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SPECIAL SUPPLEMENT

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Alameda County EMS Improves Cardiac Arrest Survival

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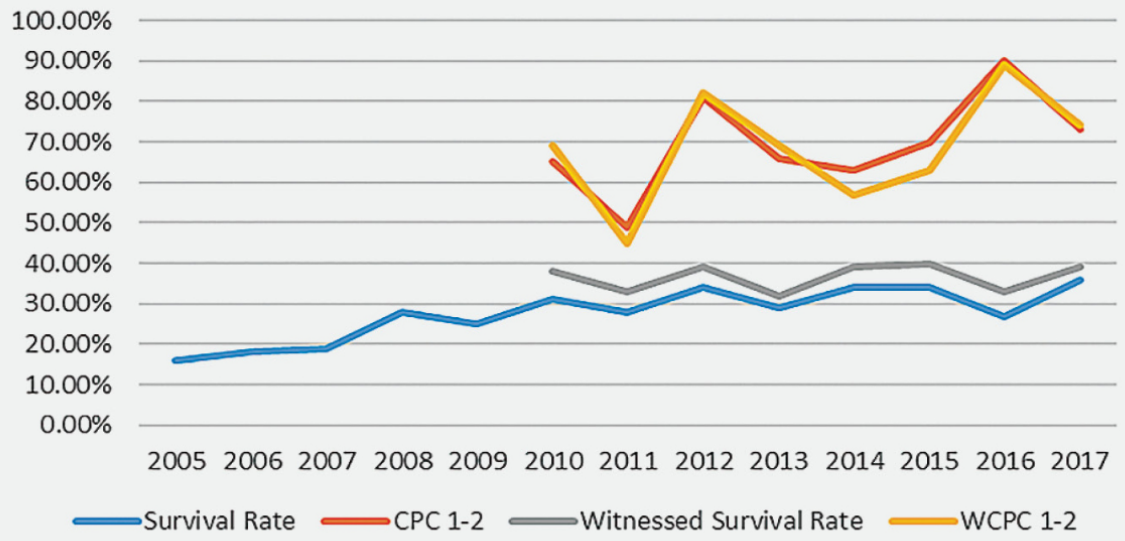
Figure 1: Alameda County EMS v fib/v tach with good neurologic survival



Year	Intervention
2006	Adopted 2005 AHA Guidelines; implemented intraosseous (EZ-IO)
2007	EtCO2 monitoring, dispatch-assisted CPR, comprehensive data collection based on CARES
2008	Advanced airway training for all EMS
2009	Impedance threshold device (ITD)
2010	Hospital therapeutic hypothermia; EMS pit crew CPR; EMS hypothermia; CPR training in all schools
2011	ITD retraining
2012	Mechanical CPR implemented countywide; PulsePoint activated
2013	OHCA transported to cardiac arrest centers
2014	Discontinued prehospital therapeutic hypothermia
2015	Adopted 2015 AHA guidelines for CPR

2005–2009: Data collection limited to all v fib or v tach OHCA. 2010–2017: Witnessed (W, in yellow) and all (in red) v fib/v tach OHCA with good neurologic function (cerebral performance category 1 or 2 [CPC 1–2]).

Alameda County is approximately 750 square miles with a population of 1.6 million and is marked by demographic and socioeconomic diversity. The county consists of urban, suburban, as well as rural areas. Alameda County Emergency Medical Services (ALCO EMS) runs approximately 170,000 emergency 9-1-1 calls and 120,000 transports annually, responding to approximately 1,300 cardiac arrests (attempting resuscitation about 1,100 times a year), and has maintained a survival rate of around 10% for the last half a decade.

ALCO EMS has made several sequential changes over the last decade to improve OHCA care. This article addresses those changes and the resulting improvement in cardiac arrest resuscitation.

The endorsed system of care for OHCA by ALCO EMS has been modeled after that of the decade-old and nationally recognized Take Heart America.[1]

All of the changes and system design are based upon recommended evidence-driven treatment strategies, techniques and devices that are consistent with the 2005, 2010 and 2015 American Heart Association (AHA) Guidelines.[2–4]

These have included measures to improve the rate of bystander CPR through CPR-7, a community outreach education program using seventh graders and those they train; use of dispatch-assisted CPR; and the implementation of PulsePoint, a method of crowdsourcing citizen CPR.

We've improved prehospital cardiac arrest treatments from 2005 to the present with annual training on pit-crew CPR, advanced airway placement with the availability of a supraglottic backup airway, intraosseous access and the use of mechanical chest compression devices.

The training includes a renewed focus on high-quality CPR that emphasizes the correct compression rate and depth, minimal interruptions, full recoil of the chest wall, and proper use of the impedance threshold device (ITD), which was introduced systemwide in 2009 for both bag-valve mask ventilation as well as with any advanced airway.

In 2009, ALCO EMS started collecting all data elements (dispatch, EMS and hospital) from the Cardiac Arrest Registry to Enhance Survival (CARES), and we continue to work closely with our receiving hospitals to obtain patient outcomes.

After the third complete year of data collection in 2012, a marked increase was noted in both the return of spontaneous circulation (ROSC) and those discharged alive with a cerebral performance category (CPC) score of 1-2 (i.e., good neurologic function). Closer scrutiny and analysis of those data was published in *Prehospital Emergency Care*.[5]

During the study period (2009–2012), patients with ROSC with coma received prehospital surface cooling and were transported to hospitals capable of therapeutic hypothermia, with transport times generally less than 10 minutes.

All receiving hospitals in the study area had surface cooling protocols that included patients with primary ventricular fibrillation (v fib) or ventricular tachycardia (v tach), and a few included primary non-shockable rhythms.

Prior to 2012, mechanical CPR devices were available on approximately 10% of our first responder engines, which are all staffed and equipped for ALS. Beginning in 2012, all first responder paramedic engines were equipped with a LUCAS mechanical CPR device and responded to all cardiac arrests.

Resuscitation Hypothesis

We hypothesized that the increased use of therapies in 2012 that focused on perfusion during CPR using mechanical adjuncts and protective post-resuscitation care with in-hospital therapeutic hypothermia would improve survival with good neurologic outcome (CPC score of 1 or 2) compared to the lesser use of such therapies in 2009–2011.

Statistical findings on final analysis suggested that multiple strategies for OHCA implemented in our community over time resulted in a significant increase in ROSC (from 29% to 34%) and a 76% relative increase in those patients surviving with good neurologic outcome.

The subgroup that received mechanical CPR with an ITD and hospital hypothermia had the greatest improvement with a survival rate of 24%. We also found that for those that experience OHCA and not achieving spontaneous circulation promptly following initial EMS effort, optimizing a therapy-specific system of care that focuses on enhanced circulation during CPR and cerebral recovery after ROSC improves survival with favorable neurologic outcome.

In 2013, ALCO EMS had a mature ST-elevation myocardial infarction (STEMI) receiving center (SRC) program with six of 13 hospitals participating. Those same centers also had three years of therapeutic hypothermia experience managing comatose ROSC patients, hence leading those specialty SRCs to also be designated as cardiac arrest receiving centers (CARCs) for the system.

EMS field protocol directs patient transport to these CARCs if ROSC or a shockable cardiac rhythm is achieved at any time. This allows the patient to be taken to a facility that has the capability and experience in 24/7 emergent cardiac catheterization, targeted temperature management and metabolic support in the ICU, as well as electrophysiology and rehabilitation services.

ALCO EMS established a contractual agreement with all SRCs/CARCs in our system by a memorandum of understanding. This has fostered an instrumental collaboration with system stakeholders regarding ongoing review and revisions of prehospital protocols, as well as in-hospital order sets and treatment pathways based on current scientific

evidence. These continuous professional relationships are pivotal to help ensure the continuity of care from dispatch to discharge.

ALCO EMS performance and survival data captured and reported by CARES demonstrates that in 2016, the system demonstrated its highest utilization of prehospital ITD and mechanical chest compression, as well as in-hospital percutaneous coronary intervention (PCI) and targeted temperature management.

Despite a slight decrease in overall survival (10%) and v fib/v tach survival (27%) from recent years past, the 2016 data reflects the highest overall ROSC rate for the system in the past decade (37%).

And from those patients admitted that survived to hospital discharge, the mass majority (75%) were neurologically intact and an even higher number (89%) for both witnessed and unwitnessed v fib/v tach. (See Figure 1.)

At an ALCO SRC/CARC meeting in the second quarter of 2016, shortly after the release of the 2015 AHA Guidelines, the topic of extracorporeal CPR (ECPR) using an extracorporeal membrane oxygenation (ECMO) device for patients experiencing refractory cardiopulmonary arrest including OHCA was presented by EMS leadership.

This presentation was prompted by the case of a 15-year-old male that was a witnessed OHCA, received bystander CPR and was found in v fib by EMS on arrival. Initial ACLS was delivered by EMS according to ALCO-prescribed prehospital protocol and the patient was transported to the nearest SRC/CARC in a shock refractory state.

On arrival at the receiving center, the patient received an additional 90 minutes of gallant and innovative resuscitative effort by the ED staff 120 minutes before the patient was pronounced dead.

With collaborative review of this case, it was clear that the SRC/CARC had no other care in our existing protocol to offer the patient or family by the end of the resuscitation. The only ECMO-capable hospital in Alameda County, currently and at the time of this case, was the local Children's Hospital. ECMO wasn't considered by the adult SRC/CARC at the time of resuscitation, especially for use in refractory OHCA.

This particular SRC/CARC is very familiar with aggressive resuscitation strategies—two cardiac arrest patients had been taken to the catheterization lab with active mechanical CPR that same year, both of which survived with good neurologic function.

From Concept to Practice

In the fourth quarter of 2016, only a few months after the first discussion with ALCO's SRC/CARC stakeholders regarding the concept of using mechanical CPR as a bridge to ECMO, one center had their first opportunity to utilize the ECMO option … and they did with amazing success!

At the time of this case, Highland Hospital didn't have the capability to perform ECMO, and received an otherwise healthy 52-year-old male who presented with left coronary artery occlusion, arrested in the catheterization lab, and was unable to achieve ROSC after an hour of resuscitation. The cath lab contacted the University of California, San Francisco (UCSF) Medical Center, who agreed to dispatch their ECMO team to initiate ECMO care and transfer the patient to UCSF. The patient was maintained on a LUCAS device in the cath lab while waiting for the ECMO team to arrive.

The total time from 9-1-1 call to UCSF transfer was just a little over eight hours, and during that time the patient received nearly six hour of continuous mechanical CPR until being placed on ECMO for seven days. The patient was discharged alive, with good neurologic function, three weeks after admission.

Even though this case may be perceived as an outlier and an exception to the rule, it strongly suggests that it does take a fearless scientific community working together on behalf of the patient to achieve the unexpected. This case exhibits what we may have found to be the next frontier in cardiac arrest resuscitation, prolonged care with mechanical compressions and the application of ECMO.

In January 2017, ALCO EMS designated the seventh SRC/CARC in the system (out of 12 adult hospitals in the county). Even though 2017 CARES data demonstrates an increase in ROSC compared to 2016 (42% vs. 37%)—virtually the same survival rate (10.4% vs. 10.1%)—there was a slightly lower neurologically intact survival rate (7.3% vs. 7.6%). According to 2017 CARES data, ITD and mechanical CPR use were at an all-time high (81% and 78%, respectively), as well as hospital admission (46%), but coronary angiography was significantly lower compared to the 2016 data (15% vs. 23%). EMS transports and those that received targeted temperature management remained about the same. As of 2019, Alameda County still doesn't have an ECMO-capable adult hospital.

Resuscitation Goals

In 2019, the ALCO EMS system goals to improve neurologically intact survival from OHCA include: working closer with dispatch to improve time to first compression; capping the cumulative maximum dose of epinephrine to three within 30 minutes and prolonging dosing frequency to q 10 minutes in EMS ACLS protocol; implementing

head-up CPR feasibility study; selecting a new supraglottic airway to replace the King LT; coordinate with county SRC/CARC's to better standardize inclusion criteria for both cardiac angiography and TTM, as well as become ECMO-capable, or at minimum to establish a formal agreement with an "ECMO-to-go" hospital in the bay area.

References

1. Lick CJ, Aufderheide TP, Niskanen RA, et al. Take Heart America: A comprehensive, community-wide, systems-based approach to the treatment of cardiac arrest. *Crit Care Med*. 2011;39(1):26-33.

2. Hinchey PR, Myers JB, Lewis R, et al. Improved out-of-hospital cardiac arrest survival after the sequential implementation of 2005 AHA guidelines for compressions, ventilations, and induced hypothermia: The Wake County experience. *Ann Emerg Med*. 2010;56(4):348-357.

3. ECC Committee, Task Forces of the American Heart. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2005;112(24 Suppl):IV1-203.

4. Field JM, Hazinski MF, Sayre MR, et al. Part 1: Executive summary: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2010;122(18 Suppl 3):S640-S656.

5. Sporer K, Jacobs M, Derevin L, et al. Continuous quality improvement efforts increase survival with favorable neurologic outcome after out-of-hospital cardiac arrest. *Prehosp Emerg Care*. 2017;21(1):1-6.

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