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Epidemiology



Bulletin

Recommendations
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Reports

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Out-of-Hospital Cardiac Arrest Survival and the CARES Registry: The Alaska Experience, 2012–2016

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Executive Summary

Out-of-hospital cardiac arrest (OHCA) is a leading cause of death among Alaska adults. Nationwide, there can be as much as a ten-fold difference in the likelihood of surviving such an event, depending upon the community in which it occurs. Communities with better outcomes tend to be those that have instituted a chain of survival that includes participation in a data registry, which allows objective monitoring of outcomes and the metrics associated with improvement in those outcomes. The Municipality of Anchorage has participated in such a registry for over a decade and has achieved survival outcomes that have exceeded the national average. Over the past 6 years, a growing number of Alaska communities have joined this registry. The expanded availability of registry data can help communities determine opportunities for system improvements that could ultimately result in lives saved.

Introduction

Out-of-hospital cardiac arrest (OHCA) is a leading cause of death in the United States and has the potential to leave those who do survive with irreversible disability.¹ Nearly 400,000 patients suffer OHCA in the United States every year, with only about 10% surviving to hospital discharge.² Many people who suffer OHCA can be resuscitated with good neurologic outcomes in communities that devote sufficient resources to develop their chain of survival.³

A successful resuscitation from cardiac arrest requires the performance of a series of appropriate actions along the entire “chain of survival.” This system of care begins with citizen training on how to perform cardiopulmonary resuscitation (CPR), how to use an automatic electronic defibrillator (AED), and how to activate emergency medical services (EMS) by calling 911. The EMS response begins with a public safety access point (911) that can rapidly recognize cardiac arrest, provide CPR instructions, and dispatch responders. The timely arrival of trained rescuers to continue resuscitation and provide post-resuscitation care and transport is of paramount importance. Best-practice hospital care is the final necessary component required to achieve a successful discharge of the patient back to the community with a good neurologic outcome.

No national surveillance system for OHCA currently exists. In 2015, the National Academies of Sciences published *Strategies to Improve Cardiac Arrest Survival: A Time to Act*.³ This report illustrates how national heterogeneity in OHCA data sources and definitions has resulted in varying estimates of OHCA incidence, as well as a wide range of survival estimates that may reflect demographic risk factors, but also EMS- and hospital-system-level factors.⁴⁻⁷ One way to decrease heterogeneity in OHCA data is to follow a uniform reporting template to describe OHCA events. First published in 1991 by the International Liaison Committee on Resuscitation, the so-called *Utstein Style* (named after the Norwegian abbey at which the conference was held) is the international standard for the uniform tracking of cardiac arrests in both in-hospital and out-of-hospital settings.

The Utstein Style is a set of definitions and reporting templates that were developed to more systematically capture OHCA data and to promote international consensus on resuscitation guidelines. The Utstein Style defines OHCA as meeting each of the following *criteria*: a resuscitation is attempted, no pre-hospital “Do Not Resuscitate” (DNR) orders are stated, the etiology is non-traumatic, a bystander without EMS

training was present, and the patient was found to be in a cardiac rhythm likely to be responsive to electric shock delivered by an AED. The Utstein Style is endorsed by the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council.⁸ This style was updated in 2015 and the elements are shown in Table 1.⁹ One common way of displaying Utstein survival for OHCA is through the use of an Utstein Survival Report, which stratifies arrests into three categories (unwitnessed, witnessed by bystander, and witnessed by EMS personnel) and by the type of initial cardiac rhythm (Figure 1).¹⁰

Established in 2004 by Emory University and the Centers for Disease Control and Prevention (CDC), the Cardiac Arrest Registry for Enhanced Survival (CARES) is a secure, web-based OHCA data management system.¹¹ CARES allows participating sites to enter their local OHCA-related data using the Utstein Style, generate summary reports, and compare local data with similar communities elsewhere. Communities can compare their performance data to de-identified aggregate statistics at the local, state, or national level. Access to the site is restricted to authorized users; users are prohibited from viewing identifiable data elements from another agency or hospital.

The ultimate goal of CARES is to help communities identify when and where OHCA events occur, who is affected, which elements of the response system are functioning properly and which are not, and what changes can be made to improve cardiac arrest outcomes.¹² Collecting these elements allows communities to make informed decisions on how to improve their processes and performance and evaluate the efficiency of their system.

Trends and gaps in systems of care may be identified to provide evidence for changes in practices and protocols; the CARES mantra is “Measure-Improve.”¹³ CARES allows agencies and hospitals to benchmark themselves against state and national numbers on a yearly basis.¹⁴

The Anchorage Fire Department started participating in CARES in 2007. Additional EMS groups throughout Alaska began participating in CARES in 2012 as a result of the HeartRescue effort to improve outcomes from OHCA by improving resuscitation (<http://www.heartrescueproject.com/>). By 2016, 96% of the state’s population lived in an area covered by an agency participating in CARES.¹⁵ Participating Alaska EMS agencies and hospitals and year of first participation are summarized in Table 2.

CARES Registry Methodology

The CARES registry includes data on persons who have a non-traumatic out-of-hospital cardiac arrest and who received either resuscitative efforts by a 911 responder or persons who were shocked by an AED prior to EMS arrival. Calls recorded as “obvious death”, persons with DNR orders, and injuries of traumatic etiology are excluded from analyses.¹⁶

The data elements that are collected include Utstein criteria variables (i.e., a resuscitation is attempted, no pre-hospital DNRs are stated, the etiology is non-traumatic, a bystander without EMS training was present, and the patient was found to be in a cardiac rhythm likely to be responsive to electric shock delivered by AED) and data helpful for evaluating various aspects in the chain of survival. Data obtained

from 911 call centers, EMS providers, and hospitals are linked to portray each OHCA event (see below).

1) 911 Call Centers

- **Data elements:** incident location, time 911 call was received, time of dispatch for both first responder and EMS providers, and time of arrival at the scene.
- **Data entry:** Data are entered directly online or uploaded in batched files from a computer-aided dispatch center (CAD).
- **Data notes:** A wide variation in how response-time elements are defined in each community prevents aggregation of response-time data on a national level. Instead, these data are typically used for local benchmarking, with historic data used for comparison.

2) EMS Providers

- **Data elements:** Patient demographic information (i.e., name, age, date of birth, address of event, sex, and race/ethnicity); any event-specific information (i.e., location of event, witnessed versus unwitnessed arrest, and presumed etiology); and resuscitation-specific information (i.e., whether resuscitation was attempted, bystander-initiated CPR information, who initiated defibrillation, initial cardiac rhythm, return of spontaneous circulation, and prehospital survival status).
- **Data entry:** Data are entered directly online using a data-entry template on the CARES website or uploaded directly from EMS services that use an electronic patient-care record system.
- **Data notes:** Data entry checks are embedded in the software to help minimize errors and to enhance the accuracy of the data collection process. Each EMS agency also has a method to make sure that all of its resuscitation efforts are reported, which involves either an electronic query of its electronic patient-care record system or a manual review of its paper charts.

3) Hospitals

- **Data elements:** Emergency department outcome (i.e., admitted, died, or transferred); hospital outcome (i.e., discharged alive, died, or transferred); patient disposition (i.e., discharged home or transferred to a second hospital, a rehabilitation facility, or a skilled nursing facility); neurologic outcome at discharge as determined by using the Cerebral Performance Category (CPC) Scale (Table 3); whether therapeutic hypothermia treatment was provided; and whether the patient had a cardiac catheterization study with or without stent placement or required cardiopulmonary bypass or placement of an automatic internal defibrillator.
- **Data entry:** If EMS providers document ongoing resuscitation in the emergency department, the CARES software automatically sends the designated hospital contact a reminder via e-mail that prompts the contact to log in to the CARES website and provide the missing information on outcomes to complete the data collection process. A hospital contact who logs in to the secure CARES website is able to determine the patient's name, date of birth, and date of admission as entered by the EMS provider. The hospital contact is then able to review the discharge summary or hospital emergency department log and quickly determine the survival status and neurologic outcomes requested.

- **Data notes:** Neurologic outcome information is crucial to the value of this registry; it represents the ultimate goal in optimizing survival.

Data are entered by staff at each facility; the state CARES coordinator (located in Seattle, WA) collates the data to generate a detailed record for a single patient event. If a community uses a unique identifier number, CARES uses that number to link the 911 call center, EMS, and hospital datasets to form a complete record for each event. When a unique number does not exist, the files are linked by matching the patient name and age with the event time, date, and location. To preserve patient confidentiality, individual identifiers are removed from each record. The state CARES coordinator confirms the completeness and accuracy of each event.

Registry data are used for a variety of purposes, such as obtaining metrics on the EMS system, quality assurance, and calculating overall and Utstein survival rates. The Utstein survival rate is defined as persons who met the Utstein criteria for OHCA (see above) and survived to hospital discharge.

Alaska CARES 2012–2016 Data Summary

Alaska CARES data from 2012–2016 came from 11 participating Alaska EMS agencies (Table 2).

- During 2012–2016, the survival rates in Alaska among OHCA patients who had resuscitation attempted in the pre-hospital setting were higher than the national average for patients who met the “overall” and the “Utstein” criteria (Figure 2).
- During 2012–2016, the proportion of OHCA patients that had resuscitation attempted in the pre-hospital setting in Alaska, met the “overall” criteria for OHCA, and had good neurologic outcomes (CPC 1 or CPC 2; Table 3) at hospital discharge ranged from 13%–16% (Figure 3).
- During 2012–2016, the proportion of OHCA patients who received CPR in the pre-hospital setting that was *initiated by a bystander* increased considerably in Anchorage and statewide (Figure 4).
- During 2012–2016, among OHCA patients who had resuscitation attempted in the pre-hospital setting, overall survival rates were generally higher if the event was witnessed by a bystander and the patient was found to be in a rhythm where electric cardioversion would be indicated (Figure 5). However, while the numbers are small, it is important to note that 9–12% of patients whose OHCA was not witnessed by a bystander and who were found to be in a rhythm where electric cardioversion would not be indicated (e.g., pulseless electrical activity and asystole) survived to hospital discharge with good neurologic outcomes (Figure 5).
- In 2016, the majority of OHCA reported in Alaska CARES were of presumed cardiac etiology. Other notable etiologies included respiratory/asphyxia and drug overdose (Figure 6).

Discussion

Data from this brief report indicate that during 2012–2016, a) the proportion of OHCA patients who received CPR that was *initiated by a bystander* in the pre-hospital setting increased considerably in Alaska,

b) the survival rates in Alaska among OHCA patients who had resuscitation attempted in the pre-hospital setting were higher than the national average, and c) most OHCA patients who survive to hospital discharge in Alaska (and nationwide) are discharged with good neurologic outcomes.

CARES registry data are used for surveillance and quality improvement purposes to monitor trends over time and to highlight specific parts of the chain of survival in need of improvement. 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.¹⁷ For example, CARES data were useful for the Anchorage Fire Department in determining that their 911 response system needed to be improved to achieve better outcomes. In the past, the department used a standard proprietary system for 911 call-taking, including the provision of dispatcher-assisted CPR. Initially, the goals of achieving shorter times to CPR and increasing bystander participation were not being met. A different system was adopted in May of 2014 that included as part of its structure the “all-caller interview” for calls placed by someone other than the patient, which starts with two simple questions: 1) is the patient awake and alert? If “NO” then 2) is the patient breathing normally? If “NO” then the dispatcher tells the caller to start CPR. Subsequent review showed a considerable decrease in time to dispatcher recognition of cardiac arrest, decrease in time to first chest compression, and higher compliance with bystander CPR.

CARES provides an annual executive report that allows agencies to compare their performance to national benchmarks.¹⁷ This report includes an executive summary, demographics and national numbers, survival outcomes, research highlights, and information on why CARES matters. In the 2017 CARES Annual Report, Criteria Based Dispatch in Anchorage was highlighted for notable performance.¹⁷

In conclusion, the CARES registry offers a vital source of actionable information for improving survival from OHCA by addressing those links in the chain of survival showing the greatest opportunity for improvement. Various metrics can be obtained to review a range of factors involved in OHCA survival including response times, community engagement, bystander CPR training, and circumstances where laypersons identified OHCA early enough to activate the chain of survival in a timely manner. Stakeholders are encouraged to review data that are specific to their own systems and communities to identify areas of success and areas in need of improvement. Agencies and hospitals should review their outcomes data over time to identify temporal trends. Such reviews can be useful for establishing new benchmark goals to further improve survival rates. Lastly, the utility of OHCA registries as an important tool for improving OHCA survival has been emphasized by recent reports by the National Academies of Sciences and CDC.^{3,18}

Table 1. International Liaison Committee on Resuscitation: Core and Supplemental Data Elements

Domain	System	Dispatch	Patient	Process	Outcomes
Core	Population served	Dispatcher-identified cardiac arrest	Age	Response times	Survived event
	Cardiac arrests attended	Dispatcher CPR instructions	Gender	Defibrillation time	Any ROSC 30-day
	Resuscitation attempted		Witnessed arrest	Target temperature control	Survival-to-discharge
	System description		Arrest location	Drugs	Neurologic outcome
			Bystander CPR/AED	Reperfusion attempted	
			First monitored rhythm		
			Arrest etiology		
Supplemental	DNAR legislation		Independent living	Airway control type	Transport to hospital
	Termination of resuscitation rules		Comorbidities	Number of shocks	Treatment withdrawal
	Dispatch software used		Presence of STEMI		Cause of death
	Resuscitation algorithms followed		Ventricular assist devices		Organ donation
	Data quality activities		Cardioverter-defibrillator		Patient-reported outcome measures
	Prehospital EKG capability				Quality-of-life measures
					12-month-survival

NOTE: AED = automated external defibrillator; CPR = cardiopulmonary resuscitation; DNAR = do not attempt resuscitation; EKG = electrocardiogram; ROSC = return of spontaneous circulation; STEMI = ST-segment elevated myocardial infarction.

Source: Perkins et al., 2014. Adapted with permission from the American Heart Association, 2015.

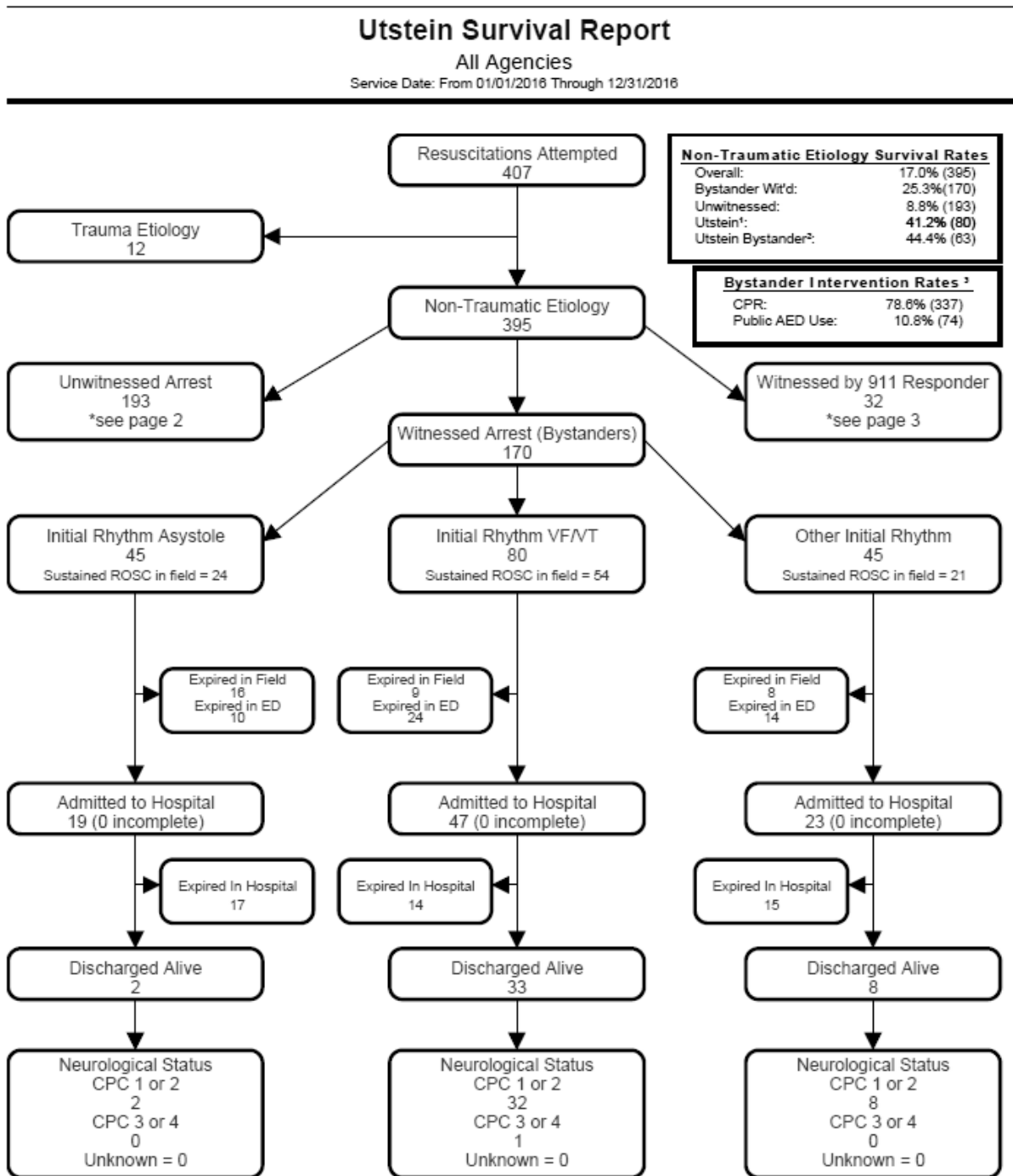
Table 2. Emergency Medical Services (EMS) Agency Enrollment in CARES, by Year of Enrollment and Corresponding Hospital — Alaska 2007–2017

Participating EMS Agency	Participating Years (Shaded)							Corresponding Hospital
	2007–2011	2012	2013	2014	2015	2016	2017	
Anchorage Fire Department*	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Providence Alaska Medical Center, Alaska Regional Hospital, Alaska Native Medical Center
Capital City Fire and Rescue		Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Bartlett Regional Hospital
Mat-Su Borough Department of Emergency Services		Shaded	Shaded	Shaded	Shaded	Shaded	Shaded	Mat-Su Regional Medical Center
Central Emergency Services			Shaded	Shaded	Shaded	Shaded	Shaded	Central Peninsula Hospital
Ketchikan Fire Department			Shaded	Shaded	Shaded	Shaded	Shaded	PeaceHealth Ketchikan Medical Center
Nikiski Fire Service Area			Shaded	Shaded	Shaded	Shaded	Shaded	Central Peninsula Hospital
Sitka Fire Department			Shaded	Shaded	Shaded	Shaded	Shaded	Sitka Community Hospital, SEARHC/Mt. Edgumbe Hospital
North Pole Fire Department					Shaded	Shaded	Shaded	Fairbanks Memorial Hospital
Steese Fire Department					Shaded	Shaded	Shaded	Fairbanks Memorial Hospital
University of Alaska Fairbanks Fire Department					Shaded	Shaded	Shaded	Fairbanks Memorial Hospital
Fairbanks Fire Department						Shaded	Shaded	Fairbanks Memorial Hospital
Anchor Point Fire and Emergency Services							Shaded	South Peninsula Hospital

Table 3. Cerebral Performance Category (CPC) Scale

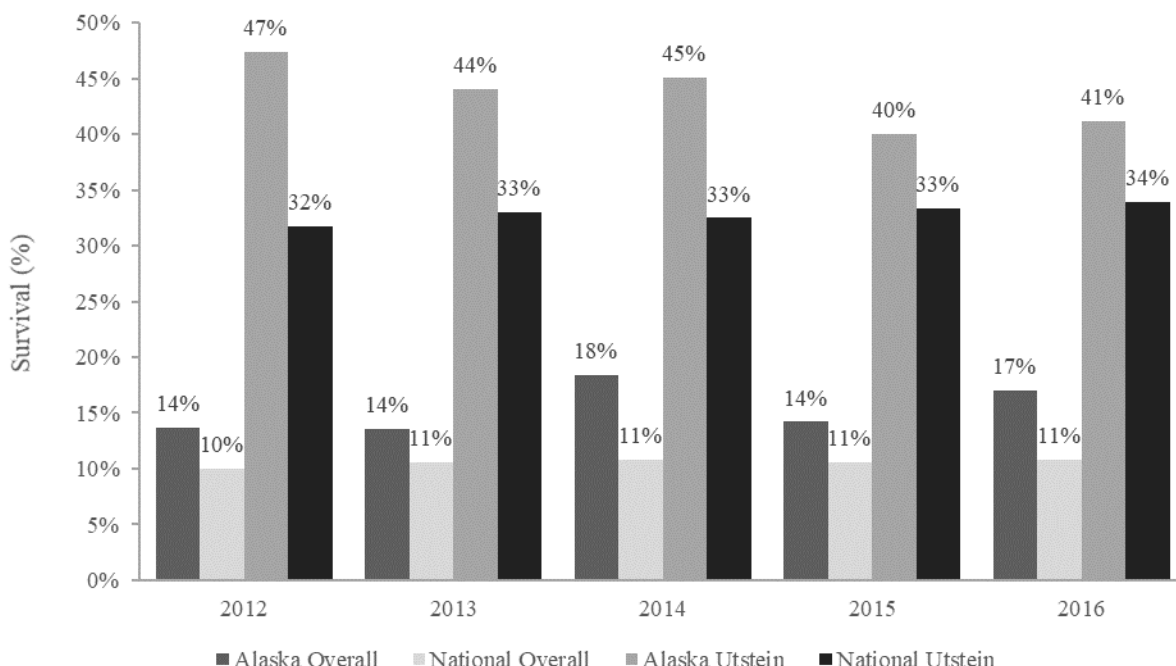
Neurologic Outcome at Discharge from Hospital	Definition
Good Cerebral Performance (CPC 1)	Conscious, alert, able to work and lead a normal life.
Moderate Cerebral Disability (CPC 2)	Conscious and able to function independently (dress, travel, prepare food), but may have hemiplegia, seizures, or permanent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

Figure 1. Example of Utstein Survival Report — Alaska Statewide Data, 2016



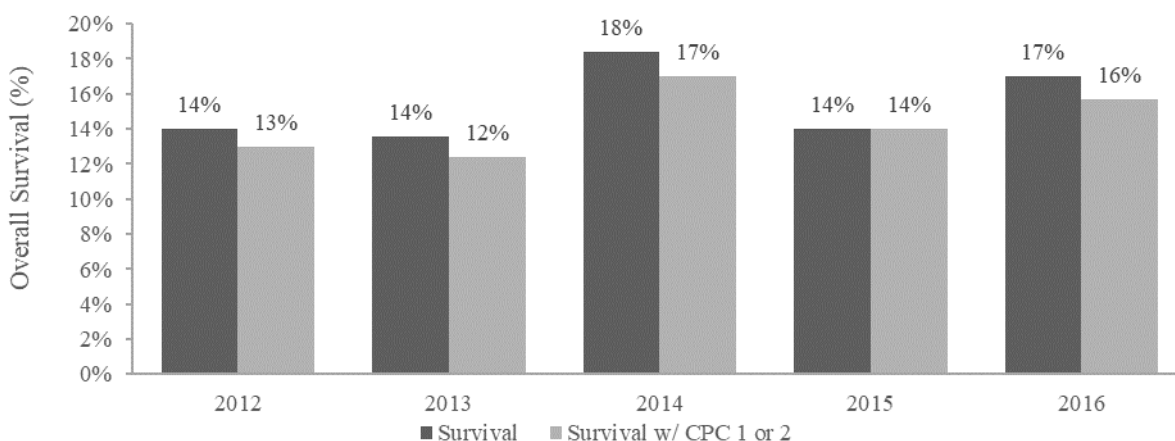
¹Utstein: Witnessed by bystander and found in shockable rhythm.
²Utstein Bystander: Witnessed by bystander, found in shockable rhythm, and received some bystander intervention (CPR and/or AED application).
³Bystander CPR rate excludes 911 Responder Witnessed, Nursing Home, and Healthcare Facility arrests. Public AED Use rate excludes 911 Responder Witnessed, Home/Residence, Nursing Home, and Healthcare Facility arrests.
 *Only data from the previous calendar year is fully audited. Data from the current calendar year is dynamic.

Figure 2. Proportion of Out-of-Hospital Cardiac Arrest Patients that had Resuscitation Attempted in the Pre-Hospital Setting and Survived to Hospital Discharge, by “Overall Survival” and “Utstein Survival” Criteria* — Alaska and the United States, 2012–2016



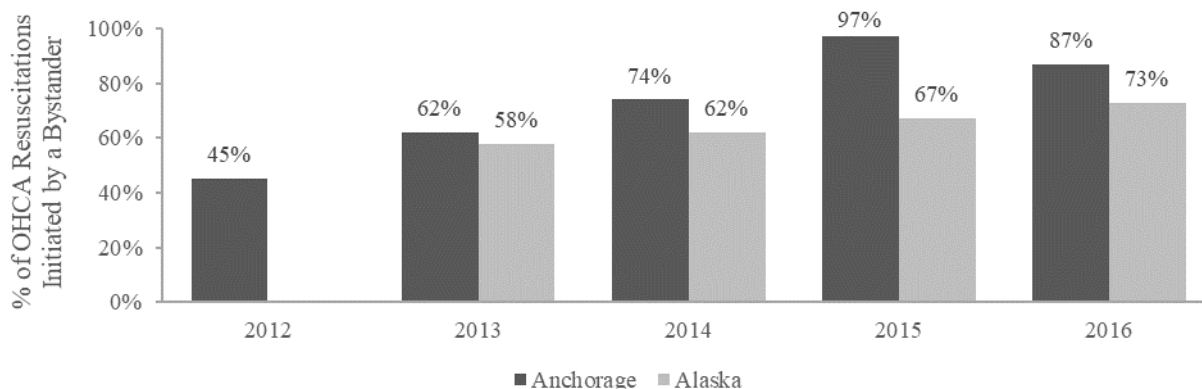
*Overall survival: proportion of patients that survived a non-traumatic out-of-hospital cardiac arrest that had a resuscitation attempted and no previously stated do-not-resuscitate order (DNR). Utstein survival: proportion of patients that survived a non-traumatic out-of-hospital cardiac arrest that had a resuscitation attempted, no pre-hospital DNRs were stated, the etiology was non-traumatic, a bystander without EMS training was present, and the patient was found to be in a cardiac rhythm likely to be responsive to electric shock delivered by an automatic electronic defibrillator.

Figure 3. Proportion of Out-of-Hospital Cardiac Arrest Patients that had Resuscitation Attempted in the Pre-Hospital Setting and Survived to Hospital Discharge, by “Overall Survival” and “Good Neurologic Outcome” Status* — Alaska, 2012–2016



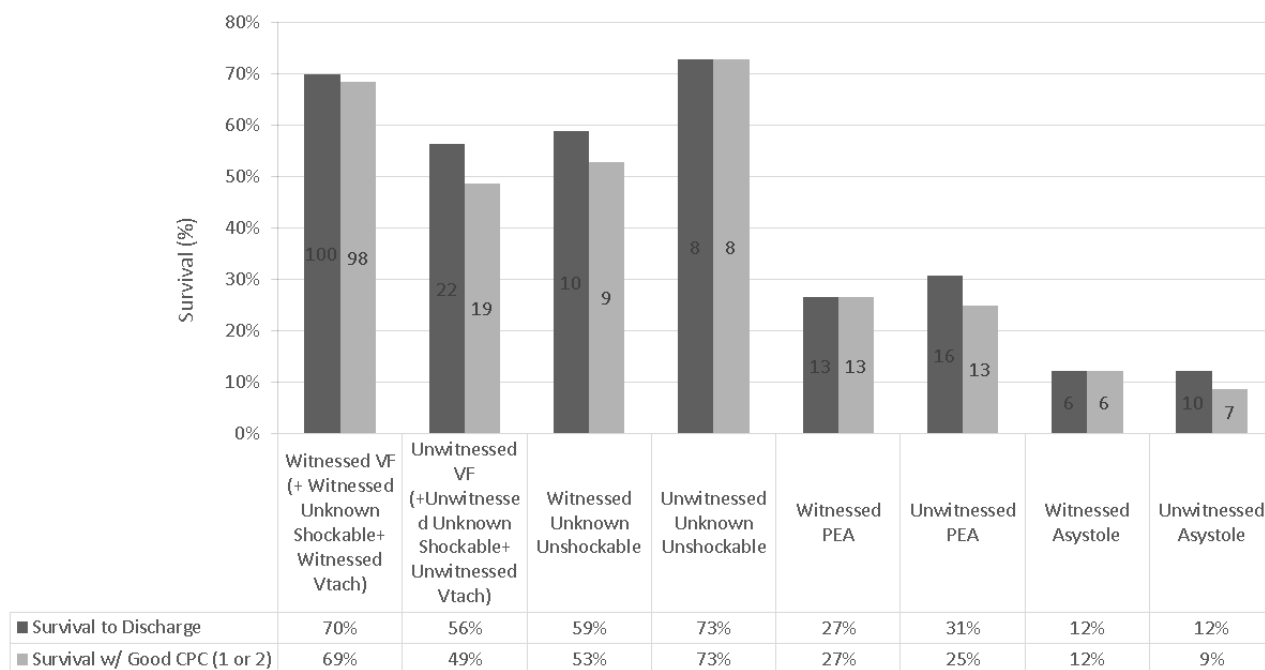
*Overall survival: proportion of patients that survived a non-traumatic out-of-hospital cardiac arrest that had a resuscitation attempted and no previously stated do-not-resuscitate order. Good neurologic outcome: patients who survived with a Cerebral Performance Category (CPC) 1 or CPC 2 upon hospital discharge (see Table 3).

Figure 4. Proportion of Out-of-Hospital Cardiac Arrest (OHCA) Patients whose Resuscitation Attempt in the Pre-Hospital Setting was Initially Conducted by a Bystander — Anchorage and Alaska*, 2012–2016



*Statewide data were not available for 2012.

Figure 5. Proportion of Out-of-Hospital Cardiac Arrest (OHCA) Patients who were Admitted to the Hospital* and Survived to Hospital Discharge,† by Witnessed Status,‡ Initial Rhythm, and Neurologic Outcome Status± — Alaska, 2012–2016



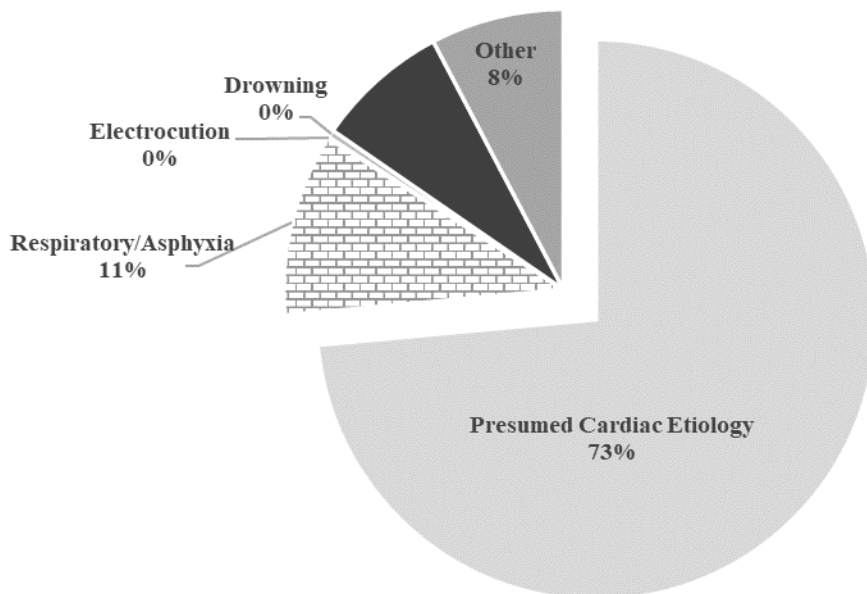
*The denominator for proportions displayed in this figure represent the subset of OHCA patients who survived at least long enough to be admitted to the hospital. (Note: The denominators for proportions displayed in Figures 2 and 3 are larger in that they also include OHCA patients who expired in the field or in the emergency department.)

† Overall survival: proportion of patients that survived a non-traumatic out-of-hospital cardiac arrest that had a resuscitation attempted and no previously stated do-not-resuscitate order.

±Witnessed: arrest was witnessed by a bystander.

Good neurologic outcome: patients who survived with a Cerebral Performance Category (CPC) 1 or CPC 2 upon hospital discharge (see Table 3).

Figure 6. Etiologic Breakdown for Out-of-Hospital Cardiac Arrest Documented in Alaska CARES — Alaska, 2012–2016



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