Part 4: Systems of Care and Continuous Quality Improvement

2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

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Introduction

The science and recommendations discussed in the other Parts of the *2015 American Heart Association* (AHA) *Guidelines Update for Cardiopulmonary Resuscitation* (CPR) *and Emergency Cardiovascular Care* (ECC) form the backbone of resuscitation. They answer the "why", "what," and "when" of performing resuscitation steps. In a perfectly controlled and predictable environment, such as a laboratory setting, those answers often suffice, but the "how" of actual implementation depends on knowing the "who" and "where" as well. The ideal work flow to accomplish resuscitation successfully is highly dependent on the system of care as a whole.

Healthcare delivery requires structure (eg, people, equipment, education, prospective registry data collection) and process (eg, policies, protocols, procedures), which, when integrated, produce a system (eg, programs, organizations, cultures) leading to outcomes (eg, patient safety, quality, satisfaction). An effective system of care (Figure 1) comprises all of these elements—structure, process, system, and patient outcomes—in a framework of continuous quality improvement (CQI).

In this Part, we will focus on 2 distinct systems of care: the system for patients who arrest inside the hospital and the one for those who arrest outside it. We will set into context the building blocks for a system of care for cardiac arrest, with consideration of the setting, team, and available resources, as well as CQI from the moment the patient becomes unstable until after the patient is discharged.

The chain of survival metaphor, first used almost 25 years ago,[1] is still very relevant. However, it may be helpful to create 2 separate chains (Figure 2) to reflect the differences in the steps needed for response to cardiac arrest in the hospital (in-hospital cardiac arrest [IHCA]) and out of the hospital (out of hospital cardiac arrest [OHCA]). Regardless of where an arrest occurs, the care following resuscitation converges in the hospital, generally in an emergency department (ED) or intensive care unit (ICU). This post–cardiac arrest care is depicted as the final link in both chains, symbolized by a hospital bed with a monitor and thermometer, which represent advanced monitoring and targeted temperature management. As noted above, the structure and process elements before the convergence of the 2 chains, however, vary significantly.

Patients with OHCA depend on elements within the community for support. Lay rescuers must recognize the patient's arrest, call for help, and initiate CPR and early defibrillation (public-access defibrillation [PAD]) until a team of professionally trained emergency medical services (EMS) providers assumes responsibility and then transports the patient to an ED and/or cardiac catheterization lab, and then on to an ICU for post–cardiac arrest care. Ideally, all victims of OHCA receive bystander CPR and defibrillation; if not, CPR and defibrillation won't occur until EMS personnel arrive, and the victim's chance of survival is then much lower.

In contrast, patients with IHCA depend on a system of appropriate surveillance and prevention of cardiac arrest, which is represented by a magnifying glass in the first link. When cardiac arrest occurs, prompt notification and response to a cardiac arrest should result in the smooth interaction of a multidisciplinary team of professional providers, including physicians, nurses, respiratory therapists, and others. This team provides high-quality CPR, prompt defibrillation, and advanced cardiovascular life support when appropriate. The chain metaphor endures: in any resuscitation, the chain is no stronger than its weakest link.

The level of complexity is high for both in-hospital and out-of-hospital systems. The challenges encountered, however, are different. Teamwork and coordination among responders is a critical determinant of patient outcomes. An in-hospital multidisciplinary team has immediate access to additional personnel as well as all the resources of the ED, ICU, and laboratories, whereas in out-of-hospital settings, 2 paramedics may find themselves alone with no resources except those they brought with them. Factors such as crowd control, family presence, space constraints, transportation,

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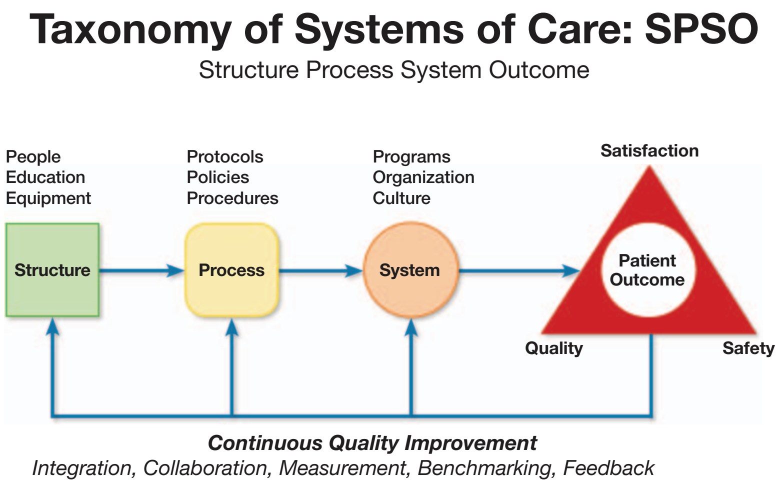

Figure 1. Taxonomy of systems of care.

and device failures can be common to both settings. In both settings, systems must be in place to address expected and unexpected challenges and must be continually monitored and re-examined to address their flaws and failures.

The classic resuscitation Chain of Survival concept linked the community to EMS and EMS to hospitals, with hospital care as the destination.[1] But patients with a cardiac emergency may enter the system of care at one of many different points (Figure 3).

A cardiac arrest can present anywhere, any time—on the street or at home, but also in the hospital's ED, inpatient bed, ICU, operating suite, catheterization suite, or imaging department. The system of care must be able to manage cardiac emergencies wherever they occur.

The concept of a system of care has been applied previously in emergency care, including regional systems of care for trauma, stroke, and ST-segment elevation myocardial infarction (STEMI). This Part addresses the idea that IHCA has similarities to, but is very different from, OHCA. It also considers how the elements of a system of care apply to the comprehensive management of cardiac arrest.

In-Hospital Cardiac Arrest

Epidemiology

IHCA is a major patient safety and public health concern. Approximately 209 000 adults[2] and more than 6000 children[3] receive CPR for IHCAs in the United States annually. In contrast to adult OHCAs, which are mostly due to presumed cardiac etiologies and occur unexpectedly, most IHCAs are secondary to presumed acute respiratory compromise and/or circulatory shock, with predictable progressive deterioration before the event.[4–6] Although CPR training programs have tended to focus on out-of-hospital CPR, professional in-hospital CPR is provided to similar numbers of adults and children each year as professional out-of-hospital CPR, and the patient characteristics, rescuers, and systems of care are quite different.

Figure 2. System-specific Chains of Survival.

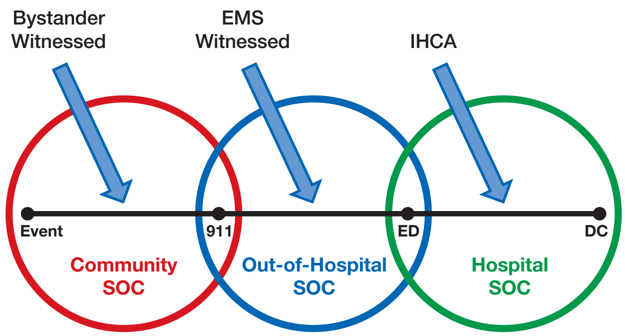

Figure 3. Patient's point of entry.

Outcomes from in-hospital CPR have improved over the past 10 to 15 years within hospitals participating in the AHA's Get With The Guidelines®-Resuscitation program. For adults, there has been improvement, with risk-adjusted rates of survival to discharge increased by 4% per year, from 13.7% in 2000 to 22.3% in 2009.[5] Importantly, more than 80% of these adult IHCA survivors had relatively favorable neurologic outcomes, with Cerebral Performance Category (CPC) scores of 1 or 2 at hospital discharge.[5] For children, risk-adjusted rates of survival to discharge increased by 8% per year from 2000 to 2009, with unadjusted survival rates increasing from 14.3% to 39.4%.[6]

Notably, case-mix–adjusted IHCA incidence rates and survival rates vary considerably across hospitals. For example, case-mix–adjusted incidence of adult cardiac arrest was twice as high in the bottom quartile of Get With The Guidelines-Resuscitation hospitals compared with the top quartile (1.3/1000 bed-days versus 0.7/1000 bed-days).[7] Conversely, the case-mix–adjusted rates of survival to discharge were nearly double in the top decile of Get With The Guidelines-Resuscitation hospitals compared with the bottom decile (22.7% versus 12.4%).[8] These data also showed a 42% greater likelihood of patients with identical covariates surviving to hospital discharge at one randomly selected Get With The Guidelines-Resuscitation hospital compared with another.[8] Similarly, the range of risk-standardized survival rates for pediatric cardiac arrest varied from 29% to 48%.[9] These variabilities in incidences and outcomes suggest that more cardiac arrests can be prevented and that survival rates can be improved through effective quality improvement strategies.

Other IHCA data raise concerns about potential deficiencies in our systems for treatment of IHCAs in the United States. As with other medical issues, survival rates from IHCAs are substantially lower on nights and weekends compared with weekdays,[10] which suggests differential quality within hospitals by both time and day. In addition, lower-income patients and African-American patients have lower survival rates after an IHCA.[7,11] After controlling for the hospital site where the cardiac arrest occurred, the disparity was essentially ameliorated, which suggests differential quality across hospitals.[11]

Because most IHCAs are secondary to respiratory failure and/or circulatory shock, quality improvement efforts with rapid response teams and medical emergency teams have focused on early recognition of respiratory failure, shock, and neurologic deterioration of patients at risk, with targeted interventions and transfers to highly monitored intensive care settings. Perhaps as a result of such efforts, cardiac arrests and CPR on general wards are much less common than cardiac arrests and CPR in ICUs and other highly monitored units, such as the ED, operating suites, and cardiac catheterization suites. Only 5% of pediatric in-hospital CPR occurred on general wards in Get With The Guidelines-Resuscitation hospitals from 2000 to 2010, compared with 74% in ICUs, 10% in the ED, 5% in the operating suite, and 6% in a procedural suite, such as interventional radiology or cardiac catheterization suites. In addition, the relative frequency of ward CPR decreased substantially over that decade.[12] Similarly, 19% of adult CPR was provided on unmonitored wards, 16% in telemetry, 48% in ICUs units, and 18% in EDs or operating or procedural suites.[13] These data suggest that most in-hospital CPR is provided in ICUs, EDs, operating rooms, and other procedural units where teams and systems can be optimized to provide the highest level of care.

Prearrest Rapid Response Systems

Recognition *EIT 638, Peds 818*

The wide variability in incidence and location of cardiac arrest in the hospital suggests potential areas for standardization of quality and prevention of at least some cardiac arrests. More than half of cardiac arrests in the hospital are the result of respiratory failure or hypovolemic shock, and the majority of these events are foreshadowed by changes in physiology, such as tachypnea, tachycardia, and hypotension. As such, cardiac arrest in the hospital often represents the progression of physiologic instability and a failure to identify and stabilize the patient in a timely manner. This scenario is more common on the general wards, outside of critical care and procedural areas, where patient-to-nurse ratios are higher and monitoring of patients less intense. In this setting, intermittent manual vital sign monitoring with less frequent direct observation by clinicians may increase the likelihood of delayed recognition. An observational study of both surgical and medical wards reported that approximately 1 in 5 patients developed abnormal vital signs, and more than 50% of these events went unnoticed by nursing staff. Patients with abnormal vital signs had a threefold higher 30-day mortality rate.[14]

Strategies to combat delayed recognition of patient deterioration include increased electronic monitoring of high-risk patients in the form of traditional electrocardiogram (ECG)-based telemetry, newer heart and respiratory rate sensors, or increased clinician surveillance. In addition, composite risk scores, such as the Modified Early Warning Score (MEWS) and more complex, statistically derived algorithms, which can include laboratory data, increase the discrimination for detection compared with single-parameter criteria.

Early Warning Sign Systems, Rapid Response Teams, and Medical Emergency Team Systems—Updated

Rapid response teams (RRTs) or medical emergency teams (METs) were established for early intervention in patients whose conditions were deteriorating, with the goal of preventing IHCA.[15,16] They can be composed of varying combinations of physicians, nurses, and respiratory therapists. These teams are usually summoned to patient bedsides when an acute deterioration is recognized by other hospital staff. Monitoring and resuscitation equipment and drug therapies often accompany the team. The 2015 ILCOR systematic review addressed the use of early warning sign systems (EWSS), RRTs, and METs in children and adults.

The evidence for EWSS was demonstrated in 1 before-after study by using an aggregated weighted scoring system (MEWS), which reported significantly higher cardiac arrest rates in MEWS bands 3 and 4 after intervention but not in MEWS bands 0 through 2 or 5 through 15; however, overall cardiac arrest rate significance was not reported.[17] The evidence for RRTs or METs in adults consists of a ward-randomized trial[18] and numerous observational studies. The introduction of a MET system was associated with a significant improvement in hospital survival[19–33] and a decrease in the incidence of IHCA.[19–29,31,33–40] A cluster-randomized trial and several other observational studies failed to confirm those results.[17,34,36,39,41–51]

The evidence for RRTs or METs and the usefulness of a Pediatric Early Warning System (PEWS) in children is observational but contradictory, and it is not as consistent in showing a decrease in either the incidence of cardiac and/or respiratory arrest outside of the ICU setting[52–54] or hospital mortality[53,55–59] for either PEWS or a MET. However, in a single observational study, PEWS use was associated with a reduction in cardiac arrest rate when used in a single hospital with an established MET system.[60]

2015 Recommendations—Modified

For adult patients, RRT or MET systems can be effective in reducing the incidence of cardiac arrest, particularly in general care wards (Class IIa, LOE C-LD).

Pediatric MET/RRT systems may be considered in facilities where children with high-risk illnesses are cared for on general in-patient units (Class IIb, LOE C-LD).

The use of EWSS may be considered for adults and children (Class IIb, LOE C-LD).

Continuous Assessment

Once patients with acute decompensation or gradual deterioration are recognized and cared for by RRTs, these patients require continuous assessments until stabilized. Patients who are recognized to be at high risk of IHCA or who are refractory to early interventions are generally transferred to high-acuity hospital units (eg, ICUs). With more personnel and resources available (eg, technology, drug therapies), these high-acuity units enable improved monitoring and treatments. Further, there is increasing data indicating that delays in transfer to an ICU are associated with increased mortality. In 1 study, every hour of delay was associated with a 1.5% increase in hospital mortality.[61] Interestingly, the pediatric community of providers has had remarkable success in nearly eradicating cardiac arrest on the general wards and could serve as a model for the adult community. The focus on prevention has been emphasized for pediatrics, as evidenced by the 1998 departure from the traditional Chain of Survival to one that included prevention as a first link in the chain. Pediatric resuscitation experts also led this change in hospitals, and pediatric arrests that occur on general care wards are becoming a thing of the past.

Do Not Attempt Resuscitation and Palliative Care

One of the unintended consequences of the success in developing and promoting modern resuscitation is that, currently, many people who are in the natural process of dying receive CPR at the end of life. Resuscitation has become the default expectation for everyone and, unless specifically noted to the contrary as with an advanced directive or a Do Not Attempt Resuscitation (DNAR) order, is likely to be performed, at least for witnessed deaths. As such, another proposed mechanism for the decrease in cardiac arrest rates associated with RRTs is increased use of palliative care services and DNAR orders for patients who are dying and for whom resuscitation attempts are likely to be futile or inconsistent with their goals of care. Once a patient has a cardiac arrest, institution of a DNAR order to prevent further resuscitation attempts is frequently entertained. However, many of these patients may have been appropriate for consideration of such an order before the arrest, and failure to properly consider it could result in an unwanted aggressive end to life and a waste of considerable resources. As such, it is consistent with a system of care to seek patient or family preferences regarding aggressive resuscitation measures, such as CPR and mechanical ventilation, in patients with advanced age or terminal condition and short life expectancy who are admitted to a hospital, and to issue a DNAR order based on patient or family preference as well as expectation of outcome, taking into account the clinical judgment of experienced providers.

Cardiac Arrest

Even in high-risk, in-hospital environments, cardiac arrests and CPR are relatively uncommon, and the members of the resuscitation teams may be different with each cardiac arrest. Therefore, optimal performance depends on rigorous pre-event interdisciplinary collaborative planning and practice. Excellent outcomes can occur after well-choreographed, high-quality CPR with effective chest compressions, ventilation and early defibrillation.[62] Hospital leaders have the opportunity to optimize outcomes with rigorous resuscitation programs that include the cycle of quality improvement: measurement of performance and outcomes, comparison, interventions to improve outcomes, and continuous measurement of performance and outcomes after interventions.

Activating the IHCA System of Care

Once IHCA is recognized, hospitals are expected to have a standardized method for promptly notifying and activating a team that specializes in treating cardiac arrest. A survey of hospitals revealed that 93% used a hospital-wide public address system, 53% paged or called team members, and 11% used a local alarm.[63]

Crisis Resource Management Principles for Resuscitation Teams

The quality of bedside resuscitation team leadership affects team performance.[64–68] Crisis resource management principles suggest that resuscitation teams will function best when the team knows who is leading the resuscitation efforts, what their individual roles are, and how to communicate and work together most effectively.[69,70] Crisis resource management techniques that have been incorporated for use during in-hospital CPR efforts include training to be an advanced life support team leader, using checklists for leadership activities, standardizing communication, and performing cross-checks for safety of team members before defibrillation (eg, "all clear").[70–74]

Resuscitation Team

Crisis resource management principles suggest that preparation for cardiac arrests and resuscitations include a designated, dedicated resuscitation team available 24 hours a day, 7 days a week, with adequate experience, expertise, and training and retraining to maintain skills, minimize errors, and optimize outcomes.[71,75–77] Although 77% of hospitals from a survey of US hospitals have a predesignated resuscitation team, nearly one quarter do not. Such teams usually consist of varying combinations of physicians, nurses, respiratory therapists, and pharmacists.[63] Some centers include security personnel, clergy, social workers, and others. Furthermore, just-in-time, just-in-place training is an excellent manner for the team members to practice so that they can be prepared to use the equipment and work with their colleagues in their own practice setting.[75] Just-in-time or just-in-place training ranges from activities as simple as training on a manikin in basic life support and the use of a defibrillator[78–80] to interdisciplinary advanced life support at a simulation room embedded in the clinical unit. Hospitals with training programs may require that resuscitation teams include an attending physician with resuscitation experience and expertise to supervise the physician in training on the resuscitation team during the resuscitation.

Training

Few studies have evaluated training programs that improve the early identification of prearrest patients. A longitudinal, multicenter study of the Acute Life-Threatening Events Recognition and Treatment (ALERT) course suggested an increase in prearrest calls, a reduction in the number of IHCAs, and an improved survival-to-discharge rate after IHCA.[81] After the initial training, interval training updates are necessary to maintain these important skills. Recognition of patient deterioration is an element of an IHCA system of care, with physicians, nurses, and staff being able to recognize that deterioration.

Standard advanced cardiovascular life support or pediatric advanced life support courses may not adequately train providers with specific processes unique to individual hospitals. Hospital-specific resuscitation training can be contextualized for the individual wards and hospital settings to increase familiarity and effectiveness of the resuscitation team and responses to cardiac arrest.

Debriefing—Updated[EIT 645]

Acute debriefing for either an individual or the team immediately after the resuscitation event ("hot debriefing") has been a time-honored approach to improve care and has been previously recommended in AHA Guidelines for CPR and ECC.[75] However, finding the time to do this properly in the highly intense and sometimes chaotic postarrest setting is problematic when practitioners are focused on postarrest care and/or communicating time-sensitive and emotionally sensitive information to families and staff. These acute postarrest debriefings may address several domains, including psychomotor skill issues, cognitive issues, team issues, family emotional issues, and professional staff emotional issues.

Another approach to debriefing an individual or the team is to communicate about the various domains at a later time ("cold debriefing"). The advantages of cold debriefing are adequate time for the debriefing personnel to prepare for optimal communication, availability of experienced debriefing personnel, and adequate time for the debriefing communication session to meet and discuss the resuscitation. However, it is often difficult to reconvene the same resuscitation team members at a later meeting.

Alternatively, cold debriefing can include both the resuscitation team that was present at the event and the broader multidisciplinary team of the entire unit so that all can learn from both their own and others' experiences. This allows many more unit members to profit from the experience, and it can result in quality improvement in the unit-wide resuscitation culture. The 2015 ILCOR systematic review examined the utility of briefing and/or debriefing to determine if there was an impact on outcome.

2015 Evidence Review

Data from 2 in-hospital observational before-after studies, 1 in adults[82] and 1 in pediatrics[83] that involved a total 318 patients and 2494 epochs of chest compressions, demonstrated improved outcomes (eg, favorable neurologic outcome at discharge and compression depth, compression rate within target range) after implementation of a data-driven, performance-focused debriefing program for resuscitation team members using CPR-quality defibrillator transcripts.

2015 Recommendation—Updated

It is reasonable for in-hospital systems of care to implement performance-focused debriefing of rescuers after IHCA in both adults and children (Class IIa, LOE C-LD).

Post–Cardiac Arrest

Patients who achieve return of spontaneous circulation (ROSC) after cardiac arrest in any setting have a complex combination of pathophysiologic processes described as post–cardiac arrest syndrome, which includes postarrest brain injury, postarrest myocardial dysfunction, systemic ischemia/reperfusion response, and persistent acute and chronic pathology that may have precipitated the cardiac arrest.[84] Post–cardiac arrest syndrome plays a significant role in patient mortality. Survival rates in IHCA patients who achieve ROSC range from 32% to 54%.[85] Higher-volume hospitals and teaching hospitals have the highest survival rate, with an average survival of 38% for patients who have an arrest outside the ICU and 32% for patients who have an arrest in the ICU.[4]

Comprehensive post–cardiac arrest care requires optimization of hemodynamics, treatment and reversal of precipitating factors, and targeted temperature management and is discussed fully in "Part 8: Post–Cardiac Arrest Care." Routine implementation of existing post–cardiac arrest protocols and order sets helps maintain consistent and optimal care to attenuate the detrimental effects of post–cardiac arrest syndrome. These patients also require access to a collaborative and multidisciplinary team of providers, including cardiologists, interventional cardiologists, cardiac electrophysiologists, intensivists, neurologists, nurses, respiratory therapists, and social workers. If these services are not readily available within the hospital, an effective system of care would include appropriate structures and processes for interhospital transfer to ensure access to these collaborative resources.

Out-of-Hospital Cardiac Arrest

Introduction

OHCA affects approximately 326 000 victims annually in the United States.[2] Given that OHCA has an annual incidence of 132/100 000 population, communities of all sizes should prepare a system of care for the eventual OHCA event.[2] Organized community programs that prepare the lay public to provide bystander CPR and early defibrillation offer the best opportunity for successful resuscitation in the initial minutes after OHCA and represent the community link in the OHCA Chain of Survival. This preparation begins with a surveillance system to measure the incidence and outcomes of OHCA. The AHA Scientific Statement "Essential Features of Designating Out-of-Hospital Cardiac Arrest as a Reportable Event"[86] makes recommendations to achieve the measurement of this public health burden as well as capture the data points needed to address quality improvements for continuous improvement in outcomes from OHCA.

Community

Bystander CPR is a potentially lifesaving procedure that can be performed by community members without equipment or professional credentials. Although bystander CPR plus early defibrillation can more than double the rate of survival from OHCA,[87] the number of OHCA victims who receive bystander CPR remains between 10% and 65%.[2] Recent evidence suggests that chest compression–only CPR is no less effective than traditional CPR when performed by bystanders for adult victims of cardiac arrest in the out-of-hospital setting.[87] CPR training can be accomplished via traditional classes or brief self-instruction media, public policy initiatives such as CPR training as a high school graduation requirement, training of likely rescuers (primarily family members and caregivers of populations at high risk for cardiac arrest), or mass community CPR training in large public venues. CPR training programs can help build a culture of expectation for chest compressions to be performed in whatever setting cardiac arrest occurs.

Further opportunities to provide community CPR training can coincide with the implementation of PAD initiatives. PAD programs provide bystanders with automatic electronic defibrillators (AEDs) that can be used by the lay public to deliver shocks to victims of ventricular fibrillation OHCA.

Public-Access Defibrillation—Updated[BLS 347]

The 2015 ILCOR systematic review compared the implementation of a PAD program with traditional EMS response to determine if there was an impact on outcome from OHCA.

2015 Evidence Review

The ILCOR Basic Life Support Task Force reviewed the evidence involving PAD and its effect on outcome from OHCA. This evidence is derived from many observational studies and 1 randomized controlled trial[88] with associated variations in rates of witnessed arrests, EMS programs, and recommended practice of bystander CPR.[89,90] Evidence from 3 observational studies[91–93] that enrolled 182 119 patients demonstrated improved survival to 30 days with favorable neurologic outcome with PAD compared with no community program. Improved clinical outcomes favoring PAD programs were seen consistently across the studies.[89,90] Some studies included in the ILCOR *2015 International Consensus on CPR and ECC Science With Treatment Recommendations*[89,90] may involve repeat analysis and reporting of the same cardiac arrest population, which limits the ability to provide a summative effect measure in the reported analyses.

2015 Recommendation—Modified

It is recommended that PAD programs for patients with OHCA be implemented in communities with individuals at risk for OHCA (Class I, LOE C-LD).

A system-of-care approach for OHCA might include public policy that encourages reporting of public AED locations to public service access points (PSAPs; PSAPs have replaced the less-precise term "EMS dispatch centers"). Such a policy would enable PSAPs to direct bystanders to retrieve nearby AEDs and assist in their use when OHCA occurs.

Many municipalities as well as the US federal government have enacted legislation to place AEDs in municipal buildings, large public venues, airports, casinos, and schools. For the 20% of OHCAs that occur in public, these community programs represent an important link in the Chain of Survival between recognition and activation of the emergency response system.

Victims of OHCAs that occur in private residences are much less likely to receive chest compressions than are victims who experience cardiac arrest in public settings. Real-time instructions provided by emergency dispatchers may help push in-home callers past the stress or fear that may be inhibiting their willingness to act. These improved outcomes can be achieved by having robust community CPR training programs for cardiac arrest in place in conjunction with effective, prearrival dispatch protocols.

Emergency Medical Services[BLS 740, BLS 359]

PSAPs are the interface between EMS and the communities they serve. While individuals may be unsure of what to do in the setting of a cardiac arrest, the general population knows to call 9-1-1. Herein lies the opportunity to leverage the call for help into strategies for the initiation of early treatment as part of a larger system of care. Communities are best served by PSAPs that are designed to quickly recognize the occurrence of cardiac arrest, dispatch the nearest appropriate resources, and help bystanders provide immediate care before the arrival of EMS.

The link between the call for help to the PSAP and arrival of first medical care is the emergency dispatcher. In disease states that are time dependent, such as cardiac arrest, acute coronary syndrome (ACS), stroke, and trauma, recognition of symptoms and initiation of intervention can result in improved outcomes. In cardiac arrest, dispatcher-guided CPR has been extensively described.[94,95] In these descriptive studies, dispatcher-guided CPR has been shown to reduce time to first compression.

Dispatcher Recognition of Cardiac Arrest—Updated

The 2015 ILCOR systematic review addressed whether there are descriptions of any specific symptoms among adults and children who are in cardiac arrest outside a hospital compared with no description that helped emergency dispatchers identify cardiac arrest. Appropriate recognition of a patient in cardiac arrest is an important component of the discussion between a dispatcher and the bystanders with a cardiac arrest victim. This identification can lead to initiation of dispatcher-guided CPR and provide valuable information to EMS providers.

2015 Evidence Review

Evidence is derived from observational investigations that involve more than 17000 patients from 27 different studies. In 2 studies that evaluated emergency dispatcher recognition alone, the sensitivity of recognition ranged from 18% to 83%.[96,97] In systems that currently have protocols to aid dispatchers in the recognition of cardiac arrest, the sensitivity when using protocols ranged from 38% to 96.9%, with a specificity exceeding 99%. Use of these scripted protocols has been shown to increase the rate of dispatcher-guided CPR.[98–100] The identification of abnormal breathing or agonal gasps is particularly important in the recognition of cardiac arrest by emergency dispatchers. This abnormal pattern is described by a wide range of heterogeneous words and phrases: difficulty breathing, poorly breathing, impaired breathing, occasional breathing, barely/hardly breathing, heavy breathing, labored breathing, sighing, and strange breathing.[96,101] The presence of agonal gasps is a factor that negatively affects the identification of cardiac arrest. One study reported agonal gasps were present in 50% of cardiac arrests that were not identified.[99] Training of emergency dispatchers in the recognition of agonal gasps has been associated with increased dispatcher-guided CPR.[102,103]

2015 Recommendations—Updated

It is recommended that emergency dispatchers determine if a patient is unconscious with abnormal breathing after acquiring the requisite information to determine the location of the event (Class I, LOE C-LD).

If the patient is unconscious with abnormal or absent breathing, it is reasonable for the emergency dispatcher to assume that the patient is in cardiac arrest (Class IIa, LOE C-LD).

Dispatchers should be educated to identify unconsciousness with abnormal and agonal gasps across a range of clinical presentations and descriptions (Class I, LOE C-LD).

There are limited data regarding the use of emergency dispatchers to appropriately identify patients with myocardial infarction. Using a protocol-driven approach, emergency dispatchers have been able to instruct patients with symptoms to self-administer aspirin, but there has not been a study that showed this improved outcomes.[104] However, in a system of care, identification by emergency dispatchers of symptoms that suggest a myocardial infarction may assist in the triage of these patients by EMS personnel and result in rapid transport to hospitals with adequate resources. In stroke patients, there is also evidence for reduced time from scene to hospital,[105] and identification of stroke symptoms by emergency dispatchers and prehospital providers is consistent with a system of care for the appropriate triage of stroke patients within that system of care.

Dispatcher Instruction in CPR—Updated

It has been hypothesized that dispatcher-initiated CPR instruction will improve outcomes, and the ILCOR systematic review sought to identify evidence of improved outcomes. Dispatcher-initiated CPR instruction has become integrated into many systems of care and viewed as an important link between the community and the EMS system.

2015 Evidence Review—Updated

Evidence related to this question was assessed in several studies (1 meta-analysis, 3 randomized clinical trials, and 11 observational studies). There was no statistical benefit in survival with favorable neurologic outcome at the time of hospital discharge to 1 year.[103,106–108] A meta-analysis showed an absolute survival benefit of 2.4% (95% confidence interval, 0.1%–4.9%) with the use of dispatcher instructions for continuous compressions over traditional CPR.[109] There is no evidence, however, to show that dispatcher instructions were associated with ROSC.[99,106] When the use of dispatcher instructions on CPR parameters was evaluated, dispatcher-guided CPR with bystander CPR initiation increased performance of chest compressions and ventilation.[107,110] There is no evidence that dispatcher-guided CPR decreases time to commence CPR.[98,100,103,111,112]

2015 Recommendation—Updated

We recommend that dispatchers should provide chest compression–only CPR instructions to callers for adults with suspected OHCA (Class I, LOE C-LD).

Use of Social Media to Summon Rescuers—Updated[EIT 878]

Summoning rescuers to the scene of an OHCA may lead to initiation of CPR or defibrillation before the arrival of dispatched EMS providers. In a few localities, a system of care has been evaluated that includes emergency dispatcher activation of social media to summon nearby willing rescuers to provide bystander CPR until EMS providers arrive. The 2015 ILCOR systematic review addressed whether EMS dispatchers summoning rescuers with the use of technology or other social media improves patient outcomes.

2015 Evidence Review

Two case series examined the use of computer-generated phone calls and text messages sent to lay responders within 500 or 1000 meters of patients with suspected cardiac arrest. In one study, lay responders arrived first in 44.6% of episodes,[113] while in the second study, time to first shock was improved.[114] In a randomized trial, social media was used by dispatchers to notify nearby potential rescuers of a possible cardiac arrest. Although few patients ultimately received CPR from volunteers dispatched by the notification system, there was a higher rate of bystander-initiated CPR (62% vs 48% in control group).[114a]

2015 Recommendation—New

Given the low risk of harm and the potential benefit of such notifications, it may be reasonable for communities to incorporate, where available, social media technologies that summon rescuers who are willing and able to perform CPR and are in close proximity to a suspected victim of OHCA (Class IIb, LOE B-R).

EMS and Transition to the Hospital

High-performance EMS is a key component of the OHCA system of care. An EMS culture of excellence reinforces itself through CQI, whereby successful OHCA resuscitations are considered the norm rather than the exception. Focused CQI review, supported by comprehensive data collection, seeks to evaluate what went right and what went wrong during the resuscitation and apply lessons learned to future resuscitation efforts.

OHCA Quality Metrics

Continuous efforts to improve resuscitation outcomes are impossible without data capture. The collection of resuscitation process measures is the underpinning of a system of care's quality improvement efforts. The ILCOR Consensus Statement "Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest"[115] includes recommendations for cardiac arrest data collection based on updated and simplified Utstein templates. The core Utstein data set capture is recommended as the minimum data required for CQI. These data form the data set for CPR registries at all levels. In addition, supplementary data are essential for further resuscitation research. Examples of supplementary data would be 12-lead ECG and CPR quality measurement—interventions available in some prehospital settings but not all.

High-performance EMS responders understand that high-quality CPR is the foundation on which all of their resuscitation efforts depend. Furthermore, when CPR quality is measured, responders strive to perform the highest quality of CPR. Actual CPR performance improves when providers know that their performance is being measured—the well-known Hawthorne effect. Chest compression fraction (the percent of total resuscitation time spent compressing the chest), chest compression quality (rate, depth, and chest recoil), and ventilation rate are fundamental metrics defining high-quality CPR. CPR quality measurement is needed to provide timely feedback to the responding providers.

Advanced life support (ALS) bridges the transition from OHCA care to the receiving facility. ALS can provide the OHCA patient with advanced cardiac monitoring, 12-lead ECG, additional defibrillation and cardioversion interventions, vascular access, appropriate pharmacologic interventions, and advanced airway care. This same broad scope of practice for ALS providers can be further leveraged to provide comprehensive postresuscitation care (eg, hemodynamic optimization, oxygen- and volume-limiting ventilation) once ROSC is achieved.

ACS and STEMI Systems of Care

A systems-of-care approach to STEMI encompasses a well-organized approach with system-wide integration that includes primary prevention and recognition, EMS, ED, in-hospital, specialty cardiac center, rehabilitation, and secondary prevention community resources. This approach has all of the required elements and characteristics of a system of care. The STEMI system of care starts with rapid identification by EMS providers in the field. The goal for the EMS system is early identification, initial management, and transport to an appropriate facility for definitive care.

The system begins with the community recognizing the signs of a potential ACS and calling 9-1-1 early. Approximately 40% to 60% of STEMI patients call 9-1-1, and the remaining patients present directly to the hospital.[116,117] Given the risk of sudden cardiac arrest in these patients, improving the rate of calling 9-1-1 is a clear goal. The dispatchers may provide prearrival advice (eg, early aspirin administration). On scene, the paramedics will assess quickly; perform a prehospital 12-lead ECG; and administer aspirin, nitrates, and other medications. Prompt identification of STEMI is the key that allows consideration of the method of reperfusion: prehospital fibrinolysis, notification of the hospital for early in-hospital fibrinolysis, and/or specific hospital destination with notification of the catheterization team for primary percutaneous coronary intervention (PPCI). Interpretation of the prehospital ECG is critical to the process. The methods to interpret that ECG, which are consistent with a system of care, are reviewed in "Part 9: Acute Coronary Syndromes."

Prehospital fibrinolysis requires a system including provider expertise, well-established protocols, comprehensive training programs, medical oversight, and quality assurance. Not all systems may be able to support such a program. Similarly, PPCI requires an infrastructure of high-volume local or regional cardiac catheterization facilities and experienced providers. Thus, the decision regarding prehospital fibrinolysis, in-hospital fibrinolysis, or transport directly to a PPCI center is determined by the local system's resources.

The cardiac arrest and STEMI systems of care are linked in that a disproportionally high number of patients with ACS and STEMI also have sudden cardiac arrest. A key part of the postarrest management is consideration of patient evaluation in the catheterization laboratory. To achieve prompt recognition and treatment of ACS, the 2 systems of care—out of hospital care and in-hospital care—must be integrated.

Transport to Specialized Cardiac Arrest Centers[EIT 624]

The 2015 ILCOR systematic review addressed whether transport of OHCA patients by EMS directly to a specialist cardiac arrest center improves outcomes.

A cardiac resuscitation center is a hospital that provides evidence-based practice in resuscitation and post–cardiac arrest care, including 24-hour, 7-day PCI capability; targeted temperature management, cardiorespiratory and systems support with an adequate annual volume of cases; and commitment to ongoing performance improvement that includes measurement, benchmarking, and both feedback and process change.

2015 Evidence Review—Updated

Only 1 prospective study[118] compared survival outcomes in OHCA patients who were transported to a critical care medical center with those who were transported to a noncritical care hospital, while 20 observational studies performed comparisons of patient destination based on differences in hospital characteristics,[85,119–126] transport times,[127–131] or before-and-after implementation of regionalized systems of care.[132–137] These studies, reporting on more than 120 000 patients surviving to hospital discharge, suggest an association between improved survival (or neurologically intact survival when reported) and patient transport to specialist cardiac arrest centers.

2015 Recommendation—Updated

A regionalized approach to OHCA resuscitation that includes the use of cardiac resuscitation centers may be considered (Class IIb, LOE C-LD).

Continuous Quality Improvement

Over the past 15 years, we have seen considerable improvements in the number of survivors from both IHCA and OHCA. These improvements have been associated with increased focus and attention in areas such as increasing bystander CPR, improving CPR quality, early defibrillation and optimizing rapid response systems and post–cardiac arrest care. The wide variability in survival that remains across systems, however, highlights the success that individual high-performing systems have accomplished and pushes the envelope on what is possible.

Certain qualities of a system of care make it effective and lead to desired outcomes. Whether it spans organizations or is located within 1 unit, systems benefit from conscious pursuit of clarity, focus, discipline, and engagement.[138] Successful systems of care in both the in-hospital and out-of-hospital settings engage in CQI. There are numerous approaches to quality improvement that have been used across industries, but all of them share several key concepts, including goal setting, a process-centric focus, measurement, and accountability.

Goal Setting

It is difficult to be successful without first defining what success is. And the definition of success, or the goal, has to be defined specifically enough that a person and/or system can be held accountable to it. For most quality improvement goals, that means specifying both the quantity of change expected and the date by which that change is to be completed. For example, the AHA ECC 2020 Impact Goals include doubling survival from cardiac arrests between 2010 and 2020 from 19% to 38% in hospitalized adults and from 7.9% to 15% for all out-of hospital arrests. The goals also set a target of doubling bystander CPR rates from 31% to 62% and increasing survival from cardiac arrests from 35% to 50% in hospitalized children.[139] These highly specific goals enable evaluation of the current survival and bystander CPR rates in the context of both the progress made and work needed to achieve the stated goals by 2020.

Individual systems of care need to define their own goals based on their assessment of what the most important outcomes are. In their book, *The 4 Disciplines of Execution* (4DX), McChesney and colleagues termed these the "wildly important goals," or WIGs, and cautioned against focusing on more than 1 or 2 at a time to ensure success.[140] Subsystems can, in turn, focus on 1 to 2 WIGs in pursuit of system-wide WIGs. An example of a WIG is the ECC Systems of Care Subcommittee's including doubling of the number of states with CPR/AED training as a high school graduation requirement, a metric the advocacy committee has been working hard to achieve. Individual EMS systems may target the percentage of 9-1-1 calls for cardiac arrest with dispatcher instructions, enabling the caller to start CPR within 1 minute. Hospitals, in pursuit of the ultimate goal of decreasing cardiac arrest on the general wards, might target the number of RRT calls made for patients with physiologic evidence of deterioration. The key is that these process-oriented measures, or lead measures, as they are referred to in 4DX language, are in a system's control to modify and are the ones most expected to move the needle on the outcome metric of interest. The 4DX principle is to focus on the "wildly important" (but lagging) goals while acting on the leading measures.

Effecting Change

Those responsible for improving a resuscitation system can choose from a number of scientific problem-solving models to achieve continuous improvement (eg, Lean, Six Sigma, Total Quality Management, Plan-Do-Check-Act or Adjust, Plan-Do-Study-Act). While each has its own language and approach (eg, Lean, the continuous transformation of waste into customer value by workers; Six Sigma, the continuous decrease of variation; and PDCA, the iterative process of continuous small improvements; Figure 4), each uses data to drive the process improvement.

The framework used is not as important as an agreed-upon method and language and an established process whereby improvements are made after direct observation and analysis of root causes, with changes piloted as experiments, ideally by the workers who propose them. This drive—to improve

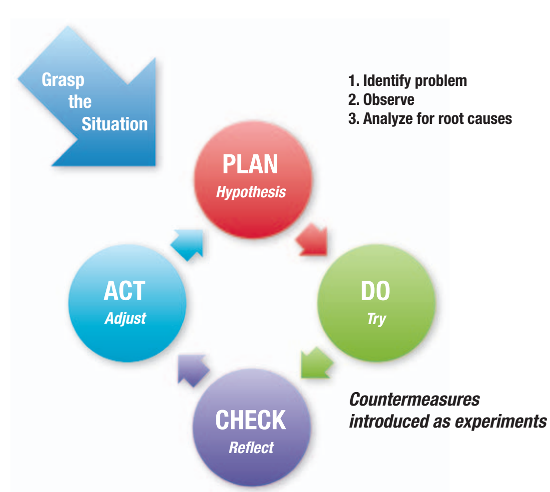

Figure 4. The Plan-Do-Check-Act cycle.

continually a complex system's performance to meet its goal—characterizes the best systems, sometimes described as complex adaptive systems. The individuals and leaders in the system continually assess processes, form hypotheses, design possible improvements, run experiments, check results, and reflect—and then start again.[141]

Measurement

Goal setting and effecting change are data-driven processes. As such, they are dependent on regular and accurate measurement of the process and outcome variables. Candidate measures have been defined in Utstein guidelines and AHA consensus statements for the benefit of generalizability and to enable comparisons across systems, but they are not consistently used. Registries such as Get With The Guidelines-Resuscitation and the Cardiac Arrest Registry to Enhance Survival exist for this purpose as well, but they currently represent only a small fraction of existing hospitals and EMS systems.[142–144] Significant improvement in arrest outcomes depends on collection, analysis, feedback, and interventions based on data and observations. This includes measuring structure, process, and outcomes of the steps involved in the resuscitation system of care. Only once these data are routinely collected will it be possible to continuously evaluate and improve what is done.

Accountability

For data to be useful, it has to be fed back to the team and used to assess progress toward the goal. That requires people to be accountable to that data for making the next round of changes. In the OHCA system of care, such stakeholders should come equally from the community, the EMS and the hospital systems of care. In the hospital, candidates for accountability include resuscitation team members; CPR committee members; and senior executives, including the chief quality, nursing, or medical officer. In the United Kingdom, every hospital is required to have a resuscitation officer for oversight of the IHCA program at that facility. The resuscitation officer's responsibilities include ensuring appropriate and timely recognition of cardiac arrest, effective and timely interventions, and the necessary processes and training to optimize outcome. Strong leadership is considered a necessary component for a highly performing enterprise. In light of the number of IHCAs, the variability of IHCA incidences and outcomes, and the potential to save more lives, perhaps it is time for US hospitals to have resuscitation officers with appropriate authority, responsibility, resources, and accountability to lead hospital resuscitation programs.

Conclusion

Using a systems-of-care approach as well as a rigorous process for CQI that is based on data can lead to improvements in the process for managing patients with cardiac arrest and improving their outcomes. We have learned a lot from high-performing systems and have made considerable progress over the past decade. But the current variability in survival from cardiac arrest shows that both IHCA and OHCA systems have the potential for substantial improvement. Continued improvement in the processes of managing patients before, during, and after cardiac arrest will require intense focus on consistent, clear goals aimed at decreasing incidence of and improving survival from cardiac arrest. Change will depend on engaged team members willing to be accountable for seeing those goals to fruition while actively working on improving process. And all of these aspects will demand high-quality data measurement, feedback, and comparison.

Disclosures

Part 4: Systems of Care and Continuous Quality Improvement: 2015 Guidelines Update Writing Group Disclosures

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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.

Appendix

2015 Guidelines Update: Part 4 Recommendations

Year Last Reviewed	Topic	Recommendation	Comments
2015	Prearrest Rapid Response Systems	For adult patients, RRT or MET systems can be effective in reducing the incidence of cardiac arrest, particularly in general care wards (Class IIa, LOE C-LD).	updated for 2015
2015	Prearrest Rapid Response Systems	Pediatric MET/RRT systems may be considered in facilities where children with high-risk illnesses are cared for on general in-patient units (Class IIb, LOE C-LD).	updated for 2015
2015	Prearrest Rapid Response Systems	The use of EWSS may be considered for adults and children (Class IIb, LOE C-LD).	updated for 2015
2015	Debriefing	It is reasonable for in-hospital systems of care to implement performance-focused debriefing of rescuers after IHCA in both adults and children (Class IIa, LOE C-LD).	updated for 2015
2015	Public-Access Defibrillation	It is recommended that PAD programs for patients with OHCA be implemented in communities at risk for cardiac arrest (Class I, LOE C-LD).	updated for 2015
2015	Dispatcher Recognition of Cardiac Arrest	It is recommended that emergency dispatchers determine if a patient is unconscious with abnormal breathing after acquiring the requisite information to determine the location of the event (Class I, LOE C-LD).	updated for 2015
2015	Dispatcher Recognition of Cardiac Arrest	If the patient is unconscious with abnormal or absent breathing, it is reasonable for the emergency dispatcher to assume that the patient is in cardiac arrest (Class IIa, LOE C-LD).	updated for 2015
2015	Dispatcher Recognition of Cardiac Arrest	Dispatchers should be educated to identify unconsciousness with abnormal and agonal gasps across a range of clinical presentations and descriptions (Class I, LOE C-LD).	updated for 2015
2015	Dispatcher Instruction in CPR	We recommend that dispatchers should provide chest compression–only CPR instructions to callers for adults with suspected OHCA (Class I, LOE C-LD).	updated for 2015
2015	Use of Social Media to Summon Rescuers	It may be reasonable for communities to incorporate, where available, social media technologies that summon rescuers who are willing and able to perform CPR and are in close proximity to a suspected victim of OHCA (Class IIb, LOE C-LD).	updated for 2015
2015	Transport to Specialized Cardiac Arrest Centers	A regionalized approach to OHCA resuscitation that includes the use of cardiac resuscitation centers may be considered (Class IIb, LOE C-LD).	updated for 2015

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