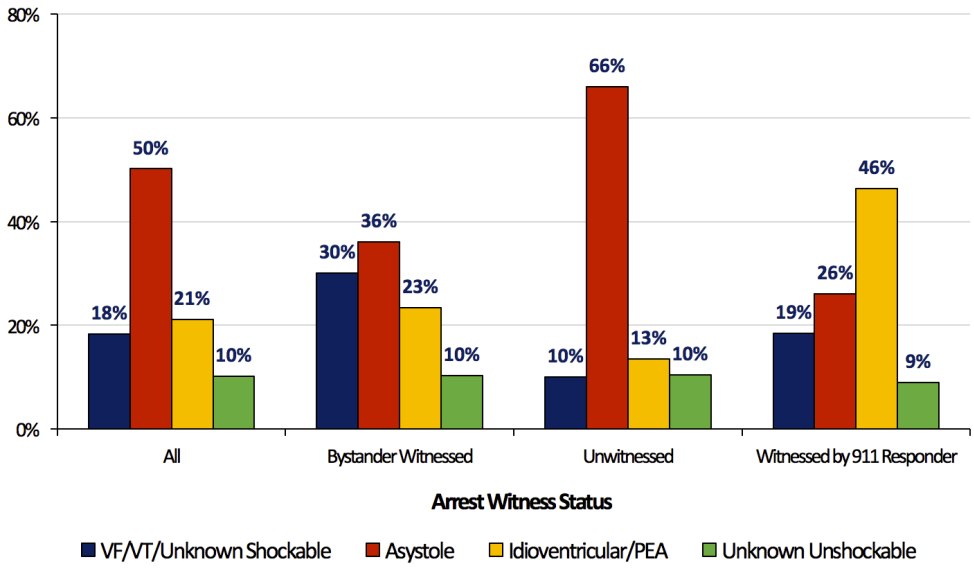
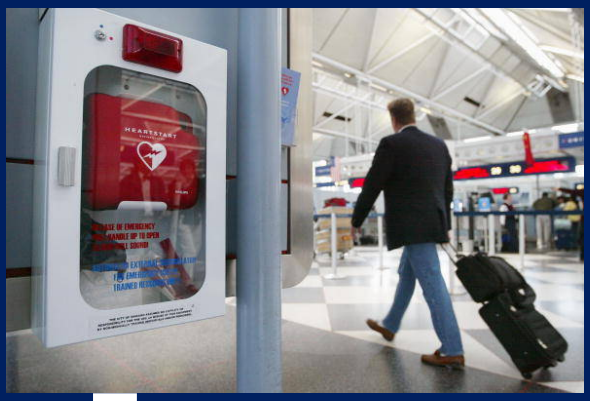


Figure 9. Presenting arrest rhythm by arrest witness status.

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 (21.3%) as well as those that were witnessed by a 911 Responder (12.3%), have been excluded from response time analyses.

In 2017, median response time by First Responders was 6.2 minutes (IQR: 4.8 - 8.6 minutes) and median response time by EMS was 7.3 minutes (IQR: 5.4 - 10.1 minutes). First Responders arrived on scene in ≤ 5 minutes for 31.2% of arrests, while EMS arrived on scene in ≤ 9 minutes for 67.6% of arrests.

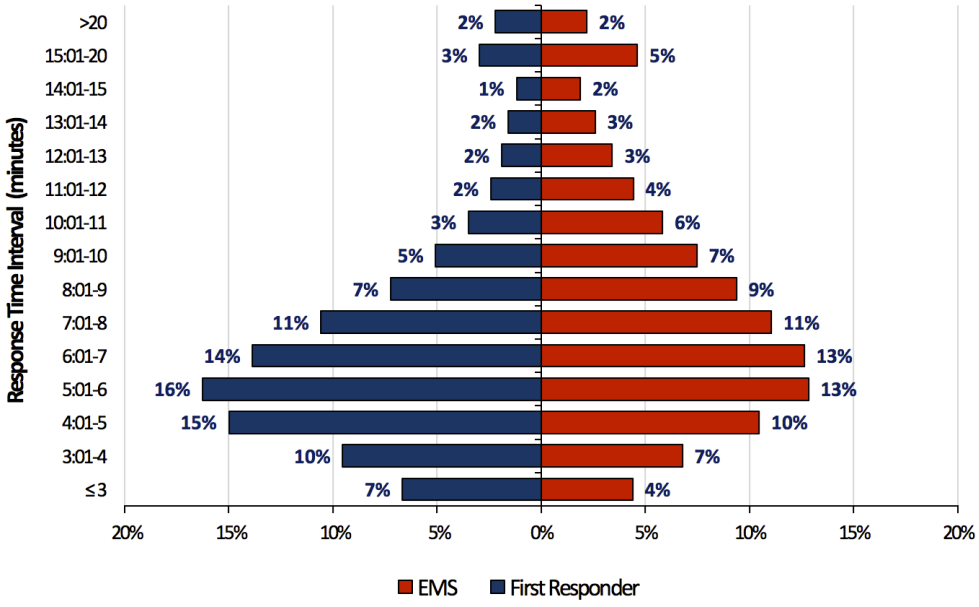


Figure 10. Distribution of First Responder and EMS response times (time interval from 911 call to arrival on scene).

Figure 11 is a bivariate analysis of survival 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.

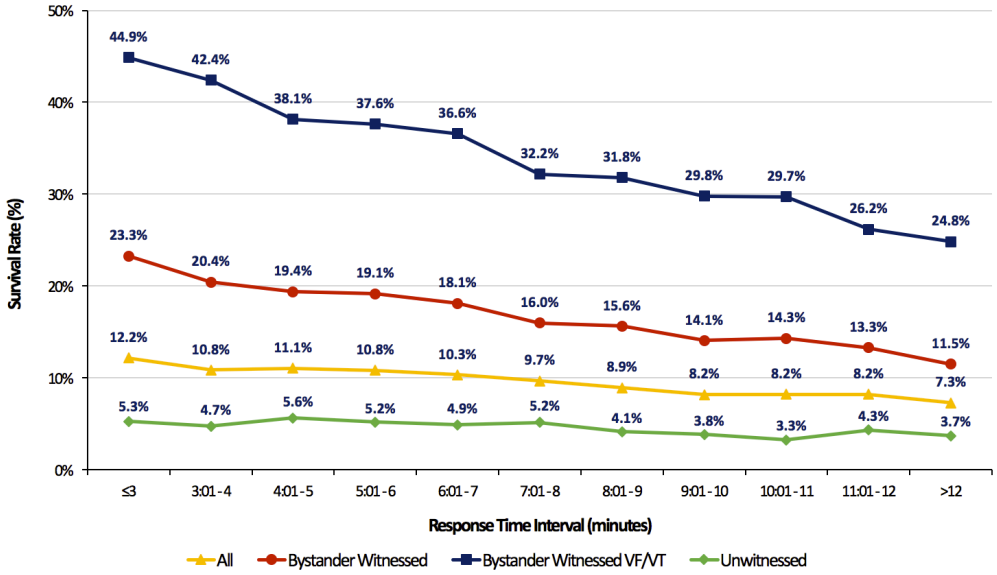


Figure 11. Survival rate by EMS response time and arrest witness status.

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.

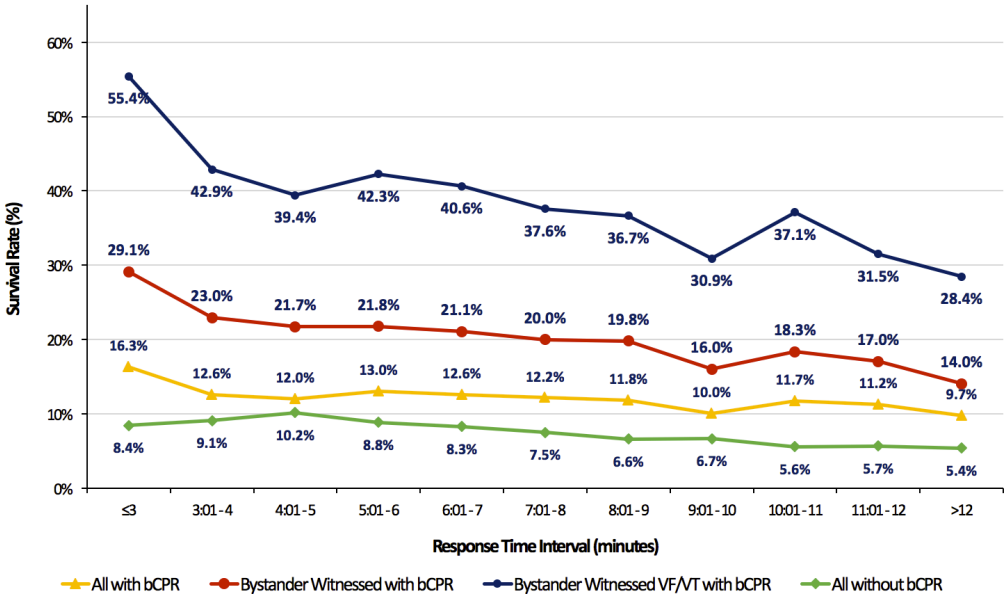


Figure 12. Survival rate by EMS response time and arrest witness status, among patients who received bystander CPR.

A telecommunicator at the Combined Communication Center in Spokane, Washington responds to 911 calls and provides dispatch for 15 local fire departments. *Photo courtesy of Spokane Fire Department.*

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 2017, bystander CPR was initiated on 38.2% 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 46.9% of bystander witnessed events, compared with 31.7% of unwitnessed events (p<.0001).

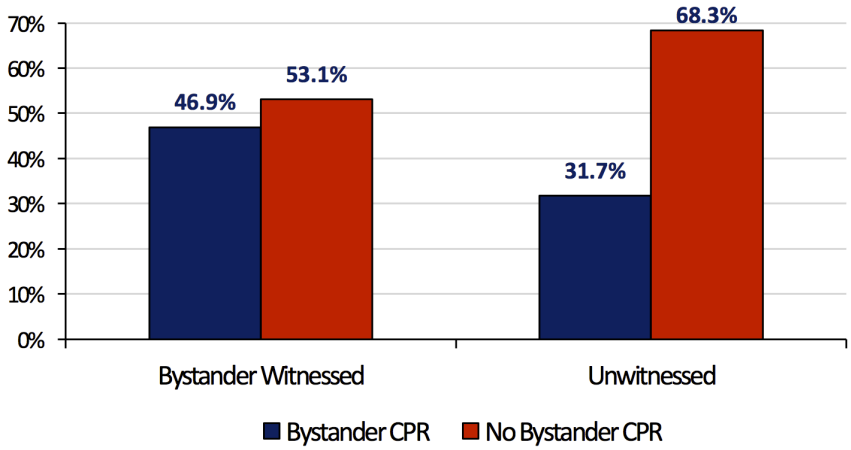


Figure 13. Bystander CPR provision by arrest witness status.

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 (13.7%) was significantly (p<.0001) higher than that of patients who did not receive bystander CPR (7.5%).

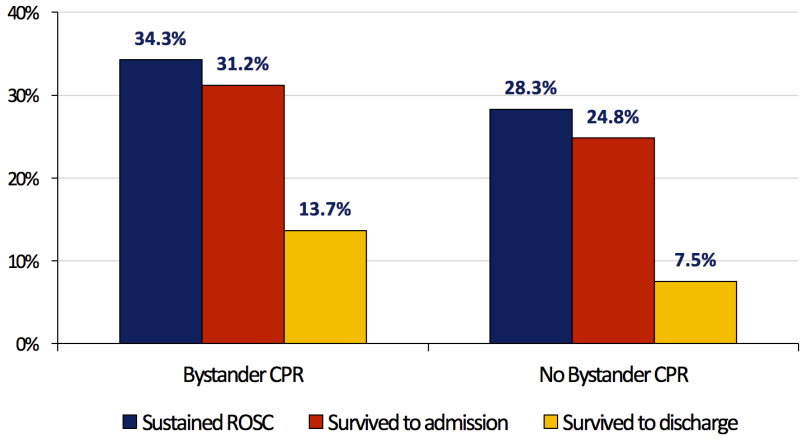


Figure 14. Unadjusted survival outcomes after bystander CPR.

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 11.4% of public arrests.

In 2017, 30.3% (n=23,100) of CARES patients were defibrillated in the field. The proportion of patients first defibrillated by a bystander was 5.2%, whereas 19.0% and 75.8% 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 49%, compared with 28% of patients first shocked by First Responders and 27% of patients first shocked by responding EMS personnel.

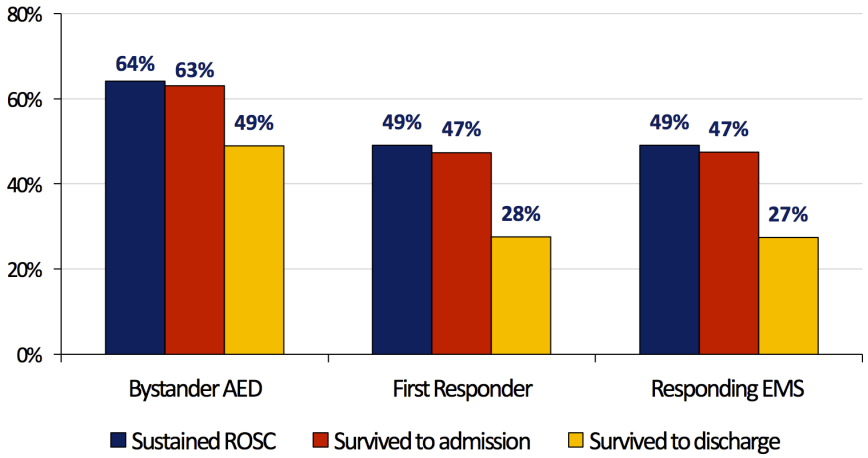


Figure 15. Unadjusted survival outcomes by who performed first defibrillation in the population with a shockable presenting rhythm.

Survival Outcomes

Patient Outcomes

On the basis of local EMS agency protocols, 35.7% of patients were pronounced on scene after resuscitative efforts were terminated in the pre-hospital setting, an increase from the last several years (30.3% in 2015 and 32.4% in 2016). A successful attempt at resuscitation in the field is often defined by a patient's return of spontaneous circulation (ROSC). In 2017, sustained ROSC (20 consecutive minutes of ROSC, or present at transfer of care to a receiving hospital) was achieved by 31.8% of CARES patients (Figure 16).

The rate of survival to hospital admission was 28.1% (ED outcome missing for 157 cases; 0.2%), and the rate of survival to hospital discharge was 10.4% (hospital outcome missing for 173 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).

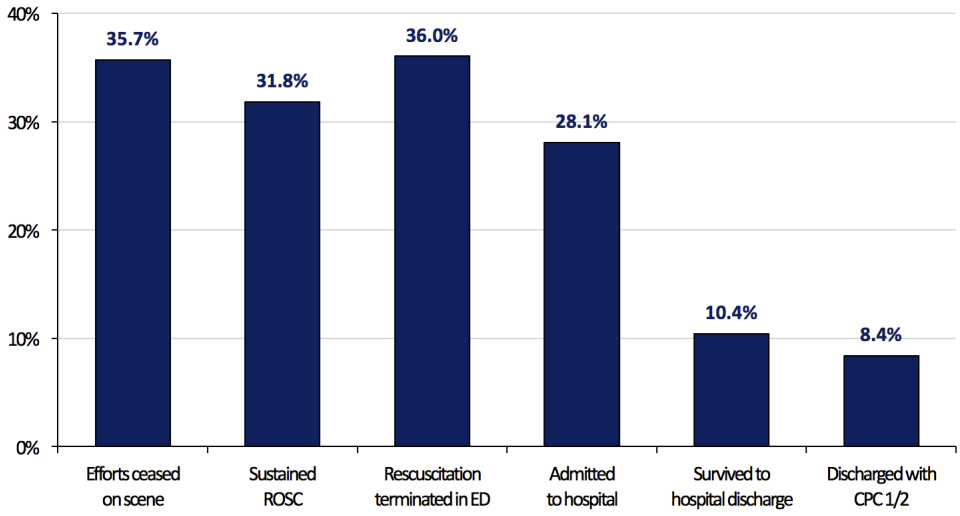


Figure 16. Unadjusted pre-hospital and in-hospital OHCA patient outcomes.

Table 3. Cerebral Performance Category (CPC) scores

CPC Score	Description
CPC 1	Good Cerebral Performance Conscious, alert, able to work and lead a normal life.
CPC 2	Moderate Cerebral Disability 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 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 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 (12.3 and 12.7%, respectively), whereas patients with an overdose-related arrest had a survival rate of 16.1%. Survival was lowest among patients with an arrest due to exsanguination or hemorrhage (4.0%) (Figure 17).

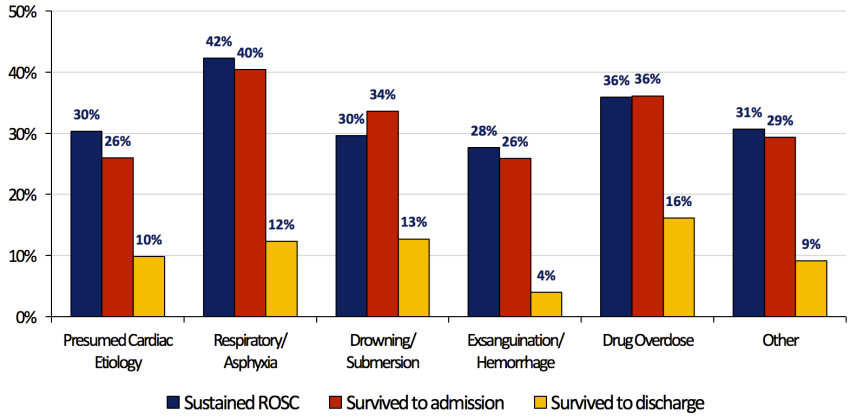


Figure 17. Unadjusted survival outcomes by arrest etiology.

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 48.5%, compared with 34.8% for those in PEA and 16.7% for those in asystole. Similarly, patients presenting in a shockable rhythm had a greater chance of being discharged alive (29.1%), compared with 10.1% of patients presenting in PEA and 2.4% of patients in asystole.

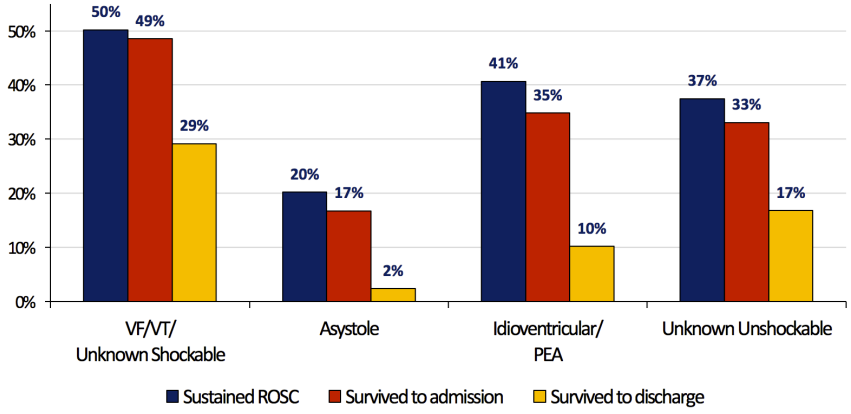


Figure 18. Unadjusted survival outcomes by presenting arrest rhythm.

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 (18.1%), followed closely by those with a bystander witnessed arrest (16.0%). In contrast, unwitnessed events had a survival rate of 4.6% (Figure 19).

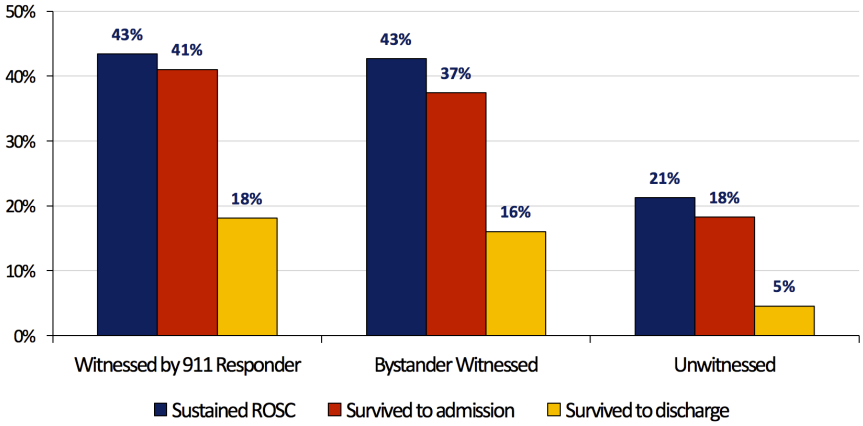


Figure 19. Unadjusted survival outcomes by arrest witness status.

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 2017. This report stratifies arrests by witness status and presenting rhythm. In 2017, the survival to hospital discharge rate for the Utstein subgroup was 32.6%. 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 36.5%.

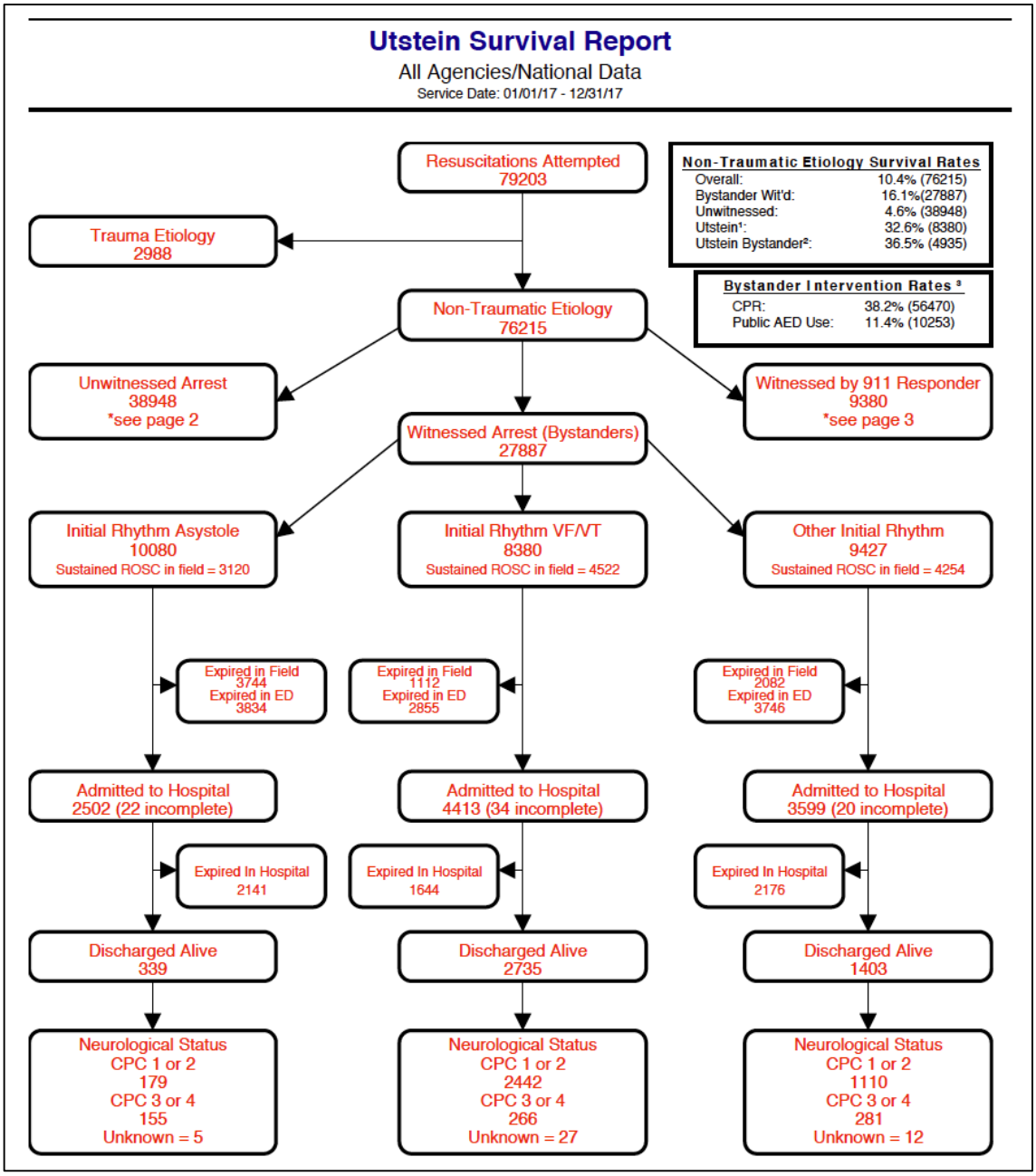


Figure 20. 2017 CARES Non-Traumatic Etiology Utstein Survival Report.

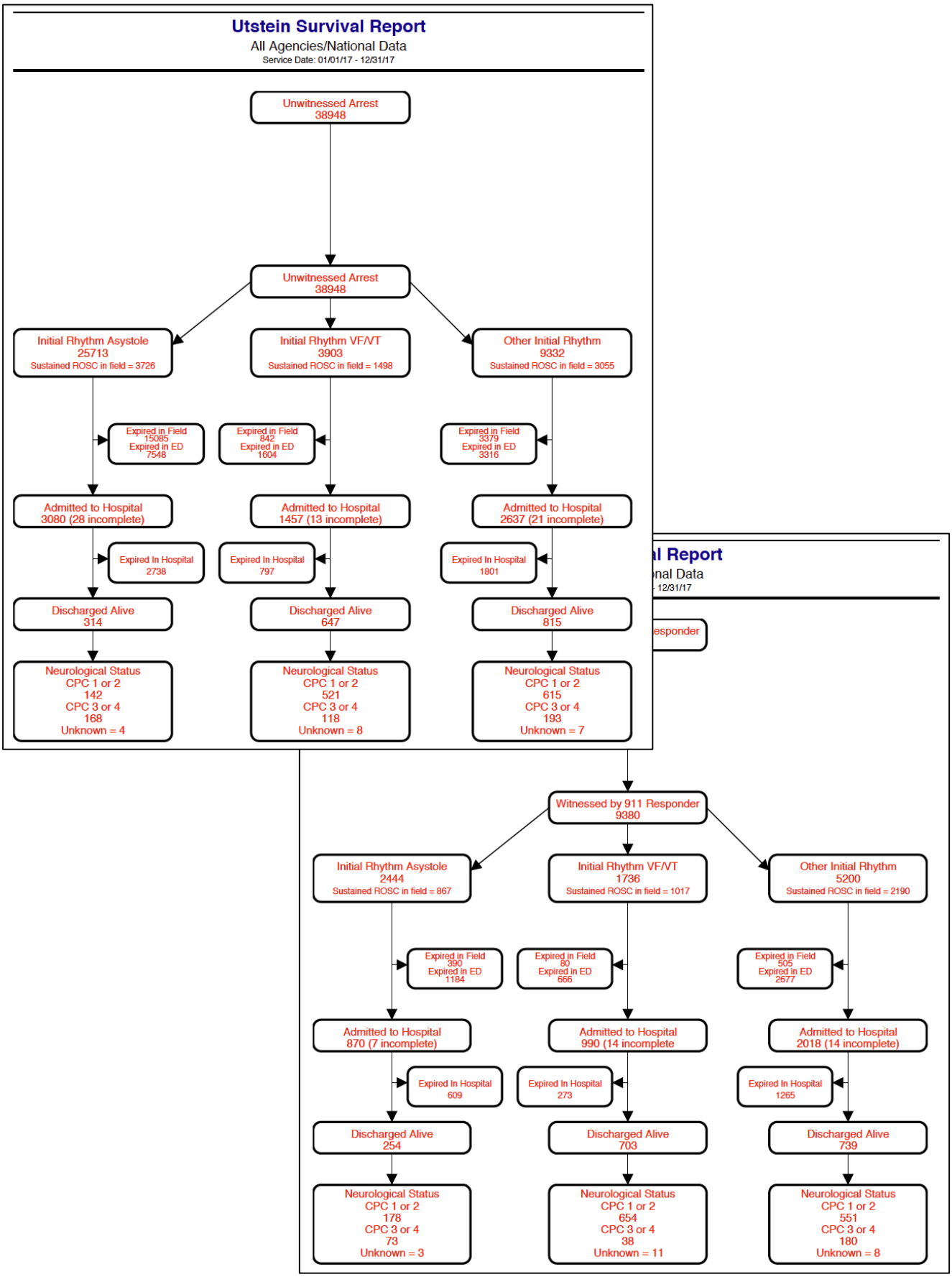


Figure 20. 2017 CARES Non-Traumatic Etiology Utstein Survival Report.

Prehospital and hospital teams transfer a patient safely to Children's National Health System in Washington, DC.
Photo courtesy of Children's National Health System.

Hospital Survival

New to CARES this year, the 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 2017.

Among all patients transported to a hospital, the survival to admission rate was 43.7% and the survival to discharge rate was 16.2%. Survival to hospital discharge was substantially higher among those who achieved sustained ROSC in the field (30.5%) compared with those who did not (2.5%), and among those who were transferred from another facility (46.0%) compared with patients who were transported directly by EMS (14.7%).

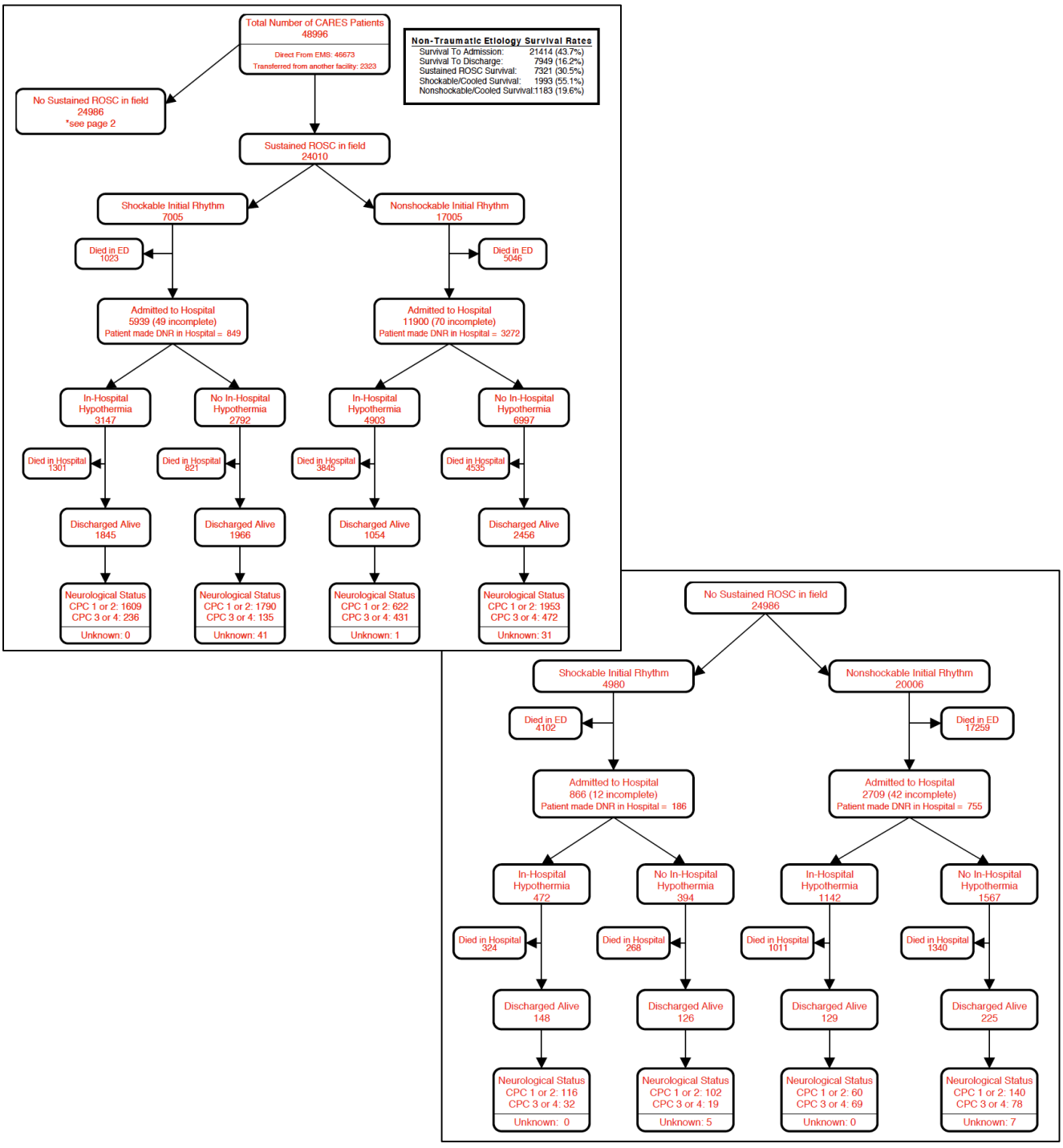


Figure 21. 2017 CARES Non-Traumatic Etiology Hospital Survival Report.

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 125 EMS agencies with ≥150 CARES cases in 2017. These figures highlight the significant variability among participating agencies (ranges: overall survival 2.9 - 21.1% (7-fold difference in survival); Utstein survival 0 - 76.5%; bystander CPR 6.3 - 81.3% (12-fold difference in bystander CPR). The bars in each figure represent communities with an underlying patient population ranging from 100,000 to over 2 million. The red dotted line denotes the national average for benchmarking purposes (overall survival: 10.4%; Utstein survival: 32.6%; bystander CPR 38.2%).

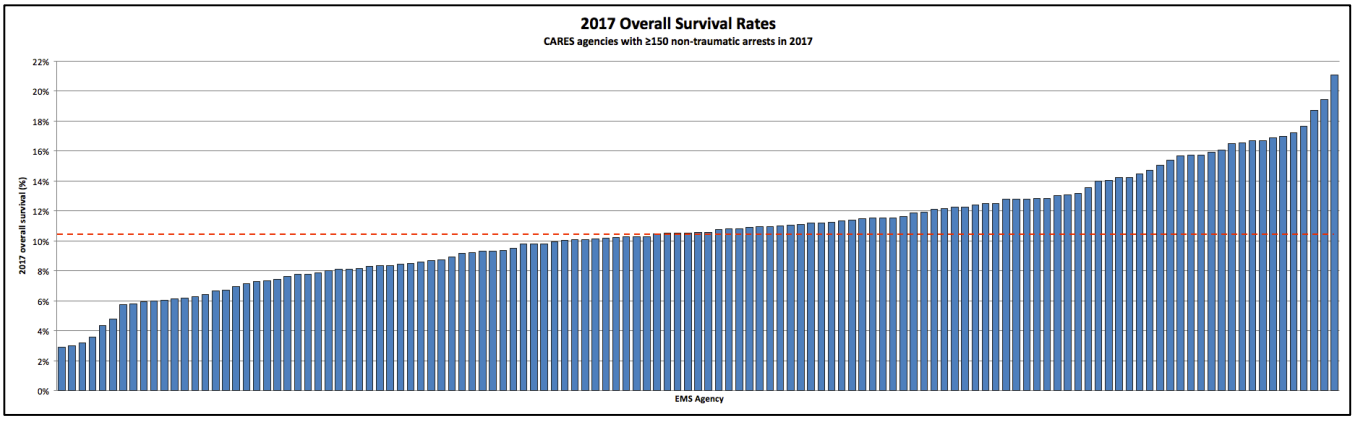


Figure 22. Variability in overall survival rates, among EMS agencies with ≥150 CARES cases in 2017.

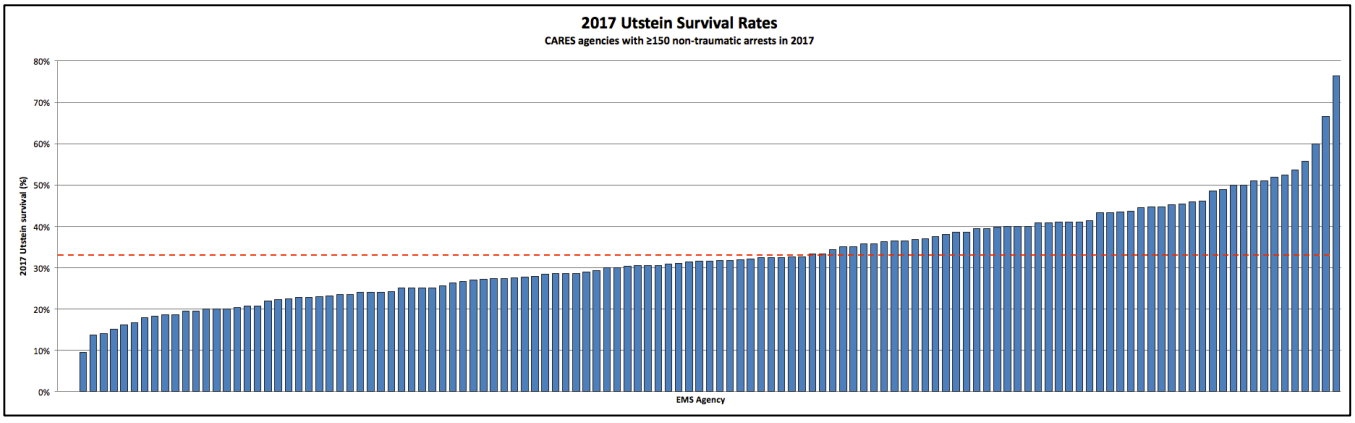


Figure 23. Variability in Utstein survival rates, among EMS agencies with ≥150 CARES cases in 2017.

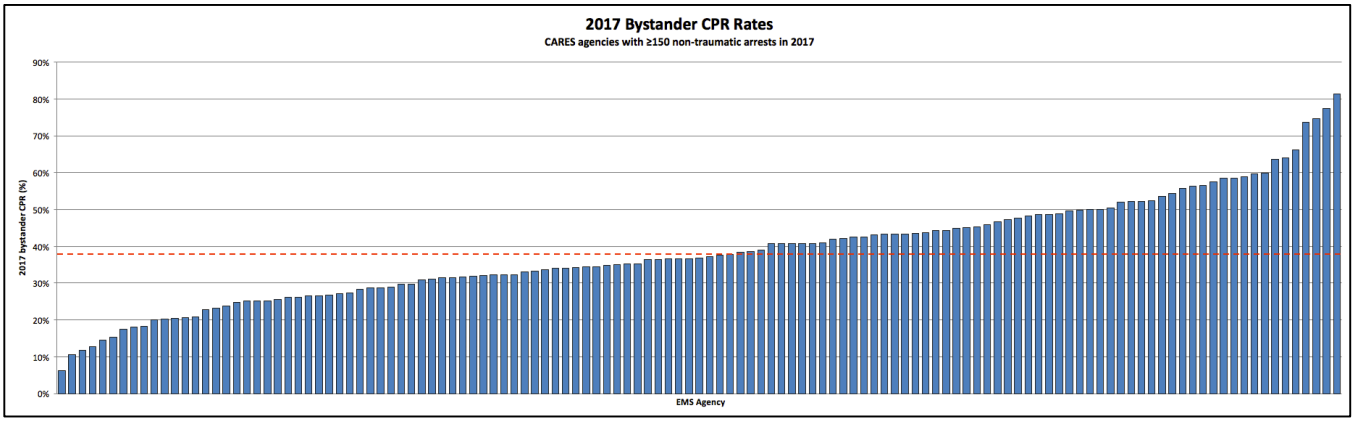


Figure 24. Variability in bystander CPR rates, among EMS agencies with ≥150 CARES cases in 2017.

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 2019). The unadjusted 2017 rates for this cohort are listed in Table 4.

Table 4. CARES Healthy People Metrics, 2017	
Bystander CPR	38.8%
Bystander AED use in public locations	11.7%
Survival to discharge among patients who received bystander CPR and/or AED application	14.0%
Survival to discharge among Utstein bystander patients	37.8%

2017 Research Highlights

Peer-Reviewed Publications

- Shah M, Bartram C, Irwin K, Vellano K, McNally B, Gallagher T, Swor R. **Evaluating Dispatch-Assisted CPR Using the CARES Registry**. *Prehospital Emergency Care*. Dec 8:1-7.
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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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A Paramedics Plus crew responds to an out-of-hospital cardiac arrest in Sioux Falls, South Dakota.
Photo courtesy of Sioux Falls Regional Emergency Medical Services Authority (REMSA); Photo credit: Matthew Gruchow.

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