AHA Special Report

The American Heart Association Response to the 2015 Institute of Medicine Report on Strategies to Improve Cardiac Arrest Survival

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Abstract—The American Heart Association (AHA) commends the recently released Institutes of Medicine (IOM) report titled, “Strategies to Improve Cardiac Arrest Survival: A Time to Act (2015).” The AHA recognizes the unique opportunity created by the report to meaningfully advance the objectives of improving outcomes for sudden cardiac arrest. For decades, the AHA has focused on the goal of reducing morbidity and mortality from cardiovascular disease though robust support of basic, translational, clinical, and population research. The AHA also has developed a rigorous process using the best available evidence to develop scientific, advisory, and guideline documents. These core activities of development and dissemination of scientific evidence have served as the foundation for a broad range of advocacy initiatives and programs that serve as a foundation for advancing the AHA and IOM goal of improving cardiac arrest outcomes. In response to the IOM report’s call to action, the AHA is announcing 4 new commitments to increase cardiac arrest survival: 1) the AHA will provide up to $5 million in funding over 5 years to incentivize resuscitation data interoperability; 2) the AHA will actively pursue philanthropic support for local and regional implementation opportunities to increase cardiac arrest survival by improving out-of-hospital and in-hospital systems of care; 3) the AHA will actively pursue philanthropic support to launch an AHA resuscitation research network; and 4) the AHA will cosponsor an “National Cardiac Arrest Summit” to facilitate the creation of a national cardiac arrest collaborative that will unify the field and identify common goals to improve survival. In addition to AHA’s historic and ongoing commitment to improving cardiac arrest care and outcomes, these new initiatives are responsive to each of the IOM recommendations and demonstrate the AHA’s leadership in the field. However, successful implementation of the IOM recommendations will require a timely response by all stakeholders identified in the report, and a coordinated approach to achieve our common goal if improved cardiac arrest outcomes.

Key Words: cardiac arrest, heart arrest, resuscitation, cardiopulmonary resuscitation, cardiac arrest survival, CPR quality, emergency medical dispatch
EXECUTIVE SUMMARY

For more than 40 years, the American Heart Association (AHA) has produced Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC) and through promoting the principles of the chain of survival – early recognition and activation of emergency medical services (EMS), early CPR, early defibrillation, and early access to emergency medical care – have contributed to saving hundreds of thousands of lives around the world over the past 50 years. Despite this success, the full lifesaving potential of an optimized system of care remains elusive in most communities. There are striking disparities in cardiac arrest survival, with some systems of care reporting a 5-fold difference survival.(1-6) For an out-of-hospital cardiac arrest (OHCA) or in-hospital cardiac arrest (IHCA) victim to survive, witnesses and initial responder must be ready, willing, and able to take quick action within a comprehensive patient-centered system of care. Such systems must be able to rapidly coordinate and integrate each aspect of resuscitation care that is focused on optimizing patient survival to with good neurologic function and return to prearrest state.

In 2010, the AHA Emergency Cardiovascular Care Committee set a 10-year goal of doubling OHCA and IHCA survival(7) (Table 1). Over the past 5 years, the AHA has undertaken a number of innovative approaches to raise public awareness around cardiac arrest,(8) increase public CPR preparedness and training(9) and increase the resuscitation competency of healthcare professionals.(10)

However, to truly save as many lives as possible it will take additional novel and innovative approaches to improve outcomes as well as an intense commitment, dedication and collaboration of countless stakeholders and partners at a national, state and local level. Implementation and measuring outcomes have historically been difficult as needs and gaps – such as politics, resources, leadership engagement – differ between communities and location. Although the AHA has published a number of scientific and advisory statements on elements of surveillance, resuscitation systems of care, and public CPR, the successful development and implementation of solutions requires action by collaborators, partners and stakeholders.(11,12)

One such novel approach is the Institute of Medicine (IOM) “Strategies to Improve Cardiac Arrest Survival: A Time to Act (2015).”(13) This IOM study was supported by the AHA, American Red Cross, American College of Cardiology, National Heart, Lung, and Blood Institute, Centers for Disease Control and Prevention (CDC), and the Department of Veterans Affairs. The purpose of this AHA special report is to amplify the key recommendations of the IOM report, highlight areas where the AHA has been or is currently active, and announce plans to launch new initiatives in response the IOM recommendations. The impartial, thoughtful expert opinion of the IOM-appointed panel of experts lends additional depth and strength to all interested stakeholders’ efforts to improve resuscitation outcomes, and truly is a call to accelerate and coordinate these efforts.

AHA Support of the 2015 IOM Report on Cardiac Arrest

The AHA supports the recently released IOM report entitled “Strategies to Improve Cardiac Arrest Survival: A Time to Act (2015).”(13) The report highlights the public health burden of cardiac arrest and makes important recommendations regarding how the country should move forward. Table 2 lists the IOM’s recommended strategies to improve cardiac arrest survival.

The AHA recognizes the unique opportunity created by the report to meaningfully advance the objectives of improving outcomes for sudden cardiac arrest. For decades, the AHA has focused on the goal of reducing morbidity and mortality from cardiovascular disease though robust
support of basic, translational, clinical, and population research.(14-20) The AHA also has developed a rigorous process using the best available evidence to develop scientific, advisory, and guideline documents.(14-20) These core activities of development and dissemination of scientific evidence have served as the foundation for a broad range of advocacy initiatives and programs that serve as a foundation for advancing the AHA and IOM goal of improving outcomes related to cardiac arrest.(21-28) Table 3 highlights recent AHA scientific statements and guidelines related to the 2015 IOM cardiac arrest recommendations. Table 4 maps ongoing AHA efforts to each of the specific 2015 IOM cardiac arrest recommendations.

National efforts to improve resuscitation require that the multiple stakeholder organizations highlighted by the IOM step forward and actively participate. Although each organization brings important resources and expertise, real synergy to advance cardiac arrest care and outcomes will occur only if there is collective efforts by stakeholder organizations. In addition, it is critical to note that position statements and guidelines are necessary but not sufficient to truly drive change. The AHA is committed to continuing its decade’s long leadership in improving cardiac arrest outcomes, but we also acknowledge we cannot do it alone. It will truly take a community of dedicated stakeholders, sister organizations, EMS and hospital leaders, and the public at large to reach the full potential of a truly strong chain of survival. Now is the time for the resuscitation community to take a stand by committing to engaged, thoughtful discussion and action so that we may bring the IOM recommendations to life across the country.
NATIONAL CARDIAC ARREST REGISTRY

IOM Recommendation 1. Establish a National Cardiac Arrest Registry.(13)

The Centers for Disease Control and Prevention (CDC)—in collaboration with state and local health departments—should expand and coordinate cardiac arrest data collection through a publicly reported and available national cardiac arrest registry, including both out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA) data, to help increase federal and state accountability for current system performance and promote actions to improve cardiac arrest outcomes.

Specifically, CDC should

- Establish a cardiac arrest surveillance system for the nation that includes IHCA and OHCA data in pediatric and adult populations;
- Make data publicly available through appropriate mechanisms to enable comparisons across datasets in order to increase public awareness about cardiac arrest incidence and treatments, improve accountability for EMS system and health care system performance, and target interventions that will reduce disparities and improve patient outcomes;
- Identify and adopt standardized definitions, criteria, and metrics (such as age, gender, race and ethnicity, socioeconomic status, and primary language) for cardiac arrest identification, treatment, and outcome assessment; and
- Promote and coordinate the development and implementation of unique diagnostic codes for OHCA and IHCA in ICD coding models through its North American Collaborating Center, working with the Centers for Medicare & Medicaid Services and the World Health Organization.

Specifically, state, territorial, and local health departments should

- Mandate tracking and reporting of all cardiac arrest events; and
- Publicly report the incidence and outcomes of IHCA and OHCA within and across various areas within states and territories, taking appropriate steps to protect patient privacy and confidentiality.

Past and Current AHA Initiatives

The availability of timely, accurate and essential data is the foundation for any local, state, or national efforts to improve cardiac arrest treatment and provide guidance in developing, implementing, and assessing the effectiveness of quality improvement initiatives. In 2007, the AHA published a scientific statement on essential features of cardiovascular disease and stroke surveillance(31) that was followed by a 2008 AHA scientific statement on OHCA surveillance systems(32) that made the following recommendations:

- OHCA and their outcomes through hospital discharge should be classified as reportable events as part of a heart disease and stroke surveillance system
- Data collected on patients’ encounters with EMS systems should include descriptions of the performance of CPR by bystanders and defibrillation by bystanders
• National annual reports on key indicators of progress in managing acute cardiovascular events in the out-of-hospital setting should be developed and made publicly available.

The AHA’s commitment to the importance of data-driven quality improvement is demonstrated through our 15+ year support of the AHA Get With The Guidelines-Resuscitation program, (formerly known as the National Registry of CPR),(41) 10-year support of the Resuscitation Outcomes Consortium (ROC) cardiac arrest “epistry,”(46) and since October 2012, has been one of the funding sponsors and an Oversight Board member for the Cardiac Arrest Registry to Enhance Survival (CARES) program.(47)

The AHA spans the country and interacts with every element of the chain of survival, thus providing a unique opportunity to influence, support and provide interconnectivity between other local, state, and national efforts aimed at our shared goal of improving cardiac arrest survival.

In 2007, the IOM Roundtable on Value & Science-Driven Health Care(49) proposed creating a continuously learning health system in which science, informatics, incentives, and culture are aligned for continuous improvement and innovation. Through this lens, the AHA can and should play an integral role in a “resuscitation learning health system” (Figure 1) to drive implementation of best practices while creating and capturing new knowledge as part of the patient care process.

**Metrics**

The IOM report highlights the need to measure CPR and defibrillation by using a national platform that incorporates common, accepted terminology. Thus, measurement is essential to benchmark care and address the challenges of resuscitation. The AHA has consistently supported the process to develop robust terminology and definitions related to resuscitation.(14) Moreover, the AHA has supported both research and quality improvement registries that are the basis for rigorous measurement. These registries, such as CARES and ROC, have provided important scientific and public health insights with regard to early CPR and early defibrillation.

Over the past 2 years, the AHA Emergency Cardiovascular Care Systems of Care Subcommittee developed several key metrics of system success that should serve as benchmarks for every system to measure and report (Table 5).

**Opportunities to Improve Outcomes**

As outlined in the 2015 IOM Report on Cardiac Arrest,(13) one barrier to maximizing existing resuscitation registries and developing a national surveillance registry is the lack of interoperability between EMS and hospital data systems due to issues such as lack of funding, proprietary software, and the need to protect patient privacy.

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**AHA Commitment 1: Provide funding to catalyze data interoperability.**

The AHA will provide up to $5 million over 5 years to incentivize and catalyze resuscitation data interoperability of existing and novel data sources into the AHA EMS Registry (Figure 1).
As noted by the IOM report, the ideal database will automatically and seamlessly leverage electronic medical record data while also accepting applicable medical device data, as well as data from wearable devices and mobile technology, that could compliment cardiac arrest surveillance and would be essential to a research and quality improvement registry such as the AHA EMS Registry. By facilitating the breakdown of data silos, the AHA is committed to improving the breadth and depth of data available to both researchers, clinicians and the public to serve as the fuel for a resuscitation learning health system that will improve by both measurement and reporting of resuscitation data.

PUBLIC CULTURE OF ACTION

IOM Recommendation 2. Foster a Culture of Action Through Public Awareness and Training.(13)

State and local departments of health and education, and leading organizations in cardiac arrest response and treatment should partner with training organizations, professional organizations, public advocacy groups, community and neighborhood organizations and service providers, and local employers to promote public awareness of the signs, symptoms, and treatment of cardiac arrest. These efforts require public cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) training across the lifespan, creating a culture of action that prepares and motivates bystanders to respond immediately upon witnessing a cardiac arrest.

Specifically,

• State and local education departments should partner with training organizations and public advocacy groups to promote and facilitate CPR and AED training as a graduation requirement for middle and high school students;

• Employers (e.g., federal agencies, private business owners, and schools) should be encouraged to maintain easy-to-locate and clearly marked AEDs, provide CPR and AED training to their employees, and specifically include cardiac arrest in formal emergency response plans; and

• Local health departments should engage with community and neighborhood organizations and service providers to expand the types and locations of available CPR and AED training to populations over age 65 and caregivers for this population.

Past and Current AHA Initiatives

Early action by laypersons can result in better survival/outcomes after OHCA. These early actions include 1) early arrest recognition and immediate activation of emergency medical response system, 2) initiation of CPR, and 3) defibrillation, and are described by the first 3 links in the chain of survival (Figure 2).(50-55) Each of these links is time-sensitive and most effective when applied as soon as possible after arrest. Consequently, the role of the general public and first responders are critical when striving to improve outcomes. The AHA supports – through many current initiatives (Figure 3) – the IOM report that prioritizes efforts aimed at improving these foundational early links in the chain of survival.
As highlighted in the IOM report, implementation of strategies to increase layperson (early) CPR and defibrillation should be a priority to improve resuscitation. The AHA recognizes that no singular strategy can comprehensively assure early CPR and early defibrillation so that a multifaceted approach for most communities will achieve best practice and help improve survival. The AHA has supported specific initiatives as well as ongoing training resources to help achieve these goals. For example, one important initiative has been Hands-Only CPR for laypersons which focuses on calling 9-1-1 and providing uninterrupted chest compressions. Hands-Only CPR for laypersons can be an effective means to expedite training and allay laypersons’ angst and performance challenges involving rescue breathing. This compression-only approach for initial resuscitation by bystanders has been supported by scientific study, training curriculum, and community education and outreach.(9,16,19)

The AHA also supports a variety of forums and resources to achieve layperson CPR and AED skills. Traditional classroom-based training is a cornerstone strategy and is supported by a variety of AHA programs.(56) The traditional curriculum has been incorporated into school-based training programs for CPR and AED as part of a school-based emergency plan.(28) The approach engages receptive middle school and high school learners, with many states now requiring CPR training as part of a school-based curriculum.(25) Other CPR and AED training approaches developed by the AHA have incorporated socioeconomic and demographic considerations in an attempt to target groups that often are less likely to engage in CPR.(23) This consideration of cultural and social factors may improve lifesaving layperson care among those currently least likely to receive early CPR or defibrillation. Educating family members of high-risk persons in CPR and AED is also a strategy to target lifesaving training to those potentially most at need. The AHA has increasingly leveraged Web-based blended learning strategies, mobile technology and social media to reach a wide range of persons potentially at low-cost. The strategy to couple scientific rationale with programmatic layperson training and intervention is a productive approach for the AHA to continue to strive to increase early CPR and AED use.

Opportunities to Improve Outcomes

Collectively, there are a spectrum of training and just-in-time field strategies, endorsed and supported by the AHA, that can help achieve early layperson CPR and early defibrillation as well as assure high-quality professional rescuer CPR. These strategies provide a menu from which communities can strive to achieve the IOM objectives. Implementation of these evidence-based strategies focusing on CPR and defibrillation has repeatedly been demonstrated to improve survival across a broad range of communities both within and outside the United States.(57-60)

Currently, the potential lifesaving benefits of these early treatments are often not realized because they are not implemented. Importantly, there is wide variability in community bystander CPR rates ranging from >60% to <20%.(2) In addition, little is known about the interval from cardiac arrest onset to the initiation of CPR in most systems, which has been shown to have a major impact on outcomes.(61,62) Similarly layperson defibrillation occurs in only a small fraction of shockable cardiac arrest though there is substantial variability across systems, ranging from 1% to 10%.(1,2,4) Taken together, these findings indicate that best practices involving layperson CPR and early defibrillation currently ongoing in some communities provide near-term opportunity for many other communities to improve. These communities of excellence provide a potential roadmap to achieve better care for these critical early links.(1,2,4)
EMS SYSTEM PERFORMANCE

IOM Recommendation 3. Enhance the Capabilities and Performance of Emergency Medical Services (EMS) Systems.(13)

As the informal agency for EMS, the National Highway Traffic Safety Administration should coordinate with other federal agencies and representatives from private industry, states, professional organizations, first responders, EMS systems, and non-profit organizations to promote uniformly high-quality emergency medical systems by

- Convening interested stakeholders to develop standardized dispatcher assisted cardiopulmonary resuscitation (CPR) protocols and national educational standards for use by all public safety answering points; and

- Establishing a standardized definition and training curriculum for high performance CPR to be used in basic emergency medical technician training and certification.

Past and Current AHA Initiatives

Layperson training efforts are complemented by just-in-time field interventions that support bystander CPR and early defibrillation. There is a growing appreciation that 9-1-1 telecommunicator CPR can measurably increase arrest recognition and early CPR, and in turn help increase survival from cardiac arrest. A sequence of 2 questions by the telecommunicator asks if the patient is conscious and if the patient is breathing normally. A "no" response to these 2 questions identifies a person who has a high likelihood of arrest. The telecommunicator can coach effective layperson chest compressions. The AHA convened clinical leaders and the telecommunicator profession to develop the consensus on science on the topic,(17) which provides the clinical rationale and programmatic framework to implement telecommunicator CPR. Other field-based programs aim to reduce the interval between collapse and defibrillation. Nontraditional first responders such as police or security can be equipped with AEDs and dispatched to suspected arrests. In selected communities, this strategy is a key component of an effective resuscitation program. An extension of this strategy is to make AEDs accessible to laypersons. Originally termed "public access defibrillation," early defibrillation can be achieved by placing AEDs in public locations where laypersons may quickly access the AED. Importantly, early CPR and early defibrillation is supported by public policy and legislation, assuring Good Samaritan protection for persons attempting to provide resuscitation care.(21)

CPR and defibrillation by EMS personnel and hospital rescuers also influence cardiac arrest outcome. There is an evolving understanding about the components of CPR (compression rate, depth, release, interruption, and ventilation) can individually and collectively influence the likelihood of resuscitation. Health professionals with a duty to respond provide variable CPR performance as measured by chest compression depth, rate, release, interruptions, and ventilations, and this variable CPR performance is associated with the likelihood of survival.(1,2,4) In recognition of the importance of CPR quality, the AHA convened a CPR Quality Summit in May 2012 that established key parameters of CPR quality for trained rescuers including metrics of CPR performance; monitoring, feedback, and integration of the patient’s response to CPR; team-level logistics to ensure performance of high-quality CPR; and continuous quality improvement on provider, team, and systems levels.(36) Moreover, the interface between CPR and defibrillation – specifically a shorter perishock pause – is associated
with a greater likelihood of survival. Early defibrillation by health professions – in and out of the hospital – remains a core determinant of survival. AHA training approaches for prehospital and in-hospital professionals advocate for teamwork that enable coordinated resuscitation care aimed at delivering high-quality CPR. More recently, the AHA has initiated a competency-based low-dose, high-frequency training program, designed for healthcare providers, that has been shown to improve CPR skills performance over time compared with traditional training. The AHA’s Resuscitation Quality Improvement (RQI) program is a groundbreaking new approach to maintaining competence in CPR. The RQI program uses realistic eSimulation patient cases and a mobile Simulation Station, for quarterly psychomotor skills activities, to help healthcare providers retain life-saving CPR skills.

In 2010, the AHA outlined the essential elements of a regional system of care for OHCA (Figure 4). Based on the experience of trauma centers, burn centers, ST-segment elevation myocardial infarction (STEMI) centers, and stroke centers, along with emerging data on resuscitation systems, the AHA criteria is meant to guide the development and implementation of standards for regional systems of care. In 2012, Mission: Lifeline Resuscitation was launched as one tool to assist in developing regional resuscitation systems of care.

Opportunities to Improve Outcomes

In 2014, the AHA released its basic life support for prehospital providers course, which includes a module on high-quality team CPR that focuses on teaching providers how to conduct a code with teams ranging from 2 to 6 people. This emphasis on teamwork and high-quality CPR will continue in future course updates and should provide a foundation for improved provider teamwork.

In conjunction with the publication of the scientific statement on dispatcher-assisted CPR, the AHA also launched an education initiative to increase awareness of the importance of dispatcher-assisted CPR instructions. More recently, there are good examples of successful telecommunicator training programs and initiatives, such as the Resuscitation Academy program and toolkit and the Arizona SHARE (Save Hearts in Arizona Registry & Education) telephone-assisted resuscitation program that could offer opportunities for interested organizations to collaborate to truly realize the lifesaving potential of effective telecommunicator CPR.

NATIONAL STANDARDS FOR HOSPITALS AND HEALTHCARE SYSTEMS


The Joint Commission—in collaboration with the American Red Cross, the American Heart Association, hospital systems, hospitals, professional organizations, and patient advocacy groups—should develop and implement an accreditation standard for healthcare facilities specific to cardiac arrest care for adult and pediatric populations.
Past and Current AHA Initiatives

Based on a series of scientific statements published in 2007,(68) the AHA launched its Mission: Lifeline initiative to support and foster the development of STEMI systems of care. And, in 2012, the AHA launched the cardiac resuscitation systems of care component(40) after the recommendations of an AHA statement on developing cardiac arrest systems of care.(35) The AHA Get With The Guidelines-Resuscitation program provides quality improvement data to increase provider compliance with established treatment guidelines while also providing opportunities for retrospective analysis to analyze and develop improved treatments.(41)

Using these out-of-hospital and in-hospital programs the AHA has developed a comprehensive menu of recognition, accreditation, and certification opportunities.(42) Figure 4 highlights characteristics of Level 1 and Level 2 cardiac resuscitation centers that could serve as the basis for additional future accreditation or certification initiatives.(12)

Opportunities to Improve Outcomes

The 2010 AHA statement on "Regional Systems of Care for Out-of-Hospital Cardiac Arrest"(35) noted the importance and need for external credentialing (versus self-designation) to support the sustainable development of high-quality, postarrest patient care. This may suggest that the number of level 1 cardiac resuscitation centers should be limited to maintain both provider and system skill levels needed to care for this unique population of patients.

The AHA has been active and successful in developing accreditation and certification programs in other areas of cardiovascular disease and stroke; a similar set of programs for EMS and hospital components of a resuscitation system of care would likely spur additional investment in training, quality and leadership that could contribute to improving resuscitation outcomes.

In addition, the development, adoption, and implementation of evidence-based performance measures and core measures could greatly enhance efforts to broadly and consistently focus improvements on IHCA and OHCA patient treatments and outcomes.

CONTINUOUS QUALITY IMPROVEMENT PROGRAMS

IOM Recommendation 5. Adopt Continuous Quality Improvement Programs. Emergency medical services (EMS) systems, health care systems, and hospitals should adopt formal, continuous quality improvement programs for cardiac arrest response that(13)

- Assign responsibility, authority, and accountability within each organization or agency for specific cardiac arrest measures;

- Implement core technical and non-technical training, simulation, and debriefing protocols to ensure that EMS and hospital personnel can respond competently to both adult and pediatric cardiac arrests; and

- Actively collaborate and share data to facilitate national, state, and local benchmarking for quality improvement.
Past and Current AHA Initiatives

In 1999, the AHA launched the National Registry of CPR that was relaunched in 2010 as Get With The Guidelines-Resuscitation. The Get With The Guidelines-Resuscitation program allows users to collect and analyze in-hospital cardiac arrest data to identify quality improvement opportunities while also providing performance comparison with other participating hospitals. The program also has a robust recognition opportunities for hospital team achievement.

In early 2015, the AHA launched its RQI program as an innovative competency-based training program to focus on high-quality CPR and improving patient outcomes. Research has shown that “low-dose/high-frequency training” is effective at maintaining skills and the RQI program uses quarterly psychomotor skills training to maintain provider’s high-quality CPR skills.

Opportunities to Improve Outcomes

Many recommendations in the current IOM report have been put forward by AHA and other stakeholder organizations in the past but not yet implemented on a widespread or consistent basis. To avoid the same fate for the current IOM recommendations, stakeholder organizations identified in the report will need to take prompt and coordinated action to develop sustainable quality improvement programs for OHCA and IHCA systems of care.

Using a related cardiovascular emergency as a model, the AHA has relevant experience and success building regional systems of care and quality improvement for the rapid diagnosis and reperfusion of STEMI in the Mission: Lifeline program. In cities and states across the United States, collaborating with thousands of local and regional leaders in emergency cardiac care, Mission: Lifeline has implemented successful coordinated systems for the timely treatment of myocardial infarction. These efforts establish local leadership, set common protocols and standards for diagnosis and treatment that follow national guidelines and randomized trial evidence, and provide ongoing measurement and feedback through regional hospital and EMS comparison that incent faster performance and better patient outcomes. Cornerstones of the program include agreement among the majority of hospitals and EMS agencies in a region to contribute prehospital and hospital data to the ACTION Registry-GWTG, and collating and reporting these data in quarterly regional reports with letter-coded hospital-specific measures that serve as targets for process improvement. Other important elements responsible for the programs’ success include training, implementation and feedback directed by dedicated cardiovascular care coordinators who activities span the entire episode of care, and the ability of the local affiliate AHA staff to overcome natural competitive barriers and function as the neutral conveners of the systems.

Going forward, this successful model has been and can be further applied to cardiac arrest with a similar framework. In the AHA mid-Atlantic Affiliate, in collaboration with hospitals and EMS agencies in North Carolina, regional systems for OHCA have been implemented in a similar manner. As 80% of victims die before they are admitted to the hospital, and bystander and dispatcher response appear most critical to successful resuscitation efforts, system emphasis has been focused to include early response. In addition, the HeartRescue project is another example of a collaborative, systems-based approach to improve the recognition, treatment and measurement of out-of-hospital cardiac arrest.

Innovative training models will be a key component of any successful quality improvement program. On such example is the AHA’s RQI program. The RQI program offers the possibility of
being “win, win, win, win”: provider training is much more efficient (quarterly brief skills sessions versus classroom training); hospitals save scarce provider time and dollars via brief quarterly training; provider skills are maintained at a high level; and the ultimate holy grail, improved patient care and outcomes should result from improved provider skills. In fact, Texas Health Presbyterian Dallas has already experienced the first “three wins”(75) as the very first hospital to fully launch RQI for its staff. This early success demonstrates the potential for the RQI program to improve CPR skills when used within a culture of quality such as exists at Texas Health Presbyterian Dallas. The RQI program is just one example of the AHA’s commitment to foster a culture of innovation(76) as part of our commitment to build healthier lives, free of cardiovascular diseases and stroke.

As noted by the 2015 IOM Report on Cardiac Arrest,(13) effective continuous quality improvement is based on a virtuous cycle of collecting, analyzing and reporting data with the intent of developing interventions that translate best practice knowledge into improved performance and outcomes at the local level. Limited funding to initiate of quality improvement programs and develop innovative quality improvement strategies remains a major hurdle. Therefore, in response to this IOM recommendation, the AHA is committed to actively pursue philanthropic support to fund local, state, and regional implementation and quality improvement programs.

**AHA Commitment 2: Cultivate philanthropic support for implementation opportunities.**

Actively pursue philanthropic support for local and regional implementation opportunities to increase cardiac arrest survival by improving out-of-hospital and in-hospital systems of care.

In order to identify new, effective treatments for cardiac arrest, the National Institutes of Health (NIH), the American Heart Association, and the U.S. Department of Veterans Affairs should lead a collaborative effort with other federal agencies and private industry to build the nation’s research infrastructure that will support and accelerate innovative research on the causal mechanisms of onset, pathophysiology, treatment, and outcomes of cardiac arrest. These actions should

• Strengthen laboratory, clinical, and translational resuscitation research support to levels commensurate with the public health burden of cardiac arrest for adult and pediatric populations across federal agencies, including NIH institutes; and

• Establish a balanced and comprehensive portfolio of grants across the full spectrum of science translation to encourage the development and application of novel and efficient research strategies and innovative trial designs in preclinical, clinical (e.g., exploratory and hypothesis-generating studies), and population-based resuscitation research.

Current State of Research

The numbers speak for themselves in terms of the quality of evidence to support the 2010 AHA Guidelines for CPR and ECC (Table 6). In nearly 300 pages of guidelines and 686 total recommendations in 2010, there were only 162 Class I recommendations (24%) and only 57 (8%) were based on Level of Evidence A. There is so much guidance to give to so many, but often using less than ideal evidence. In preparation for the 2015 Guidelines, the International Liaison Committee on Resuscitation (ILCOR) Task Forces assigned high priority status to only 147 topics based on controversial subjects or if there was new published evidence. This is about a 50% decrease in the number of the topics covered in 2010. In sharp contrast to the 2010 Guidelines where 686 recommendations were made, only 308 recommendations are made in the 2015 Guidelines and any topics not reviewed defer to the recommendations in the 2010 AHA Guidelines for CPR and ECC. The limited body of work that has been published in the 5 years since the release of the 2010 AHA Guidelines for CPR and ECC has significantly impacted the number of topics ILCOR could review. Moreover, most of the resulting reviews still had very low evidence. With the relatively low quantity and quality of evidence in much of the resuscitation literature, it is unlikely that the scientific evidence alone in the 2015 AHA Guidelines for CPR and ECC will transform practice.

The state of current clinical research on cardiac resuscitation can be surmised from a review of trials listed at the Web site clinicaltrials.gov (search performed using the terms “cardiac arrest” and “cardiac resuscitation”).(77) A total of 192 unique trials have been registered in the site since its inception. Of them, 62 trials are ongoing, 89 have been completed or terminated, 15 have not yet been started and, for 9, their status is unclear. Overall, the location of the site of origin of the trial was the United States in 43, Canada in 19, and other countries in 130. Currently, there are 13 trials from United States or Canada listed on the site; only 5 of those are supported by federal funding (including 2 which are also supported by the AHA). It is therefore clear that research on cardiac arrest/resuscitation is underfunded, particularly when one
compares these numbers with those corresponding to funded research on other lethal conditions, such as myocardial infarction. Based on 5 federally funded trials in cardiac arrest listed currently it is unlikely that much has changed since comparative statistics were published by Ornato et al(78) in 2010 (Table 7). This article pointed out that since the term randomized controlled trials was indexed in 1990, thousands of trials in myocardial infarction, stroke, and heart failure were cited in Medline compared with only 177 trials in cardiac arrest. Strikingly, the number of trials per 10,000 US deaths per year was 400 for myocardial infarction and 6 for cardiac arrest.

Is there hope in current granting agencies? A review of the NIH(79) and AHA(43) Web sites for funding reveals some interesting data summarized in Tables 8 and 9. At the NIH within the 25 integrated review groups (IRG) with an average of ten study sections each, only 1 IRG; Cardiovascular and Respiratory Sciences(80) specifically mentions resuscitation and cardiac sudden death in 1 study section entitled Clinical and Integrative Cardiovascular Sciences. The lack of an NIH study section(s) with a major focus on cardiac arrest research is perceived by many as a significant barrier to achieving informed peer review of cardiac arrest grant applications. The AHA has recently recognized and taken steps to address this issue. Beginning in 2015 intake of AHA grant applications, Cardiac Arrest was assigned a major science classification with independent study sections for basic science and clinical and population science grant proposals. Although an important step, AHA research grants are relatively small and primarily serve to support the pipeline of young investigators who eventually need to obtain sustained federal funding. One strategy to implement the IOM recommendation regarding discovery research would be for the NIH Center for Scientific Review to create ≥1 study sections whose primary focus is cardiac arrest research.

Barriers to Advancing Resuscitation Research

**Lack of a Large Translational Network**
Technology transfer from Basic Science to the bedside and curbside is too slow. The linkages between basic science, technological advances and clinical trials are lacking. Translational networks in resuscitation are rarely funded in the United States. The Resuscitation Outcomes Consortium conducted 5 large randomized clinical trials (RCTs) addressing important questions related to cardiac arrest but a complementary basic science and large animal scientific network was not concomitantly funded and that meant the questions addressed by clinical trials were dependent on discoveries funded by other agencies or in other disease states. Without dedicated funding the pathway from bench to bedside is too slow and inefficient. Recently, the ROC investigators collaborated with 5 basic science labs across the United States and Canada to answer a single question in 9 animals in each laboratory using a single protocol and single data collection strategy. The question was highly relevant to a clinical trial design under development that will address the efficacy of epinephrine in cardiac arrest based on titrated dose given under controlled infusion rates. The multisite large animal study has concluded and the results will be submitted for peer review shortly. This proof of concept initiative foreshadows what is possible and what is required to advance the science quickly and effectively.

**Exemption From Informed Consent Requirement for Emergency Research (21 CFR 50.24 Rule)**
We consider essential that emergency trials on cardiac resuscitation (especially those conducted in the field or immediately upon hospital arrival) be considered exempt from informed consent requirement. The US Food and Drug Administration published a guidance document for institutional review boards, clinical investigators, and sponsors regarding exemption from informed consent requirement for emergency research, known as 21 CFR 50.24 rule.(81) It was
first published in 1996 and last updated in April 2013. Under this rule, exemption from informed consent can be granted for investigations involving “human subjects who have a life-threatening medical condition that necessitates urgent intervention (for which available treatments are unproven or unsatisfactory), and who, because of their condition, cannot provide informed consent.” For the rule to apply, the research must study an “investigational product that, to be effective, must be administered before informed consent from the subject or the subject’s legally authorized representative can be obtained.” Although some trials may fall clearly under this rule (eg, evaluation of automatic defibrillators in public venues the ROC PRIMED [Prehospital Resuscitation using an Impedance valve and Early versus Delayed] trials(82,83) and the ongoing ROC ALPs [Amiodarone, Lidocaine or Placebo Study] and ROC CCC [Continuous Chest Compressions](84,85) trials), in other cases the granting of exemption from informed consent is less straightforward. For instance, trials on temperature modulation and early treatment of acute stroke have varied on their requirement to obtain informed consent before enrollment. In a trial of prehospital induction of hypothermia the “study personnel contacted the patient’s family as soon as feasible after enrollment to explain the study,(86) in the TTM (Targeted Temperature Management) trial consents were waived, delayed, or required prior to enrollment depending on the country,(87) and in a trial evaluating therapeutic hypothermia in children written informed consent was mandatory before enrollment.(88) In 2007, the AHA published a scientific statement(30) that proposed that it is ethically acceptable to stratify the intensity of community consultation and public disclosure on the basis of the anticipated incremental risks to the subjects participating in the research study. However, under the current application of the exception from informed consent rule, scientific advancements in IHCA are even rarer than OHCA and much of the care delivered in IHCA is extrapolated from out-of-hospital studies and guided by an AHA consensus statement.(12)

**Funding**

Ornato et al(78) published a commentary in 2010 outlining the funding shortfall for 24 years (1985 to 2009) as reported on the NIH Web site for cardiac arrest research when compared to research on myocardial infarction or stroke or heart failure (Table 10). As we see in the number of RCTs (outlined previously), the funding is desperately low for cardiac arrest research. This was very true in 2010 when over 9,000 funded grants pertaining to heart failure compared favorably with >6,800 in myocardial infarction and over 4,400 in stroke but dwarfed the investment in cardiac arrest at a mere 257 studies. Currently, on the same Web site, we can see much has not changed.(89)

As noted by the 2015 IOM Report on Cardiac Arrest, improvements in cardiac arrest outcomes depends on adequate, reliable funding coupled with the development of evidence-based practices that are broadly and rapidly implemented. The AHA is uniquely positioned to leverage its experience with strategically focused research networks to create a similar resuscitation research platform that can lead to improved performance, outcomes and guidelines as shown in Figure 1. As part of AHA’s package of new initiatives in response to the IOM recommendations, the AHA has committed to actively pursue philanthropic support for to launch an AHA Resuscitation Research Network.

**AHA Commitment 3:** Actively pursue philanthropic support to launch an AHA Resuscitation Research Network (Figure 1).

An AHA Resuscitation Research Network will be modeled after the AHA’s other Strategically Focused Research Networks(90) that support multiple institutions to perform collaborative basic,
clinical, and population science research. It is envisioned that this network will serve as a pipeline of proof-of-concept research projects that will feed into larger federally funded programs to support definitive and transforming science in cardiac arrest care.

Defining Priorities for Future Research Directions

Resuscitation research needs to grow from the bench to the bedside, from the population to the individual, and from prevention and acute resuscitation efforts to post-cardiac arrest care. Application of the concepts of precision medicine to resuscitation research may include investigations on how physiological monitoring can individualize care (eg, how brain flow monitoring can eventually guide vasopressor use during arrest) and how genotyping at curbside has the potential to influence therapy decisions. Postcardiac arrest care has gained a lot of attention in recent years, but a lot remains to be learned including the best application of temperature modulation and whether all patients benefit similarly from a single tightly controlled temperature target to optimize functional outcomes. Very little evidence exists for oxygen and vasopressor therapy, neuroprognostication decision rules, management of fever and seizures, the role of angiography for all postarrest patients, how to optimize ICD use postarrest, and qualitative research on decision making for withdrawing life-sustaining therapy and the impact of sex on decision making; essentially the field of postcardiac arrest care is wide open and ripe for discovery. Future clinical trials should measure cognitive and behavioral outcomes, quality of life, and long-term neurological function.

IMPLEMENTATION SCIENCE

IOM Recommendation 7. Accelerate Research on the Evaluation and Adoption of Cardiac Arrest Therapies.(13)

The National Institutes of Health should lead a collaborative effort with the U.S. Department of Veterans Affairs, the Agency for Healthcare Research and Quality, and the Patient-Centered Outcomes Research Institute to prioritize health services research related to the identification, evaluation, and adoption of best practices; the use of innovative technologies (e.g., mobile and social media strategies to increase bystander cardiopulmonary resuscitation [CPR] or automated-external-defibrillator use); and the development of new implementation strategies for cardiac arrest treatments.

Past and Current AHA Initiatives

As highlighted in the IOM report, new discoveries and proven therapies will not be translated into better cardiac arrest outcomes unless they can be successfully implemented within the out-of-hospital and in-hospital systems of care. The AHA has had a major impact on implementation through the generation of scientific statements, guidelines, training materials and courses for CPR and ECC. However, despite this infrastructure, translation of best practices into actual patient care is delayed, inconsistent, and implemented with tremendous variability. The AHA has recognized this as a translation barrier, and recently restructured the AHA Emergency Cardiovascular Care Committee to include a new Systems of Care Subcommittee that is
focused on optimizing implementation of new science and best practices. In addition, the AHA continues to develop and evaluate new training strategies ranging from the Hands-Only CPR campaign(9) that generates awareness and preparedness through a brief video to prepare lay rescuers to effectively respond to a cardiac arrest. The RQI program(10) for healthcare providers is translating research around “low-dose/high frequency training” to maintain resuscitation competency as an alternative to biannual refresher courses. Finally, the new AHA Major Science Classification “Cardiac Arrest/Resuscitation - Population/Health Services Science” encourages AHA grant applications focused on implementation science.(43)

**Opportunities to Improve Outcomes**

There is a lack of implementation science funding such that the survival benefits seen in RCTs are not realized in everyday care. Great science and a focus on education without implementation does not translate into improved survival. The Utstein group on the survival equation summarized this well by noting survival is impacted by the interaction of 3 factors: medical science, educational efficiency, and local implementation.(91)

The management of a life-threatening condition such as cardiac arrest with time-sensitive interventions does not lend itself to easy pragmatic trials as the environment is chaotic and uncontrolled at best. Even so, cardiac arrest does lend itself to implementation studies that help the clinician do the right thing for the right patient at the right time with the right aids at the bedside that make the right thing the easiest thing to do. If the interventions are simple and the focus is on quality implementation can have a demonstrable impact on survival rates in US communities.

We agree with the 2015 IOM report that the resources of the NIH, US Department of Veterans Affairs, the Agency for Healthcare Research and Quality, and the Patient-Centered Outcomes Research Institute will be needed to support transformative research in this area. With such an investment, the promise of new basic and clinical science discoveries will not be realized. The AHA has been and will continue to be a major advocate for this key area of scientific investigation.

As part of AHA’s package of new initiatives in response to the IOM recommendations, the AHA has committed to actively pursue philanthropic support for local and regional implementation opportunities to increase cardiac arrest survival by improving out-of-hospital and in-hospital systems of care. Similar to the discovery science goals of the proposed Resuscitation Science Research network, this program is envisioned to serve as a pipeline of proof-of-concept research projects that will feed into a larger federally funded programs to support definitive and transforming implementation science in cardiac arrest care.

**AHA Commitment 2: Cultivate philanthropic support for implementation opportunities.**
IOM Recommendation 8. Create a National Cardiac Arrest Collaborative.(13)

The American Heart Association and the American Red Cross—with the U.S. Department of Health and Human Services and other federal agencies, national and international resuscitation councils, professional organizations, private industry, and patient advocates—should establish a National Cardiac Arrest Collaborative to unify the cardiac arrest field, identify common goals, and build momentum within the field to ultimately improve survival from cardiac arrest with good neurologic and functional outcomes.

The Collaborative should

- Provide a platform for information exchange about key successes and failures in different systems and settings and for stakeholder communication about new research findings and initiatives;
- Convene working groups on short- and long-term national research priorities for cardiac resuscitation and post-arrest care, which focus on critical knowledge gaps (such as the impact of care transitions; the organization, composition and training of resuscitation teams; optimal timing of initial neurological evaluation; and appropriate withdrawal-of care protocols);
- Develop action strategies related to health policy, research funding and translation, continuous quality improvement, and public awareness and training;
- Produce and update toolkits for different stakeholders (e.g., emergency medical services [EMS] systems, hospitals, local health departments, and local health care providers) in order to facilitate effective system and individual responses to cardiac arrest;
- Hold an annual collaborative meeting in conjunction with a regularly scheduled health professional conference to discuss short- and long-term goals and progress; and
- Encourage public–private partnerships to support activities that focus on reducing the time to defibrillation for cardiac arrest, including the development of technologies to facilitate automated-external-defibrillator registries for use by the public, EMS systems, and other stakeholders.

Past and Current AHA Initiatives

The AHA has a long history of leadership and collaboration in the field of cardiac arrest with the stakeholder organizations outlined above. On the international front, the AHA is a founding member of ILCOR.(92) ILCOR was formed in 1992 to provide a forum for liaison between principal resuscitation organizations worldwide. Member councils and objectives are listed in Table 11. These objectives are strongly aligned with those outlined for a National Cardiac Arrest Collaborative. As another example of collaboration, the AHA partnered with the NIH in the Post-resuscitative and initial Utility in Life Saving Efforts (PULSE) initiative(93) that brought together key national stakeholders to set research priorities for resuscitation science. In addition, since 2005, there has been an official National Heart, Lung, and Blood Institute and Food and Drug Administration liaison to the AHA Emergency Cardiovascular Care Committee. The AHA
Emergency Cardiovascular Care Committee has also partnered with American Red Cross to jointly develop national guidelines for first aid since 2004. (94, 95) And since 1987, the American Academy of Pediatrics and the American Heart Association have worked closely together to collaboratively develop and support neonatal and pediatric resuscitation guidelines and joint education programs to ensure the unique needs of neonatal and pediatric patients. (96)

**Opportunities to Improve Outcomes**

The AHA embraces the IOM recommendation to help develop and lead a National Cardiac Arrest Collaborative. This vision is very consistent with the AHA vision of a resuscitation learning health system (Figure 1). In response to this recommendation, the AHA will engage key stakeholders in planning an initial forum for the National Cardiac Arrest Collaborative with a target date of spring 2016. Identifying a sustainable funding mechanism will be critical to the success of this initiative. In addition, as we develop a national collaborative strategy, it will be important to maintain engagement and collaboration with international stakeholders who have and continue to make major contributions to the field.

**AHA Commitment 4: Cosponsor a “National Cardiac Arrest Summit” to facilitate the creation of a national cardiac arrest collaborative that will unify the field and identify common goals to improve survival.**

The world of resuscitation scientists are pulling together globally to build high-quality registries as the United States and Canada did for ROC as they know the future of clinical trials lies with enabling RCTs through layering onto existing registries. (97) Although the NIH funding of the current model is ending, over the past 10 years, ROC has been an outstanding example of a North American clinical trials network. Encouragingly, the ROC model is being used to launch (98) networks in European countries, Pan Asian, Australia, and Canada. Large global collaborative high-quality networks have tremendous potential to launch RCTs to answer questions in resuscitation much faster than any network alone could accomplish and with a reduction in the total cost of the trial by layering onto existing infrastructure for the high-quality registry. Thus, the recommended creation of a national cardiac arrest collaborative fills a gap left by the withdrawal of NIH support for ROC and may enable the US scientific community to lead internationally and to collaborate with other national networks across the world.
# Writing Group Disclosures

<table>
<thead>
<tr>
<th>Writing Group Member</th>
<th>Employment</th>
<th>Research Grant</th>
<th>Other Research Support</th>
<th>Speakers' Bureau/Honoraria</th>
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<th>Ownership Interest</th>
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<td>Robert W. Neumar</td>
<td>University of Michigan</td>
<td>Active: R01HL123227. Reperfusion Injury Protection Strategies During Basic Life Support. Role: PI of NIH subcontract from University of Minnesota†; Pending: R44HL091616. Commercialization of a Simple Automatic Perfusion System for ECPR. Role Co-PI, NIH subcontract from Michigan Critical Care Consultants, Inc†</td>
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<td>Clifton W. Callaway</td>
<td>University of Pittsburgh, UPMC Health System</td>
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<td>Brian Eigle</td>
<td>American Heart Association</td>
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<td>N.A. Mark Estes III</td>
<td>Tufts Medical Center</td>
<td>None</td>
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<td>None</td>
<td>None</td>
<td>Boston Scientific - Educational Consultant†; St. Jude Medical - Educational Consultant†; Medtronic-Quality and Safety Consultant*</td>
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<tr>
<td>James G. Jollis</td>
<td>Duke University</td>
<td>Research Grants, &gt;$10,000, all of which goes through the Duke University Office of Grants and Contracts and IRB, and pays for grants. These include: AstraZeneca, Themedicines Company, Philips Healthcare, Medtronic Foundation†</td>
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<td>Monica E. Kleinman</td>
<td>Children's Hospital Anesthesia Foundation at Boston Children’s Hospital</td>
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<td>Laurie Morrison</td>
<td>St Michael's Hospital health care institute, University of Toronto</td>
<td>NIH Grant - ROC - grant goes to my research institution at St Michael's Hospital†</td>
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<td>Mary Ann Peberdy</td>
<td>Virginia Commonwealth University</td>
<td>Life Vest in Hospitalized patients. Sponsored by Zoll Medical. The funds go to my institution*</td>
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<td>Alejandro Rabinstein</td>
<td>Mayo Clinic</td>
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<td>Thomas D. Rea</td>
<td>University of Washington</td>
<td>Medtronic Foundation - Grant to improve resuscitation care on a statewide (regional) basis*; NIH - Resuscitation Outcomes Consortium - Grant to evaluate promising therapies related to resuscitation*; Life Sciences Discovery Fund - Grant to evaluate methods to assess arrest rhythm during CPR*; Philips Inc. - Grant to evaluate novel CPR metrics (duty cycle) and their relationship with outcome*; American Heart Association - Grant (submitted) to evaluate the relationship between socioeconomic status and resuscitation outcome*</td>
<td>None</td>
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<td>Co-author on a provisional patent to read ECG rhythm during CPR. Patent is property of the University of Washington with any receipts returning to the University and not the investigators*</td>
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<td>Sue Sendelbach</td>
<td>Abbott Northwestern Hospital</td>
<td>Neuropsychological and functional outcomes in patients following a cardiac arrest with therapeutic hypothermia. Abbott Northwestern Hospital Foundation. It was a $100,000 but none of my salary was included in the grant†; Temperature measurement in patients undergoing therapeutic hypothermia post cardiac arrest: A comparison of pulmonary artery core temperature to oral, temporal artery, bladder and esophageal temperatures*</td>
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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be “significant” if (a) the person receives $10,000 or more during any 12-month period, or 5% or more of the person’s gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10,000 or more of the fair market value of the entity. A relationship is considered to be “modest” if it is less than “significant” under the preceding definition.

*Modest.
†Significant.
REFERENCES


Table 1. American Heart Association Emergency Cardiovascular Care Committee 2020 Impact Goals

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<th>Increase Survival From Cardiac Arrest</th>
<th>Double Out-of-Hospital CPR Bystander Response</th>
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<td><strong>In-Hospital:</strong></td>
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<tr>
<td>• Adult – From 19% to 38%</td>
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<td>• Children – From 35% to 50%</td>
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<td><strong>Out-of-Hospital:</strong></td>
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<td>• All – From 7.9% to 15.8%</td>
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<td><strong>ACTION STRATEGIES</strong></td>
<td><strong>ACTION STRATEGIES</strong></td>
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<td>Improve Quality of CPR Delivered</td>
<td>Leverage existing science on the bystander effect and encourage additional research</td>
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<td>Establish data collection, reporting and benchmarks to improve surveillance and outcomes</td>
<td>Expand program development to build bystander confidence to perform CPR</td>
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<td>Define elements of comprehensive Resuscitation System of Care and a recognition program to encourage implementation</td>
<td>Advocate for emergency medical dispatch coverage in every community and develop tools to support implementation</td>
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<td>Explore issues related to quality of life after an event</td>
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< < < < < Increase Global AHA Training from 12.3 million/y to 20 million/y > > > >
< < < < < Continue to support and expand science and business innovation > > > >
Table 2. Recommendations from the 2015 IOM Report entitled Strategies to Improve Cardiac Arrest Survival: A Time to Act

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<th>Recommendation</th>
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<tr>
<td>1</td>
<td>Establish a National Cardiac Arrest Registry</td>
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<td>2</td>
<td>Foster a Culture of Action Through Public Awareness and Training</td>
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<td>3</td>
<td>Enhance the Capabilities and Performance of Emergency Medical Services (EMS) Systems</td>
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<td>4</td>
<td>Set National Accreditation Standards Related to Cardiac Arrest for Hospitals and Health Care Systems.</td>
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<td>5</td>
<td>Adopt Continuous Quality Improvement Programs.</td>
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<td>6</td>
<td>Accelerate Research on Pathophysiology, New Therapies, and Translation of Science for Cardiac Arrest</td>
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<td>7</td>
<td>Accelerate Research on the Evaluation and Adoption of Cardiac Arrest Therapies</td>
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<td>8</td>
<td>Create a National Cardiac Arrest Collaborative</td>
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<td><strong>Response to Cardiac Arrest and Selected Life-Threatening Medical Emergencies The Medical Emergency Response Plan in Schools A Statement for Healthcare Providers, Policymakers, School Administrators, and Community Leaders (20)</strong></td>
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<td><strong>Lay Rescuer Automated External Defibrillator (&quot;Public Access Defibrillation&quot;) Programs – Lessons Learned from an International Multicenter Trial (15)</strong></td>
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<td><strong>2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care (29)</strong></td>
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<td><strong>Community Lay Rescuer Automated External Defibrillation Programs Key State Legislative Components and Implementation Strategies A Summary of a Decade of Experience for Healthcare Providers, Policymakers, Legislators, Employers, and Community Leaders (21)</strong></td>
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<td><strong>Essential Features of a Surveillance System to Support the Prevention and Management of Heart Disease and Stroke (31)</strong></td>
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<td>2011</td>
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<tr>
<td>Importance and Implementation of Training in Cardiopulmonary Resuscitation and Automated External Defibrillation in Schools (18)</td>
<td>2011</td>
</tr>
<tr>
<td>Emergency Medical Service Dispatch Cardiopulmonary Resuscitation Prearrival Instructions to Improve Survival from Out-of-Hospital Cardiac Arrest (17)</td>
<td>2012</td>
</tr>
<tr>
<td>Increasing Cardiopulmonary Resuscitation Provision in Communities with Low Bystander Cardiopulmonary Resuscitation Rates A Science Advisory From the American Heart Association for Healthcare Providers, Policymakers, Public Health Departments, and Community Leaders (16)</td>
<td>2013</td>
</tr>
<tr>
<td>Strategies for Improving Survival After In-Hospital Cardiac Arrest in the United States: 2013 Consensus Recommendations (12)</td>
<td>2013</td>
</tr>
<tr>
<td>Cardiopulmonary Resuscitation Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital (36)</td>
<td>2013</td>
</tr>
<tr>
<td>Impact of Percutaneous Coronary Intervention Performance Reporting on Cardiac Resuscitation Centers (37)</td>
<td>2013</td>
</tr>
</tbody>
</table>

DOI: 10.1161/CIR.0000000000000233
Table 4. Ongoing AHA Initiatives Related to the 2015 IOM Cardiac Arrest Recommendations

<table>
<thead>
<tr>
<th>Ongoing AHA Initiative</th>
<th>IOM Recommendations</th>
<th>National Registry</th>
<th>Culture of Action</th>
<th>Dispatch &amp; EMS</th>
<th>National Accreditation</th>
<th>CQI</th>
<th>Discovery Science</th>
<th>Implementation Science</th>
<th>National Collaborative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advocate for and support CPR training in schools (25)</td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>Hands-Only CPR (9)</td>
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<tr>
<td>Supporting Good Samaritan law coverage (38)</td>
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<tr>
<td>CPR &amp; AED Awareness Week (39)</td>
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<tr>
<td>Mission: Lifeline Resuscitation (40)</td>
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<td>X</td>
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<tr>
<td>Get with the Guidelines-Resuscitation (41)</td>
<td></td>
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<tr>
<td>Hospital and Systems Recognition, Accreditation and Certification (42)</td>
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<tr>
<td>AHA Major Science Classifications for “Cardiac Arrest” with independent study sections for cardiac arrest basic science and clinical/populations science grant proposals (43)</td>
<td></td>
<td></td>
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<td>X</td>
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<tr>
<td>Corporate CPR &amp; AED Training (26)</td>
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<tr>
<td>Community CPR &amp; AED Training (27)</td>
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<tr>
<td>Healthcare Provider Training (BLS, ACLS, PALS, etc.) (44)</td>
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<tr>
<td>Resuscitation Quality Improvement Program (10)</td>
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<tr>
<td>2005 (29) and 2010 (14) AHA Guidelines for CPR &amp; ECC</td>
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<tr>
<td>Public Service Announcements for Hands-Only CPR (8)</td>
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<tr>
<td>CPR in Schools Program (28)</td>
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<tr>
<td>AHA High Quality CPR awareness campaign (45)</td>
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<tr>
<td>ROC Funding (46)</td>
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<tr>
<td>CARES Funding (47)</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Conducts annual Resuscitation Science Symposium (48)</td>
<td></td>
<td></td>
<td></td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Advocates to Congress to support funding of NIH medical research, including for heart disease, stroke, cardiac arrest and other cardiovascular diseases (38)</td>
<td></td>
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<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>American Heart Association/American Stroke Association advocates for public policies and resources that support a comprehensive approach to addressing Out-of-Hospital Cardiac Arrest (38)</td>
<td></td>
<td></td>
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<td>X</td>
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</tr>
</tbody>
</table>
Table 5. AHA Emergency Cardiovascular Care Committee Resuscitation Systems of Care Metrics.

<table>
<thead>
<tr>
<th>SPHERE</th>
<th>ACTORS</th>
<th>METRIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOSPITAL*</td>
<td>The Joint Commission NQF CMS</td>
<td>Adult in-hospital cardiac arrest survival rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pediatric in-hospital cardiac arrest survival rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adult in-hospital cardiac arrest rate in noncritical care, nonprocedural inpatient areas per 1000 patient-days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pediatric in-hospital cardiac arrest rate in non-critical care, nonprocedural inpatient areas per 1000 patient-days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of hospitals with at least 200 beds reporting in-hospital cardiac arrest incidence and outcomes to a national registry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of in-hospital cardiac arrests with attempted resuscitation in which objective CPR performance data were monitored</td>
</tr>
<tr>
<td>COMMUNITY</td>
<td>State legislative bodies</td>
<td>Bystander CPR rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of states with CPR training as a high school graduation requirement</td>
</tr>
<tr>
<td>PRE-HOSPITAL*</td>
<td>State legislative bodies</td>
<td>Survival rate from EMS treated out-of-hospital cardiac arrest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of out-of-hospital cardiac arrests in which dispatch-assisted CPR instructions were provided within 2 minutes of 911 call</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of the US population covered by EMS systems with EMS treated out-of-hospital cardiac arrest outcomes reported to a national registry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of EMS treated out-of-hospital cardiac arrests in which objective CPR performance data were monitored</td>
</tr>
</tbody>
</table>

*Includes only cases with attempted resuscitation - risk adjusted when comparing individual hospitals or systems. Excludes cases with DNAR orders at the time of cardiac arrest. Excludes newly born admissions.
Table 6. Distribution of 2010 AHA Guidelines for CPR and ECC by Class of Recommendation and Level of Evidence.(14)

<table>
<thead>
<tr>
<th>Class of Recommendation</th>
<th>#</th>
<th>Level of Evidence</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>162</td>
<td>A</td>
<td>57</td>
</tr>
<tr>
<td>IIa</td>
<td>196</td>
<td>B</td>
<td>256</td>
</tr>
<tr>
<td>IIb</td>
<td>265</td>
<td>C - LD</td>
<td>372</td>
</tr>
<tr>
<td>III</td>
<td>63</td>
<td>Total</td>
<td>685</td>
</tr>
<tr>
<td>Total</td>
<td>686</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7. Number of MEDLINE Citations of Clinical Trials or Randomized Controlled Trials in Cardiac Arrest Resuscitation Compared With Myocardial Infarction, Stroke or Heart Failure.(78)

<table>
<thead>
<tr>
<th>MeSH Terms Searched (Exploded)</th>
<th>Search Terms Excluded Using Boolean Operator</th>
<th>Published RCTs, n</th>
<th>Deaths per Year, n</th>
<th>Published RCTs per 10,000 Deaths per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction</td>
<td>MeSH: resuscitation, heart arrest, stroke, heart failure, education, -education (subheading)</td>
<td>7691</td>
<td>157,000</td>
<td>490</td>
</tr>
<tr>
<td>Stroke</td>
<td>MeSH terms: resuscitation, heart arrest, myocardial infarction, heart failure, education, -education (subheading)</td>
<td>3639</td>
<td>150,000</td>
<td>243</td>
</tr>
<tr>
<td>Heart failure</td>
<td>MeSH terms: resuscitation, heart arrest, stroke, myocardial infarction, education, -education (subheading)</td>
<td>4108</td>
<td>284,000</td>
<td>145</td>
</tr>
<tr>
<td>Heart arrest and resuscitation</td>
<td>MeSH: myocardial infarction, stroke, heart failure, education, -education (subheading) text words: simulat*, mankan*</td>
<td>177</td>
<td>310,000</td>
<td>6</td>
</tr>
</tbody>
</table>

Limits that were applied to the searches: humans, clinical trial, randomized controlled trial, and English. “Clinical trials” indexing term was introduced in 1965; “randomized controlled trials” indexing term was introduced in 1990.

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Table 8. National Institutes of Health Study Sections That Review Cardiac Arrest Research Applications

<table>
<thead>
<tr>
<th>Study Section</th>
<th>Topic Reviewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical and Integrative Cardiovascular Sciences Study Section [CICS]</td>
<td>Human clinical studies (and appropriate translational animal studies): including pediatric populations, mechanisms and consequences of disease: Disease states can include: cardiac or vascular ischemia, hypertension, diabetes, thyroid disease, atherosclerosis, general inflammation, or hypercholesterolemia. Modulation of cardiac/cardiovascular responses and adaptations: influence of acute and chronic exercise on metabolic function and cardiac, vascular smooth muscle, and vascular endothelial function(s). Pregnancy and aging may be considered modulatory influences. Clinical, population, or translational studies of the responses of the cardiovascular system to trauma or surgery: arrhythmias associated with cardiac surgery or cardiopulmonary bypass, cardiac sudden death, resuscitation, stenting, pacemakers; cardiovascular injury and repair, and myocardial ischemia/reperfusion injury.</td>
</tr>
<tr>
<td>Cardiovascular Sciences Small Business Activities SEP [ZRG1 CVRS-C (10)]</td>
<td>Emergency medicine, resuscitation, laboratory medicine, clinical chemistry, biomarkers</td>
</tr>
<tr>
<td>Physiology and Pathobiology of Cardiovascular and Respiratory Systems (F10A)</td>
<td>Experimental models, clinical studies and studies on mechanisms of disease states including exercise physiology as related to cardiac and pulmonary metabolism, oxygen, contractility, and respiratory function and regulation</td>
</tr>
</tbody>
</table>
### Table 9. American Heart Association Peer Review Groups That Review Cardiac Arrest Research Applications

<table>
<thead>
<tr>
<th>Major Science Categories n=53</th>
<th>Subcategories n~ 20 per Science Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiac Arrest/Resuscitation - Clinical Science</strong> Airway management/ventilation/oxygenation during CPR Bystander CPR/Layperson CPR Cardiac arrest early detection/ recognition Cardiac arrest in pregnancy Cardiac arrest prevention Clinical trials CPR Devices/Mechanical CPR CPR quality Defibrillation/AEDs Dispatch assisted CPR EMS performance Intra-arrest prognostication/Termination of CPR Intravenous/intraosseous access during CPR Neonatal cardiac arrest and resuscitation Patient safety and quality Pediatric cardiac arrest and resuscitation Post-cardiac arrest brain injury and neuroprotection Post-cardiac arrest cardiovascular dysfunction Post-cardiac arrest hemodynamic optimization Post-cardiac arrest management of STEMI and ACS Post-cardiac arrest prognostication Post-cardiac arrest rehabilitation Post-cardiac arrest targeted temperature management/therapeutic hypothermia Post-cardiac arrest ventilation/oxygenation Resuscitation ethics</td>
<td></td>
</tr>
</tbody>
</table>
| Cardiac Arrest/Resuscitation - Basic Science | Airway management/ventilation/oxygenation during CPR  
CPR devices/Mechanical CPR  
CPR physiology  
Defibrillation  
Extracorporeal CPR (ECPR)  
Mechanisms of post-cardiac arrest brain injury and repair  
Neonatal cardiac arrest and resuscitation  
Pediatric cardiac arrest and resuscitation  
Physiologic monitoring during CPR  
Post-cardiac arrest syndrome: pathophysiology and treatment  
Post-conditioning after cardiac arrest  
Therapeutic hypothermia and targeted temperature management |
| Cardiac Arrest/Resuscitation - Population/Health Services Science | Bystander CPR/Layperson CPR  
CPR/AED training  
Dispatch assisted CPR  
Epidemiology of cardiac arrest and resuscitation  
Health care policy  
Provider Education/Simulation  
Public access AEDs  
Quality assessment and improvement  
Risk factors and prevention  
Surveillance and reporting  
Systems of care for in-hospital cardiac arrest  
Systems of care for out-of-hospital cardiac arrest |
Table 10. Number of Research Projects Funded by the National Heart, Lung, and Blood Institute From 1985 to 2009.(78)

<table>
<thead>
<tr>
<th>Terms Searched</th>
<th>Funded Studies, n</th>
<th>Deaths per Year, n</th>
<th>Funded Studies per 10,000 Deaths per Year, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction</td>
<td>6886</td>
<td>157 000</td>
<td>439</td>
</tr>
<tr>
<td>Stroke</td>
<td>4403</td>
<td>150 000</td>
<td>294</td>
</tr>
<tr>
<td>Heart failure</td>
<td>9919</td>
<td>284 000</td>
<td>349</td>
</tr>
<tr>
<td>Heart arrest and resuscitation</td>
<td>257</td>
<td>310 000</td>
<td>8</td>
</tr>
</tbody>
</table>

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Table 11. International Liaison Committee on Resuscitation

<table>
<thead>
<tr>
<th>Member Councils</th>
<th>ILCOR Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Heart Association (AHA)</td>
<td>Provide a forum for discussion and for coordination of all aspects of cardiopulmonary and cerebral resuscitation worldwide.</td>
</tr>
<tr>
<td>European Resuscitation Council (ERC)</td>
<td>Foster scientific research in areas of resuscitation where there is a lack of data or where there is controversy.</td>
</tr>
<tr>
<td>Heart and Stroke Foundation of Canada (HSFC)</td>
<td>Disseminate information on training and education in resuscitation.</td>
</tr>
<tr>
<td>Australian and New Zealand Committee on Resuscitation (ANZCOR)</td>
<td>Provide a mechanism for collecting, reviewing and sharing international scientific data on resuscitation.</td>
</tr>
<tr>
<td>Resuscitation Councils of Southern Africa (RCSA)</td>
<td>Produce statements on specific issues related to resuscitation that reflect international consensus.</td>
</tr>
<tr>
<td>Inter American Heart Foundation (IAHF)</td>
<td></td>
</tr>
<tr>
<td>Resuscitation Council of Asia (RCA)</td>
<td></td>
</tr>
</tbody>
</table>
Figure 1. Resuscitation Learning Health System. The “EMS Registry” collects and connects both out-of-hospital and in-hospital data.
Figure 2. AHA Chain of Survival.(14)
**Figure 3.** AHA Activities to Influence Bystander Response During Cardiac Arrest.
**Figure 4. Proposed Resuscitation System of Care.** Adapted from Regional Systems of Care for out-of-hospital cardiac arrest. (35) It is unlikely that all Cardiac Resuscitation Centers will provide care to adults, pediatric and maternal cardiac arrest. Thus not all centers will train staff in PALS or maternal cardiac arrest and implementation requirements are different for each patient type. Figure 4 is more closely aligned with the requirements for resuscitation centers for adult non pregnant cardiac arrest.

**PROPOSED RESUSCITATION SYSTEM OF CARE**

- EMS RESPONSE
  - High-Quality CPR
  - CPR feedback
  - Rapid Defibrillation
  - Debridement
  - Monitors, reports & improves outcomes
  - Reimbursed for participation

- TRANSPORT TO APPROPRIATE HOSPITAL

- LEVEL ONE CARDIAC RESUSCITATION CENTER (ALL LEVEL 2 PLUS)
  - Aligned with STEMI Centers
  - Capable of PCI
  - Treated >40/year OHCA post—arrest patients
  - Meets ACC/AHA STEMI Guidelines for PCI
  - Resuscitation services 24x7
  - Capable of EP testing and ICD assessment & placement
  - Provides PALS training for staff (if Pediatric Receiving Center)
  - Defers assessment of prognosis for 72 hours after arrest
  - Establishes and maintains multidisciplinary team to monitor and improve resuscitation process and outcome

- LEVEL TWO CARDIAC RESUSCITATION CENTER
  - Develops plan with EMS medical direction
  - External certification not self-designation
  - Initiates hypothermia as soon as feasible when indicated
  - Early transport of OHCA post—arrest patients to Level 1 CRC
  - Plan and treat for re-arrest
  - Provides CPR & ACLS training for staff
  - Monitors, reports & improves outcomes
  - Reimbursed for participation