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Part 4: Systems of Care: 2025 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Cameron Dezfulian, MD [Chair],
José G. Cabañas, MD, MPH [Vice Chair],
Jason R. Buckley, MD,
Rebecca E. Cash, PhD, NRP,
Remle P. Crowe, PhD, NREMT,
Ian R. Drennan, ACP, PhD,
Melissa Mahgoub, PhD,
Candace N. Mannarino, MD, MS,
Teresa May, DO, MS,
David D. Salcido, PhD, MPH,
Anezi I. Uzendu, MD,
Melissa A. Vogelsong, MD,
Joshua A. Worth, MPA, CEMSO, NRP,
Saket Girotra, MD, SM

Abstract

Improving survival and quality of life after cardiac arrest requires integrated systems of people, protocols, policies, and resources along with ongoing data acquisition and review. Such systems of care, which are highly influenced by the environment in which they operate, produce efficiency and effectiveness in responding to cardiac arrest. Part 4 of the *2025 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care* focuses on systems of care, emphasizing elements that are relevant to a broad range of resuscitation situations. The chapter follows the Chain of Survival, beginning with prevention and preparedness to resuscitate, proceeding to early identification of cardiac arrest, and moving to effective resuscitation through to post–cardiac arrest care, survivorship, and recovery. This Part provides cardiac arrest systems of care guidelines on how to train specific personnel, protocols that have been demonstrated to be effective, as well as the incorporation of nonhuman resources to optimize cardiac arrest care with ongoing debriefing and quality improvement strategies. Specific to out-of-hospital cardiac arrest, included are recommendations about emergency medical services team composition and transport recommendations, community initiatives to

ARTICLE INFORMATION

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promote lay rescuer response, public access defibrillation and naloxone, and an enhanced role for emergency telecommunicators. Germane to in-hospital cardiac arrest are recommendations about cardiac arrest prevention and code team composition. Specific recommendations about extracorporeal membrane oxygenation cardiopulmonary resuscitation, transport to specialized cardiac arrest centers, organ donation, survivorship systems, and performance measurement across the continuum of resuscitation situations are also included.

Keywords

AHA Scientific Statements; cardiopulmonary resuscitation; delivery of health care; emergency medical dispatcher; heart arrest; hospital rapid response team; out-of-hospital cardiac arrest; quality improvement

PREAMBLE

Cardiac arrest SOC represent a comprehensive framework of personnel, resources, and policies and procedures designed to provide a coordinated, efficient, and highly effective response (Figure 1). The primary goal of cardiac arrest SOC is to resuscitate patients back to the function and quality of life that they enjoyed before the cardiac arrest. Important secondary goals include effective team function, optimizing the long-term survivor experience for the patient and those involved in the resuscitation, and improving the SOC through ongoing quality management and research. The objective of a cardiac arrest SOC is to quickly, efficiently, and effectively perform each step within the Chain of Survival (Figure 2). The SOC needed to execute the early links of the Chain of Survival differs between in-hospital cardiac arrest (IHCA) and OHCA, but assuming ROSC, these converge within the intensive care unit and continue through hospitalization and following discharge. These SOC guidelines are broadly applicable to persons of all ages, though are not geared toward neonatal resuscitation. These guidelines provide recommendations on how to create, maintain, and optimize systems intended to produce the best outcomes possible following cardiac arrest. Patient outcomes ultimately depend on some factors beyond the scope of this Part, such as the patient's comorbidities, yet a well-functioning cardiac arrest SOC can produce the best outcome achievable for any given patient by optimizing the execution of each link in the Chain of Survival.

The cardiac arrest Chain of Survival provides a progression of events beginning with the recognition that an individual is having a cardiac arrest and ideally results in the survival and recovery of that individual. There are opportunities to optimize each link in this chain with the ultimate goal of maximizing survival and function following cardiac arrest. The Chain of Survival is intended to be applied to both adult and pediatric in- and out-of-hospital cardiac arrest, though the details vary in each application. The recommendations in this Part follow the links of the Chain of Survival, beginning with prevention and preparedness, which precede the cardiac arrest event.

INTRODUCTION

Scope of the Guidelines

These guidelines are designed primarily for North American lay rescuers and health care professionals looking for up-to-date guidance to optimize clinical care through the design and operation of resuscitation systems. The emphasis in this Part of the *2025 American Heart Association (AHA) Guidelines for CPR and Emergency Cardiovascular Care (ECC)* is on elements of care involving coordination between different contributors to the Chain of Survival (eg, emergency telecommunicators and untrained lay rescuers), those elements common to the resuscitation of different populations (eg, community CPR training and public access to defibrillation, early interventions to prevent IHCA), and means to improve the performance of resuscitation teams and systems.

Our recommendations are directly relevant to lay rescuers, health care professionals, emergency telecommunicators, and those determining policy or legislation. These individuals operate within varied settings with differing levels of training and access to resuscitation equipment, which influences what is reasonable to recommend within that SOC. Our recommendations cover a broad temporal range from before cardiac arrest occurs until after resuscitation is successful or terminated, with guidance on assessing and improving the quality of each step.

Organization of the SOC Writing Group

The SOC Writing Group included a diverse group of volunteers from the AHA with expertise in emergency medicine, emergency medical services (EMS) pediatric and adult critical care, cardiology, education, research, epidemiology, and public health. A call for candidates was distributed to the AHA ECC committee, and members with recognized expertise in pediatric and adult resuscitation were nominated by the writing group co-chairs. Writing group members were selected by the AHA Emergency Cardiovascular Care Science Subcommittee then approved by the AHA Manuscript Oversight Committee.

The AHA has rigorous conflict of interest policies and procedures to minimize the risk of bias or improper influence during the development of guidelines. Prior to appointment, writing group members disclosed all commercial relationships and other potential (including intellectual) conflicts. These procedures are described more fully in “Part 2: Evidence Evaluation and Guidelines Development.”¹ Appendix 1 of this document lists the writing group members’ relevant relationships with industry.

METHODOLOGY AND EVIDENCE REVIEW

These SOC guidelines are based on extensive evidence evaluation. Most of the evidence evaluation was performed in conjunction with the International Liaison Committee on Resuscitation (ILCOR) and affiliated ILCOR member councils. Three different types of ILCOR evidence reviews (systematic reviews, scoping reviews, and evidence updates) were used in the 2025 process. In most cases, the SOC writing group supplemented the evidence update reviews completed by ILCOR through a literature search of additional databases (Pubmed, EMBASE, CINAHL). For knowledge chunks lacking ILCOR reviews, the writing

group worked with AHA librarians to create a relevant search strategy and conducted evidence update reviews. Each of these resulted in a summary of the literature that facilitated guideline development. A more comprehensive description of these methods is provided in “Part 2: Evidence Evaluation and Guidelines Development.”¹

Class of Recommendation and Level of Evidence

The writing group reviewed all relevant and current *AHA Guidelines for CPR and Emergency Cardiovascular Care* and all relevant *International Liaison Committee on Resuscitation Consensus on CPR and Emergency Cardiovascular Care Science With Treatment Recommendations* statements from 2020, 2021, 2022, 2023, and 2024.^{2–7} Evidence and recommendations were reviewed to determine if current guidelines should be reaffirmed, revised, or retired or if new recommendations were needed. The writing group then drafted, reviewed, and approved recommendations, assigning to each a Class of Recommendation (COR; ie, strength) and Level of Evidence (LOE; ie, quality, certainty). Criteria for each COR and LOE are described in the Table.

Guideline Structure

The 2025 guidelines are organized into “knowledge chunks,” grouped into discrete modules of information on specific topics or management issues.⁸ Each modular knowledge chunk includes a table of recommendations that uses standard AHA nomenclature of COR and LOE. Recommendations are presented in order of COR: most potential benefit (Class 1), followed by lesser certainty of benefit (Class 2), and finally, potential for harm or no benefit (Class 3). Following the COR, recommendations are ordered by the certainty of supporting LOE: Level A (high-quality randomized controlled trials) to Level C-EO (expert opinion). This order does not reflect the order in which care should be provided.

A brief synopsis is provided to put the recommendations into context with important background information and overarching management or treatment concepts. Recommendation-specific text clarifies the rationale and key study data supporting the recommendations. When appropriate, flow diagrams or additional tables are included.

Document Review and Approval

The guideline was submitted for blinded peer review to 5 subject matter experts nominated by the AHA. Before appointment, all peer reviewers were required to disclose relationships with industry and any other potential conflicts of interest, and all disclosures were reviewed by AHA staff. All guidelines were reviewed and approved for publication by the AHA Science Advisory and Coordinating Committee and the AHA Executive Committee. Comprehensive disclosure information for peer reviewers is listed in Appendix 2.

These recommendations supersede the last full set of AHA recommendations for SOC, made in 2020.⁹ The writing group members voted on and approved all guideline recommendations.

Disclosures

Appendix 1.: Writing Group Disclosures

Writing group member	Employment	Research grant	Other research support	Speakers' bureau/ honoraria	Expert witness	Ownership interest	Consultant/ advisory board	Other
Cameron Dezfulian	Baylor College of Medicine	None	None	None	None	None	None	None
José G. Cabañas	Wake County EMS	None	None	None	None	None	None	None
Jason R. Buckley	Medical University of South Carolina	None	None	None	None	None	None	None
Rebecca E. Cash	Massachusetts General Hospital; Harvard Medical School	Emergency Medicine Foundation [*] ; NIH [†] ; NIH [‡] ; Society for Academic Emergency Medicine Foundation [†]	None	None	None	None	American College of Emergency Physicians [*] ; Prehospital Guidelines Consortium [*] ; Air Methods Corp [†]	None
Remle P. Crowe	ESO	None	None	None	None	None	None	None
Ian R. Drennan	University of Toronto (Canada)	ZOLL [†]	None	Speakers' Bureau; ZOLL [†]	None	None	None	None
Saket Girotra	The University of Texas Southwestern Medical Center	NHLBI [†]	None	None	None	None	None	None
Melissa Mahgoub	American Heart Association	None	None	None	None	None	None	None
Candace N. Mannarino	Ann & Robert H. Lurie Children's Hospital of Chicago	None	None	None	None	None	None	None
Teresa May	Maine Medical Center	NINDS -1R01NS119825 [*]	None	None	None	None	None	None
David D. Salcido	University of Pittsburgh School of Medicine	Hillman Family Foundation [†]	None	None	None	None	None	None
Anezi I. Uzendu	UT Southwestern Medical Center and VA North Texas Health Care System	None	None	None	None	None	None	None
Melissa A. Vogelsong	Stanford University	Zoll Foundation Young Investigator Grant [*] ; Stanford Cardiovascular	None	None	None	None	None	None

Writing group member	Employment	Research grant	Other research support	Speakers' bureau/honoraria	Expert witness	Ownership interest	Consultant/advisory board	Other
		Health Clinical Research Innovation Grant*						
Joshua A. Worth	AmeriPro Health	None	None	None	None	None	None	None

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 \$5000 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 \$5000 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 2.: Reviewer Disclosures

Reviewer	Employment	Research grant	Other research support	Speakers' bureau/honoraria	Expert witness	Ownership interest	Consultant/advisory board	Other
Joseph Grover	The University of North Carolina at Chapel Hill	None	None	None	None	None	None	None
Lia Lowrie	St. Louis University School of Medicine	None	None	None	None	None	None	None
Christian Martin-Gill	University of Pittsburgh Medical Center	None	None	None	None	None	None	None
Michael R. Sayre	University of Washington	NIH (Collaborator) [†]	None	None	City of Bellevue, WA*	None	Stryker Emergency Care [†]	None
Scott T. Youngquist	University of Utah	NINDS (PediDOSE Trial EMS Investigator)*; DoD (PAIN Clinical Trial Site PI)*; NHLBI (ICECAP Trial Site Investigator)*; AHRQ (FEED-PT Trial Site Investigator)*	None	None	None	None	Emergency Scientific*	None

This table represents the relationships of reviewers that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all reviewers are required to complete and submit. A relationship is considered to be “significant” if (a) the person receives \$5000 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 \$5000 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.

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TOP 10 TAKE-HOME MESSAGES: SYSTEMS OF CARE

1. The Chain of Survival provides a broad overview of the critical steps to care for individuals suffering cardiac arrest, which can be customized depending on the age, etiology, and location of the arrest.
2. We present a simplified Chain of Survival meant to be applied to pediatric and adult cardiac arrest. In the future, the addition of prevention and preparedness is anticipated, given the importance of avoiding cardiac arrest altogether and optimizing resuscitation once it has occurred.
3. Systems of care (SOC) comprise policies and procedures, personnel, equipment and resources, information, and quality improvement and are highly influenced by the environment of care.
4. Community initiatives to improve lay rescuer cardiopulmonary resuscitation (CPR) are inherently multimodal, incorporating mass media, directed training, publicly available resources, mobile technologies, and policies and procedures.
5. The structure of in- and out-of-hospital resuscitation teams is variable, and adequate training, numbers of responders, and defined roles are crucial to produce good outcomes.
6. Debriefing and feedback to rescuers and analysis of data registries may be important components of a cardiac arrest quality improvement program.
7. In most cases, on-scene resuscitation aimed at achieving return of spontaneous circulation (ROSC) is preferable to patient transport with ongoing CPR, but this strategy requires that emergency medical technicians and paramedics be adequately trained on when to terminate efforts and how to provide death notifications.
8. Extracorporeal membrane oxygenation (ECMO) CPR is a promising but resource-intensive advanced resuscitation technique that requires an organized SOC to select appropriate patients and craft the optimal pathway for care delivery and optimization.
9. More research is needed to identify the optimal components of cardiac arrest centers and determine when scene or interfacility transport to such a center is beneficial.
10. An SOC that integrates inpatient and outpatient services is needed to provide elements of recovery demonstrated to be beneficial in cardiac arrest survivors.



Figure 1. Systems of care.

Graphical representation of the components of cardiac arrest systems of care.

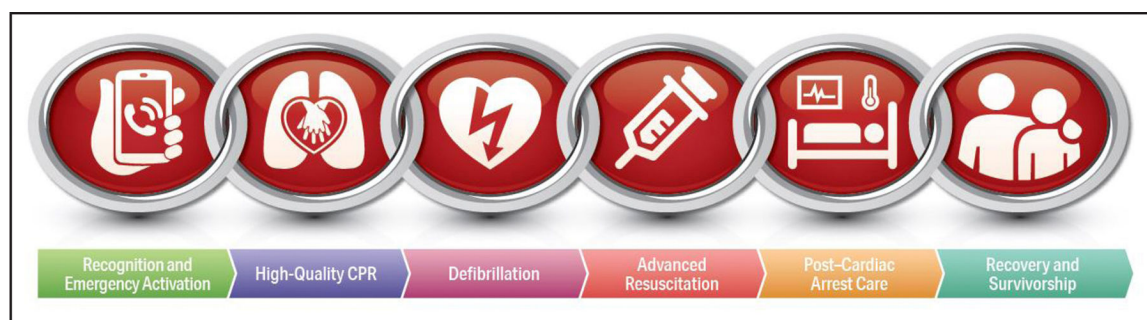


Figure 2. Updated 2025 Chain of Survival.

Table.
Applying Class of Recommendation and Level of Evidence to Clinical Strategies,
Interventions, Treatments, or Diagnostic Testing in Patient Care (Updated December 2024) *

CLASS (STRENGTH) OF RECOMMENDATION	
Class 1 (STRONG) Suggested phrases for writing recommendations: • Is recommended • Is indicated/useful/effective/beneficial • Should be performed/administered/other • Comparative-Effectiveness Phrases [‡]: - Treatment/strategy A is recommended/indicated in preference to treatment B - Treatment A should be chosen over treatment B	Benefit >>> Risk
Class 2a (MODERATE) Suggested phrases for writing recommendations: • Is reasonable • Can be useful/effective/beneficial • Comparative-Effectiveness Phrases [‡]: - Treatment/strategy A is probably recommended/indicated in preference to treatment B - It is reasonable to choose treatment A over treatment B	Benefit >> Risk
Class 2b (WEAK) Suggested phrases for writing recommendations: • May/might be reasonable • May/might be considered • Usefulness/effectiveness is unknown/unclear/uncertain or not well-established	Benefit ≥ Risk
Class 3: No Benefit (MODERATE) (Generally, LOE A or B use only) Suggested phrases for writing recommendations: • Is not recommended • Is not indicated/useful/effective/beneficial • Should not be performed/administered/other	Benefit = Risk
Class 3: HARM (STRONG) Suggested phrases for writing recommendations: • Potentially harmful • Causes harm • Associated with excess morbidity/mortality • Should not be performed/administered/other	Risk > Benefit
LEVEL (QUALITY) OF EVIDENCE[‡]	
Level A • High-quality evidence [‡] from more than 1 RCT • Meta-analyses of high-quality RCTs	

CLASS (STRENGTH) OF RECOMMENDATION

- One or more RCTs corroborated by high-quality registry studies

Level B-R**(Randomized)**

- Moderate-quality evidence[‡] from 1 or more RCTs
- Meta-analyses of moderate-quality RCTs

Level B-NR**(Nonrandomized)**

- Moderate-quality evidence[‡] from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies
- Meta-analyses of such studies

Level C-LD**(Limited Data)**

- Randomized or nonrandomized observational or registry studies with limitations of design or execution
- Meta-analyses of such studies
- Physiological or mechanistic studies in human subjects

Level C-EO**(Expert Opinion)**

- Consensus of expert opinion based on clinical experience

COR and LOE are determined independently (any COR may be paired with any LOE).

A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

* The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information).

[‡] For comparative-effectiveness recommendations (COR 1 and 2a; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

[‡] The method of assessing quality is evolving including the application of standardized, widely-used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.

MAJOR CONCEPTS

The Components of SOC

Any SOC (Figure 1) is shaped by the environment in which it is based. The guidelines provided in this Part apply best to the United States and Canada, which have societal values and structures distinct from other countries. Out-of-hospital cardiac arrest SOC involve personnel including laypersons who may recognize OHCA and ideally participate as rescuers in the resuscitation, property owners who maintain automated external defibrillators (AEDs), emergency service telecommunicators (also known as dispatchers or call-takers), and basic life support (BLS) and advanced life support (ALS) professionals working within EMS. In-hospital cardiac arrest SOC personnel often include physicians; nurses; respiratory therapists; pharmacists; occupational, physical, speech/language, and mental health therapists; and other professionals who participate in resuscitation and

postresuscitation care. Following discharge, survivorship and recovery may require physicians, social workers, family, and friends. A major part of cardiac arrest SOC involves education and training for these individuals. Policies and procedures within cardiac arrest SOC include local and national laws as well as protocols and workflows within numerous health care organizations spanning EMS and telecommunicators, hospitals, and rehabilitation centers. The establishment and optimization of these SOC often require a local champion. The resources that are essential to cardiac arrest SOC include equipment, medications, physical facilities, and ongoing innovation within these areas. Finally, quality management is crucial to optimizing any SOC. This includes ongoing review of data from cardiac arrest resuscitation resulting in system modifications and, ideally, research communication of generalizable findings to permit improvement across systems.

The History of the AHA Chain of Survival

In 1991, the AHA introduced the cardiac arrest Chain of Survival, which depicted a series of sequential steps crucial to resuscitations.¹ The initial Chain of Survival depicted early access to resuscitation, CPR, defibrillation, and advanced care. In 2010, the AHA elaborated on the Chain of Survival to include early recognition of cardiac arrest and activation of the emergency response system, early high-quality CPR, rapid defibrillation, advanced life support, and post-cardiac arrest care.² The *2020 AHA Guidelines for CPR and ECC* depicted 4 distinct but related chains of survival for adults and infants/children experiencing IHCA and OHCA.³ In all but the 2020 adult OHCA chains, the concept of prevention was also inserted into the initial link of the Chain of Survival. In 2020, an additional link was added to represent recovery. Recovery is unique in that it could be temporally quite distant from the earlier links, all of which occur in rapid succession in the process of resuscitation.

The neonatal chain of care concept (“Part 5: Neonatal Resuscitation”) differs from the Chain of Survival presented here. Neonatal resuscitation often involves different emphasis on breathing and ventilation than pediatric and adult cardiac arrest do. The timing of transition from neonatal to pediatric guidelines and chains of survival is not strictly defined and depends on the setting, resources, team preferences, and the nature of the clinical deterioration.⁴ The SOC guidelines cover pediatric and adult resuscitation, not neonatal, and likewise, the 2025 Chain of Survival is specific to pediatric and adult guidelines.

The 2025 AHA Chain of Survival

For 2025, we have elected to revert to a single Chain of Survival (Figure 2) for all forms of cardiac arrest, whether adult or pediatric, in- or out-of-hospital. This was for simplicity and because the writing groups felt each link of the chain could be applied to the different forms of cardiac arrest, although the details of this application may vary. The symbol for high-quality CPR has changed to demonstrate compressions and breaths, represented by the lungs, in recognition of the importance of breathing in resuscitation of pediatric cardiac arrest and a substantial minority of adult cardiac arrests such as those caused by drowning or opioid poisoning. The missing link from the 2025 Chain of Survival is prevention and preparedness. These actions are crucial both to avoid cardiac arrest and to equip systems to rapidly respond to it when it occurs, both of which are important steps in improving survival.

The importance of prevention and preparedness is not lost on the 2025 Guidelines writing groups, but we have elected to defer the addition of this link until the concepts can be better defined and clarified in a dedicated scientific statement.

Organization of This Part Around the Chain of Survival

The SOC chapter provides recommendations across the entire Chain of Survival, and indeed the links of the Chain of Survival have been used to organize the contents of the knowledge chunks. In the following text, we review each link in further detail and discuss some of the contents of this Part, which relate to that link.

- **Prevention and preparedness:** The best outcome from a cardiac arrest is obtained by avoiding having the arrest and thus sparing the body from global ischemia and reperfusion injury. Predictive analytics using patient vital signs and other data offer the promise of providing early warning to avoid a cardiac arrest. Public access to naloxone permits reversal of opioid-induced respiratory arrest prior to progression to cardiac arrest. Preparedness for cardiac arrest includes having appropriate teams for high-acuity conditions (rapid response, shock, high-risk obstetric deliveries) and in- and out-of-hospital resuscitation, with corresponding training and quality improvement protocols in place. Individual and team training is addressed in “Part 12: Resuscitation Education Science”⁵ and predelivery preparedness is the subject of “Part 5: Neonatal Resuscitation.”⁶
 - **Relevant knowledge chunks:** Prevention of IHCA, Public Access Naloxone
- **Recognition and emergency activation:** Detecting the onset of cardiac arrest is increasingly possible through in-hospital monitoring and out-of-hospital wearable devices. Community initiatives to increase layperson recognition of OHCA and activation of EMS and layperson rescue are crucial first steps in resuscitation, which may be aided by telecommunicator recognition and instruction. The use of video technologies to supplement telephone communications may assist in recognition and activation.
 - **Relevant knowledge chunks:** Community Initiatives to Improve Layperson Response to OHCA, Telecommunicator Recognition of Cardiac Arrest, Telecommunicator-CPR (T-CPR) Instructions, T-CPR Quality Management, Video-Based Dispatch Systems
- **High-quality CPR** involves appropriate rate and depth of chest compressions with minimal interruptions.⁷ In many cases, such as pediatric cardiac arrest or opioid-associated cardiac arrest, respiratory support through breaths or ventilation are also critical for successful resuscitation. Appropriate team composition, with defined roles and clinical debriefing and quality improvement, are crucial to optimize CPR efforts. Determining when to terminate OHCA resuscitation efforts or to transport patients still in cardiac arrest to the hospital is another important system question.

- **Relevant knowledge chunks:** Clinical Debriefing, OHCA Team Composition, In-Hospital Code Team Composition, On-Scene OHCA Resuscitation
- **Defibrillation** should be provided promptly, aided by public access to AEDs whose location and delivery may be facilitated using mobile technologies or drones, all of which require appropriately designed SOC.
 - **Relevant knowledge chunks:** Community Initiatives to Improve Layperson Response to OHCA, Public Access Defibrillation
- **Advanced resuscitation interventions** including medications, advanced airway interventions, and extracorporeal CPR (ECPR) often necessitate system-level planning.
 - **Relevant knowledge chunks:** Extracorporeal CPR SOC
- **Post–cardiac arrest care**, including critical care interventions (eg, coronary angiography), targeted temperature management, and neuroprognostication, require expertise and systems that may be regionalized to centers of excellence.
 - **Relevant knowledge chunks:** Recommendation for Cardiac Arrest Centers, Extracorporeal CPR SOC
- **Recovery**, including effective support for physical, cognitive, emotional, and family needs, continues far beyond discharge from the hospital. Systems are needed to identify these needs and deliver support and, in the case of nonsurvival, to support organ donation, which may permit survival for others.
 - **Relevant knowledge chunks:** Organ Donation, Improving Cardiac Arrest Recovery

Use of Data for Continuous Improvement

Although the Chain of Survival emphasizes key elements in the care of an individual patient, it does not sufficiently emphasize steps that are necessary for improving future performance. Data collected through registries, such as AHA’s Get With The Guidelines (for IHCA) and the Cardiac Arrest Registry to Enhance Survival (for OHCA) initiatives, have been critical to amassing the data needed to improve each link within the Chain of Survival. The goal is to become a learning health care system⁸ that uses data to continually improve preparedness and resuscitation outcomes. Application of this concept to resuscitation SOC has been previously supported and is ongoing in many resuscitation organizations.^{9,10}

- **Relevant knowledge chunks:** Data Registries to Improve System Performance

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PREVENTION OF IHCA

Recommendations for Prevention of IHCA

COR	LOE	Recommendations
2a	B-R	1. Early warning score (EWS) systems can be beneficial to detect clinical deterioration, prompt an assessment, and facilitate intervention or transfer to a higher level of care.
2a	B-NR	2. Rapid response teams (RRTs) or medical emergency teams (METs) can be effective in reducing the incidence of cardiac arrest, particularly in general care wards.
2a	B-NR	3. Implementation of safety huddles to improve situational awareness of high-risk hospitalized patients and mitigate deterioration can be effective in reducing cardiac arrest rates.

Synopsis

Survival to hospital discharge after IHCA is approximately 19% for adults and 40% for children.¹ Survival is improved when IHCA occurs in a monitored setting, such as an intensive care unit.^{2,3} Expert panels adjudicating adult IHCA and prevention initiatives

in pediatric IHCA have suggested that a proportion of IHCAs are indeed preventable by recognizing and dedicating resources to the deteriorating patient.^{4–6} Teams such as RRTs and METs are intended to evaluate and provide therapies to rescue and triage patients experiencing clinical decline to a higher level of care (eg, from the general hospital ward to the intensive care unit). Additionally, EWS systems incorporate patient characteristics, vital signs, and other physiologic parameters in an effort to identify patients at risk for clinical deterioration prior to IHCA; EWSs may trigger RRT/MET automated responses. The RRT, EWS, and cardiac arrest prevention quality improvement initiatives (eg, safety huddles for high-risk patients) have been adopted by hospitals in an effort to prevent IHCA. Variability in the structure and function of these systems has likely contributed to the inconsistency in reported outcomes regarding efficacy of these interventions. The potential benefits of RRTs, EWSs, or prevention bundles are unlikely to be impacted by patient age; therefore, these recommendations are intended to apply across the pediatric and adult age spectrum.

Recommendation-Specific Supportive Text

1. In a multicenter, international cluster randomized trial, implementation of the bedside pediatric EWS was associated with a decrease in clinically important deteriorations on the wards of nontertiary care hospitals but not with all-cause mortality.⁷ A recent systematic review identified a statistically significant increase in unplanned code events when a pediatric EWS was not utilized. This analysis also noted trends demonstrating decreased cardiac arrest events and mortality associated with EWS use.⁸ Additionally, a recent prospective multicenter cohort study in Latin America demonstrated that pediatric EWS implementation was associated with reduced rates of cardiac arrest and clinical deterioration–related mortality in pediatric patients with cancer.⁹ In adults, 2 recent observational studies reported contrasting findings about the ability of EWSs to reduce IHCA,^{10,11} which parallels earlier inconsistencies in adult studies.¹² Artificial intelligence and machine learning algorithms are currently being developed to predict clinical deterioration in hospitalized patients. These technologies may improve detection and prevent clinical deterioration better than current systems; however, additional validation and mitigation of bias from the algorithms is warranted.^{13–16}
2. The evidence supporting the efficacy of RRT/MET systems in reducing IHCAs or hospital mortality remains mixed, but their use is widespread and recommended by multiple organizations, which limits the prospect of future randomized studies.^{17–21} The RRT/MET systems have been associated with reductions in hospital mortality and cardiac arrest rates in both pediatric and adult populations.^{22–24} However, 1 observational registry study of 38 pediatric hospitals found no difference in risk-adjusted mortality rates associated with RRT/MET implementation.²⁵ Variation in RRT structure and function may drive these observed differences in outcomes, and a better understanding of best practices is needed.²⁶

3. A prospective, observational, multicenter quality improvement project demonstrated a 30% reduction in risk-adjusted IHCA rates in pediatric cardiac intensive care units of hospitals that implemented a cardiac arrest prevention bundle.⁴ A similar single-center quality improvement initiative aimed at improving situational awareness and mitigating deterioration of high-risk patients admitted to the pediatric intensive care unit reduced IHCA rates by 52%.²⁷ Both studies incorporated care team safety huddles on high-risk patients to discuss monitoring and preparedness for deterioration to prevent progression to cardiac arrest. Neither study observed a reduction in mortality. A similar initiative in hospitalized adult patients in the intensive care unit did not reduce cardiac arrests, but the successes observed in pediatrics are likely to generalize to adults with proper intervention design and utilization.²⁸

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PUBLIC ACCESS NALOXONE

Recommendations for Public Access Naloxone

COR	LOE	Recommendations
1	B-NR	1. Public policies should allow for possession, use, and immunity from civil and criminal liability for good faith administration of naloxone by lay rescuers.
2a	B-NR	2. Naloxone distribution programs can be beneficial to increase naloxone availability among lay rescuers and decrease mortality from opioid-related overdose.

Synopsis

Opioid-related overdoses continue to represent a major public health concern in the United States.¹ An estimated 1 in 6 to 1 in 3 OHCAs are related to an overdose, most commonly involving opioids.^{2–4} One common public health harm reduction strategy to decrease opioid-related overdose mortality is increasing access to naloxone in the community, also known as public access naloxone (PAN). Naloxone is an opioid antagonist that is used to reverse respiratory depression due to opioid overdose.⁵ In March 2023, the first over-the-counter naloxone product was approved for use in the United States.⁶ Presently, naloxone nasal spray is the only over-the-counter formulation available for public distribution in the United States. While the dosage is intended for adults, pediatric postmarketing data have not revealed adverse events when it is used in children.⁷ Despite the availability of naloxone over the counter, cost remains a barrier to access and not all states have legislation to support and protect its use by lay rescuers,^{8,9} though all states and Washington, DC, have laws increasing access to naloxone.¹⁰ Legislation may permit coprescribing of naloxone

with opioid prescriptions or decriminalization of distribution, possession, and administration of naloxone. Beyond legislation, specific PAN strategies include naloxone distribution programs, naloxone vending machines, and stationing of naloxone in public settings (similar to AED cabinets).^{11–14} No evidence has been found to suggest that PAN increases opioid use or opioid-related overdoses in the community.^{15,16} Secondary prevention measures include provision of naloxone by emergency departments and EMS after a nonfatal opioid-related overdose.¹⁷

Recommendation-Specific Supportive Text

1. Four observational studies^{18–21} were found that examine the effect of naloxone access laws on opioid-related overdose mortality. Two^{18,19} demonstrated that legislative changes making naloxone available without a prescription were associated with decreased opioid-related overdose mortality on a population level. One study identified an increase in opioid-related overdose deaths following implementation of naloxone access laws.²¹ One study found differing changes in opioid-related overdose mortality based on US region (Northeast versus West) with the implementation of laws allowing lay rescuer distribution; however, possession laws (ie, allowing lay rescuers to carry naloxone without a prescription) were associated with decreased mortality.²⁰ The ecological design of these studies poses challenges in assessing causality, as the increase in deaths may reflect general increases in opioid-related overdoses and deaths in a community rather than an effect attributable to naloxone access legislation. The potential benefit at a population level of increasing access to this effective, lifesaving medication was deemed by the writing group to greatly outweigh the risks.
2. There has been inconsistent evidence of the effect of PAN on opioid-related overdose mortality, depending on mode of naloxone access (ie, law versus distribution program), region studied, and time frame. Most studies have examined individual opioid education and naloxone distribution programs or used an ecological design to estimate the population-level effect. Six observational studies^{22–27} were found that examine the effect of community-based naloxone distribution programs, where naloxone was provided without a patient-specific prescription, on opioid-related overdose mortality. Four studies^{22–25} found a decrease in opioid-related overdose mortality following program implementation, with evidence of a dose-dependent effect. However, 2 additional studies^{26,27} found either no significant difference after program implementation or an increase in the number of opioid-related deaths per month. As these studies were ecological, causality cannot be inferred. The increase in deaths may, again, reflect secular trends of opioid-related overdose burden in the community. There also remains a lack of direct evidence regarding the effect of PAN on survival after opioid-associated OHCA.

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COMMUNITY INITIATIVES TO IMPROVE LAY RESCUER RESPONSE TO OHCA

Recommendations for Community Initiatives to Improve Lay Rescuer Response to OHCA

COR	LOE	Recommendations
2a	B-NR	1. Implementing a bundle of community initiatives is a reasonable strategy to improve lay rescuer response to OHCA.
2a	B-NR	2. Increasing the availability of instructor-led training in communities can be effective to improve lay rescuer response to OHCA.
2a	B-NR	3. Mobile technologies to summon responders to nearby OHCA events is a reasonable strategy to increase timely lay rescuer CPR and AED use.
2b	C-LD	4. Mass media campaigns may be considered to promote learning of CPR skills in all populations.

COR	LOE	Recommendations
2b	C-LD	5. It may be reasonable for communities to implement policies that require CPR certification in the general public.

Synopsis

Early CPR and defibrillation are staples of the Chain of Survival. Despite the recognized role of lay rescuers in improving OHCA outcomes, most communities still experience low rates of lay rescuer CPR and AED use. Community awareness of cardiac arrest and response by providing CPR play key roles in shaping survival. Interventions at the community level to improve awareness and responsiveness by lay rescuers include initiatives such as instructor-led training (eg, classes), mobile technology to summon the public, mass media campaigns (eg, social media and television advertisements), and legislative policies for CPR training. Community interventions exist at the local, state, regional, or national level and may involve collaboration between government and organizations. Interventions are most likely to be successful when taking into context the patient population, geography, and other cultural factors and when implemented with other interventions to optimize resuscitation.

Recommendation-Specific Supportive Text

1. Ten observational studies evaluated the impact of bundled interventions on lay rescuer CPR rates and survival outcomes.^{1–9} Lay rescuer CPR rates were improved in 7 of these studies.^{1–3,5–8} Interventions included classes taught in person in schools, workplaces, and the community; videos watched asynchronously; and public messaging through various forms of media.
2. Nine observational studies assessed the impact of instructor-led training.^{10–18} Three of 5 studies found improvement in survival with good neurological outcomes after implementation of instructor-led training.^{11,12,15,17,18} Two of 3 studies reported improvements in survival to hospital discharge,^{11,13,18} and 1 study demonstrated an improvement in ROSC after instructor-led training.¹³ Instructor-led training improved lay rescuer CPR rates by 10% to 19% in 5 studies.^{10–14}
3. The 2020 AHA guidelines reviewed 6 observational studies and 1 randomized controlled trial (RCT) and found uniformly positive data supporting the use of mobile technologies to summon lay rescuers for CPR.¹⁹ Thirteen new observational studies^{20–32} and 1 new RCT³³ were identified. Twelve studies examined a period when mobile technology was in place without a comparison period. One study compared the implementation of mobile technology with a retrospective cohort. There was universal improvement in rates of bystander CPR when a mobile technology alert was accepted by a lay rescuer but inconsistent data on the incidence of ROSC and survival. Studies with improved survival (4/13) were associated with higher population density and high acceptance of the alert by lay rescuers.²³ The SAMBA trial randomized mobile technology to test implementation of deployment strategies for directing lay rescuers to the

patient location versus nearest available AED first. The primary outcome of AED attachment was not significantly higher in the group directed to AEDs first (13.2% versus 9.5%, $P=0.08$); there were also no significant differences in rates of lay rescuer CPR or defibrillation.³⁰

4. One observational study reported a 12% absolute increase in lay rescuer CPR rates during a campaign of television advertisements promoting lay rescuer CPR.³⁴ The durability of this improvement was not assessed. However, mass distribution (via mail) of a 10-minute CPR instructional video to 8659 households resulted in no significant improvement in lay rescuer CPR rates when compared with a community with households that did not receive a video (47% in intervention households, 53% in controls).³⁵
5. Two studies looked at the effectiveness of laws requiring CPR certification either to graduate high school or to receive a driver's license. Both studies showed increases in lay rescuer CPR and survival to hospital discharge.^{36,37}

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TELECOMMUNICATOR RECOGNITION OF CARDIAC ARREST

Recommendations for Telecommunicator Recognition of Cardiac Arrest

COR	LOE	Recommendations
1	C-LD	1. If the patient is unresponsive with abnormal, agonal, or absent breathing, the telecommunicator should assume that the patient is in cardiac arrest.
1	C-EO	2. Telecommunicators should determine the location of the event before questioning to identify OHCA, to allow for simultaneous dispatching of EMS response.

Synopsis

Emergency telecommunicators serve as a critical link in the OHCA Chain of Survival, improving early cardiac arrest recognition and provision of lay rescuer CPR while sending EMS resources to the scene. Telecommunicators must quickly diagnose OHCA using verbal descriptions from callers and other auditory cues, which may be vague, incomplete, and even contradictory.¹ Rates of telecommunicator cardiac arrest recognition vary substantially across systems, ranging from 46% to 98%.¹ Recognition of cardiac arrest has been linked to multiple factors related to patients, callers, and telecommunicators.² The most consistent challenges to telecommunicator cardiac arrest recognition are the misinterpretation of agonal breathing^{2,3} and, to a lesser extent, misclassification of OHCA and seizures.² Cardiac arrest is unrecognized more often in children and adolescents.⁴ Various algorithms have been implemented to optimize telecommunicator recognition of cardiac arrest.

Recommendation-Specific Supportive Text

1. When a caller describes an individual as unresponsive with absent or abnormal breathing, concluding that the person is experiencing OHCA maximizes sensitivity of detection and permits immediate provision of T-CPR instructions.^{5,6} To address the variation in OHCA presentations, telecommunicators require training to identify OHCA across a broad range of circumstances, including agonal gasping and brief myoclonus.⁷ Asking the 2 scripted questions from the No-No-Go process (Figure 3) to determine if an individual is unresponsive with abnormal breathing positively identifies 92% of people suffering OHCA.⁷ Time to first compression is strongly associated with survival from OHCA.⁸ The writing group believes that the benefit of early recognition of OHCA and provision of timely chest compressions outweighs the risk of providing CPR to a person not in cardiac arrest.
2. It is critical to first obtain location information when receiving an emergency call (ie, a 911 call) to permit the dispatch of appropriate emergency medical response while additional information is being obtained and CPR instructions

are being provided.⁹ This permits a response to be mobilized even if the call is disconnected prematurely.

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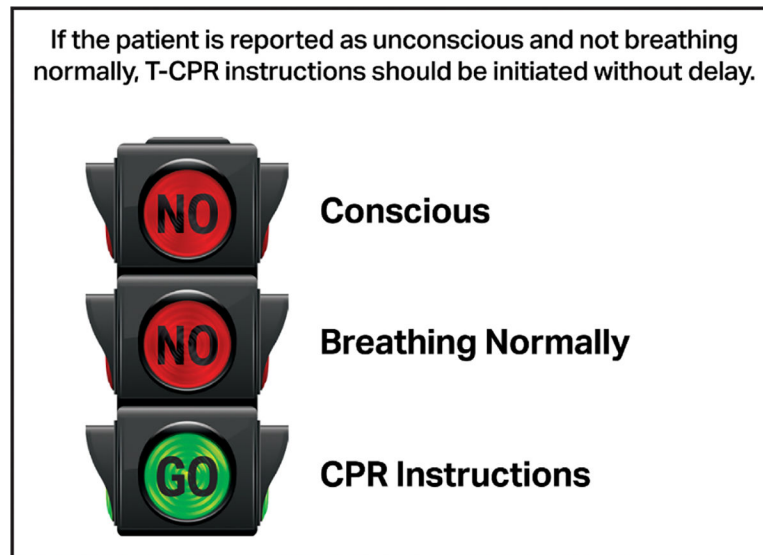


Figure 3. The No-No-Go Mnemonic for Initiation of Bystander CPR.

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T-CPR INSTRUCTIONS FOR PERSONS WITH SUSPECTED CARDIAC ARREST

Recommendations for T-CPR Instructions for Persons With Suspected Cardiac Arrest

COR	LOE	Recommendations
1	A	1. T-CPR instructions for adult OHCA should advise compression-only CPR consistent with adult BLS guidelines.
1	C-LD	2. Telecommunicators should instruct callers to initiate CPR for individuals with suspected OHCA.
1	C-LD	3. T-CPR instructions for infants and children experiencing OHCA should advise conventional CPR with breaths consistent with pediatric BLS guidelines.

Synopsis

Rates of lay rescuer CPR remain low for adults and children.¹ T-CPR instructions are verbal guidance given by emergency telecommunicators to callers that guide CPR. After identifying cardiac arrest by asking the caller whether the patient is responsive and breathing normally, telecommunicators can provide step-by-step instructions for initiating CPR, including how to position the patient, where to place hands for chest compressions, and coaching to maintain the correct rhythm and depth of compressions. Common types of T-CPR instructions include conventional CPR, which includes chest compressions and breathing, or compression-only CPR. T-CPR instructions are vital to increase rates of lay rescuer CPR and bridge the gap between the onset of cardiac arrest and the arrival of EMS.

Recommendation-Specific Supportive Text

1. While recent observational studies have reported improved neurologically intact survival outcomes with conventional CPR in adults,² these studies are vulnerable to selection bias and confounding. Three randomized trials comparing T-CPR compression-only CPR with conventional CPR instruction in adults trended toward better survival with compression-only CPR instructions.^{3–5} In a pooled analysis of these data, the improvement in survival was significant (risk ratio, 1.22; 95% CI, 1.01–1.46) with a number needed to treat of 41 (95% CI, 20–1250).⁶ In one of these RCTs, compression-only instructions were delivered 1.4 min faster and more likely to be delivered completely by the telecommunicator.³ It is noteworthy that the adult OHCA RCTs largely predate the rise in overdose-associated OHCA seen in the past decade.
2. In 3 adjusted observational studies, T-CPR instructions were associated with a greater than 5 times likelihood of provision of lay rescuer CPR^{7–9} and CPR was initiated 7 minutes sooner⁸ compared with no T-CPR instructions. The delivery of lay rescuer CPR before the arrival of EMS was associated with survival and favorable neurological outcome in 6 observational studies.^{7,8,10–13} In 2 studies, offering T-CPR was associated with improved favorable neurological survival 1 month after discharge, even after adjustment for multiple variables.^{8,11} Based on these data, the AHA has recommended T-CPR instructions and provided resources to help implement these systems.¹⁴
3. Pediatric OHCA are mostly of asphyxial etiology.¹⁵ Large observational studies comparing compression-only CPR to CPR with breaths have consistently shown improved outcomes associated with CPR that includes breaths.^{16–19} In some cases, conventional CPR was provided despite T-CPR instructions to provide compression-only CPR, which calls into question the possibility of significant selection bias.

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T-CPR QUALITY MANAGEMENT

Recommendation for T-CPR Quality Management

COR	LOE	Recommendation
1	B-NR	1. Telecommunicator recognition of cardiac arrest and T-CPR instructions should be reviewed and evaluated as part of an EMS system quality management process.

Synopsis

Quality management programs are essential for ensuring that telecommunicators consistently identify cardiac arrest and deliver effective CPR instructions. Quality management encompasses both quality assurance activities where cases are retrospectively reviewed and quality improvement activities where proactive changes are made to the system to achieve meaningful improvements. Key metrics include assessing how quickly and accurately cardiac arrest is recognized, time to first instructed compression, the clarity and completeness of CPR instructions, appropriate coaching on compression depth, chest recoil and patient positioning, and adherence to established protocols.¹ A complete list of resuscitation variables desirable to review in OHCA quality management² and in evaluating CPR quality³ is provided elsewhere. Quality management programs seek to optimize telecommunicator metrics by identifying gaps in performance and providing targeted coaching, with the ultimate goal of increasing survival rates from cardiac arrest.

Recommendation-Specific Supportive Text

1. Successful T-CPR programs incorporate a robust quality management process, including review of OHCA calls, to ensure that T-CPR is being provided as broadly, rapidly, and appropriately as possible.^{4,5} Applied quality improvement initiatives have been shown to increase rates of telecommunicator cardiac arrest recognition.^{6,7}

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VIDEO-BASED DISPATCH SYSTEMS

Recommendation for Video-Based Dispatch Systems

COR	LOE	Recommendation
2b	B-NR	1. Video-based dispatch systems for OHCA response may be reasonable in systems with such capabilities.

Synopsis

T-CPR is currently provided in many communities through a standard telephone audio call. Mobile technology has become ubiquitous, and the use of video calling technology has become more generalized. Video-based T-CPR may allow the telecommunicator to see the caller in real time, to better assess the scene and patient's condition, to coach the caller through the response, and to provide feedback on CPR performance. Video calls are more invasive, may require more cooperation from the caller, and may need multiple rescuers on scene to be effective. Video-based dispatch systems have additional costs for implementation, which may be prohibitive in some countries, and the cost-benefit of these systems has not been fully described.

Recommendation-Specific Supportive Text

1. Simulation studies have consistently shown improved CPR quality using video-based T-CPR compared with traditional audio instruction,¹ but RCTs are lacking.^{1,2} Three observational studies,^{3–5} 19 randomized simulation studies,^{6–24} and 4 systematic or scoping reviews^{25–28} compared a video-based dispatch system for OHCA with an audio-based system or no assistance. Two observational studies reporting patient outcomes^{4,5} favored video-based T-CPR over conventional T-CPR for prehospital ROSC (pooled odds ratio OR, 2.33; 95% CI, 1.87–2.88), survival to hospital discharge (pooled OR 2.33, 95% CI,

1.87–2.91), and good neurological outcome (pooled OR, 2.77; 95% CI, 2.14–3.59).² However, because a video-capable smartphone and at least 2 bystanders were needed, less than 20% of participants received video-based T-CPR in these studies. Among simulation studies, video-based T-CPR consistently improved CPR quality compared with audio-only T-CPR,²⁵ including for untrained rescuers and simulated pediatric patients. One observational study reporting on CPR quality before and after video instruction found improved hand position, rate, and depth.³ Some studies reported delays to first compression with video calls; however, the more recent observational studies have not reproduced this concern,^{4,5} potentially due to improved telecommunicator protocols and technology. Generalizability of protocols and dispatcher training to US-based systems and barriers to implementation are unclear.

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CLINICAL DEBRIEFING

Recommendations for Clinical Debriefing

COR	LOE	Recommendations
2a	B-NR	1. Performance-focused debriefing of rescuers after cardiac arrest can be effective for resuscitation improvement programs.
2a	B-NR	2. Review of objective and quantitative resuscitation data can be effective in improving the quality of postevent debriefing for adults and children.
2a	C-LD	3. It is reasonable for debriefings to be facilitated by health care professionals familiar with established debriefing processes.
2a	C-EO	4. Incorporating immediate and delayed debriefing is reasonable and may identify different opportunities for system improvement.

Synopsis

Postevent clinical debriefing is defined as “a reflective conversation about performance and may include processed select performance data” with the goal of improving future clinical practice.¹ Feedback is defined as “information about the performance compared with a standard” delivered in real time. During debriefing, resuscitation team members may identify systems issues that include process and quality of care (eg, algorithm adherence); review quantitative data collected during the event (eg, CPR metrics); reflect on teamwork, communication, and performance of specific roles; and address emotional responses to the event.^{2–6} A facilitator, typically a health care professional, leads a discussion focused on identifying opportunities and strategies for improving performance.^{2,7} Debriefings may occur either immediately after a resuscitation event (hot debriefing) or at a later time, at least a day to weeks later (cold debriefing).^{3,8,9} Some debriefings take the form of personalized reflective conversations, while others involve group discussion among a

larger, multidisciplinary resuscitation team.^{5,7} We focused on postevent clinical debriefing excluding critical incident stress debriefing (ie, psychological debriefing). Data-informed debriefing of professionals after cardiac arrest has potential benefits for both IHCA and OHCA SOC.^{6,10,11} Structured debriefing and continuous feedback play complementary roles in enhancing CPR performance and outcomes in both prehospital and hospital settings.^{12,13}

Recommendation-Specific Supportive Text

1. Debriefing following cardiac arrest is a critical practice that enhances team performance, supports rescuers, and ultimately leads to improved patient outcomes.¹⁴ A systematic review and meta-analysis compared real-time or postevent feedback with no real-time or postevent debriefing for adults with OHCA and found that feedback and postevent debriefing, when combined, improve CPR quality (compression depth, rate and fraction) and outcomes (ROSC and survival).¹² Four prospective observational studies of post-IHCA debriefing among multidisciplinary resuscitation team members showed mixed results.^{6,9,10,15} A systematic review of these studies demonstrated improved ROSC and mean chest compression depth in the period after implementation of a bundle of care that included evaluation of CPR quality, feedback, and debriefing.^{15,16} In a survey of hospital resuscitation practices linked to data and outcomes from hospitals within the Get With the Guidelines national registry, there was no association between debriefing frequency and adherence to CPR measures such as defibrillation and epinephrine administration.¹⁷
2. Because health care professional's recall of events and self-assessment of performance are often poor, the objectivity and quality of debriefings improve when supplemented with quantitative data on CPR performance. Data elements associated with improved clinical debriefing quality include chest compression rate, depth, and fraction; telemetry and defibrillator tracings; end-tidal CO₂ tracings; and resuscitation record review.^{6,10,18,19}
3. In all studies reviewed, debriefings were facilitated by health care professionals familiar with the recommended debriefing process or structure, who in some cases were supported by use of a cognitive aid⁵ or checklist.^{5,16,20} Discussions were tailored to participant type and group size and were individualized to the nature of performance during the event. Interdisciplinary debriefing in intensive care units may improve survival outcomes and foster better teamwork.^{8,13}
4. Studies have not directly compared hot versus cold debriefing. Both are recommended because each may bring out different information. Hot debriefings benefit from closer temporal proximity of the event and may foster effective teamwork. Cold debriefing provides the opportunity to review the data systematically and incorporate additional perspectives.

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OUT-OF-HOSPITAL CARDIAC ARREST TEAM COMPOSITION

Recommendations for OHCA Team Composition

COR	LOE	Recommendations
2a	B-NR	1. It can be beneficial to have an advanced life support–level clinician present during the resuscitation of a person with suspected OHCA.
2a	B-NR	2. It is reasonable to ensure that EMS systems have a team size sufficient to achieve discretely assigned roles within the team.

Synopsis

Resuscitation in the prehospital environment is a unique and complex undertaking that requires a cross-functional, highly trained team of professionals.^{1–3} The makeup of this team, from education level to experience, plays a significant role in how the team performs and the outcomes of the cardiac arrest patient.^{3–5} Most studies on prehospital team composition focus on team dynamics and guideline adherence. Increasingly, there is interest in adoption of a “pit crew” model, in which team members fill defined roles in parallel to

achieve an efficient and meticulous resuscitation.⁶ While guideline adherence is a commonly used outcome, achieving favorable patient outcomes such as neurologically intact survival is more important and was prioritized in crafting our recommendations. First responders to OHCA may be police or fire fighters trained in BLS and AED use supplemented by BLS or advanced cardiac life support (ACLS)-trained EMS professionals. The number of responders available may be dependent on resources within the community as well as population density (urban versus rural). In systems with limited human resources, the use of mechanical chest compression devices and ventilators may assist prehospital professionals, but no data support superiority over an adequately staffed team.

Recommendation-Specific Supportive Text

1. Eighteen studies examined the effect of having an ALS-level clinician at the scene of an OHCA.^{2,5–21} While there remains no consensus regarding the number of ALS clinicians (ie, paramedics or advanced emergency medical technicians) on scene that is beneficial or the specific interventions ALS clinicians performed that increased survival, the presence of an ALS clinician was consistently associated with favorable neurologically intact survival to hospital discharge.^{2,5–21}
2. Five retrospective^{5,7,12,20,21} and 2 prospective observational studies^{6,14} specifically examined the number and roles of prehospital professionals present at OHCA events and their correlation to neurologically intact hospital survival. These studies observed a consistent pattern of improved outcomes correlated to the inclusion of additional ALS clinicians; however, team size in general appeared most important because it permitted specific roles to be assigned like in a pit crew model. Much of the correlation with favorable outcomes was associated with better provision of BLS, such as high-quality CPR and shorter time to defibrillation. Various clinician configurations were explored within these studies and found to be successful; thus, systems have the opportunity to develop creative and innovative ways to obtain adequate team size using resources such as fire departments, community initiatives, and law enforcement.

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IN-HOSPITAL CODE TEAM COMPOSITION AND TRAINING

Recommendations for In-Hospital Code Team Composition and Training

COR	LOE	Recommendations
1	B-NR	1. In-hospital code teams should comprise members with ALS training.
2a	B-NR	2. Designated or dedicated code teams with clearly defined roles, diverse expertise, and adequate training incorporating simulation can be beneficial in improving patient outcomes following IHCA.

Synopsis

For patients with IHCA, prompt initiation of CPR and early defibrillation is lifesaving.¹ Accordingly, hospitals throughout the world devote considerable resources for deploying resuscitation or code teams that can promptly initiate resuscitative efforts for patients in cardiac arrest.^{2,3} Clinicians have the option to obtain ACLS training through courses like ACLS and pediatric ALS. Hospitals must determine the roles to be filled by members of the code team with recent articles comparing this model to the efficient and highly choreographed actions of a race car pit crew.⁴ There is considerable variation in IHCA survival between hospitals⁵ with variable adherence to ACLS and pediatric ALS. The structure, composition, training, and practices of code teams vary markedly across hospitals, including differences in how communication and leadership are incorporated.

Recommendation-Specific Supportive Text

1. Teamwork and leadership training have been incorporated in many aspects of patient care and resuscitation skills. Training in ACLS or pediatric ALS has been shown to be associated with higher-quality CPR and patient outcomes.^{6,7} Advanced life support training focuses both on technical and nontechnical skills, however, there remains a lack of data on patient-specific outcomes that may reflect the different methods applied to behaviors and leadership skills.⁶ A systematic review of 7 studies involving patient outcomes after participants took structured ALS courses that focused on leadership training found a low certainty of evidence that teamwork and leadership training improved IHCA outcomes.⁸ Effective leadership is critical in resuscitation contexts, with various studies identifying specific leadership behaviors and skills that correlate with improved patient outcomes.^{9,10} However, a survey of hospitals participating in a US registry found no association between adult resuscitation team leadership (physician, physician trainee, or nonphysician) with hospital's risk-standardized survival.^{9,11}

2. Resuscitation teams at hospitals with high IHCA survival tend to include hospital staff with either limited (designated team) or no other clinical responsibilities (dedicated team), ensuring consistency of clinical expertise and teamwork during resuscitation events.¹¹ Moreover, including team members from diverse disciplines (eg, pharmacists) during resuscitation efforts can enhance compliance with ACLS guidelines, suggesting that interdisciplinary collaboration may improve resuscitation care quality.^{12,13} Implementing structured simulation and training with specific role assignments (ie, the pit crew model) significantly improves CPR quality and is associated with improved survival.^{4,13,14}

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ON-SCENE OHCA RESUSCITATION

Recommendations for On-Scene OHCA Resuscitation

COR	LOE	Recommendations
1	B-NR	1. EMS systems should be prepared to perform termination of resuscitation (TOR) on scene, including death notification training for EMS professionals.
2a	B-NR	2. Prioritizing on-scene resuscitation focused on achieving sustained ROSC prior to initiation of transport for most adults and children experiencing OHCA can be beneficial in the absence of special circumstances.

Synopsis

EMS systems play a central role in OHCA SOC and emphasize delivery of high-quality resuscitation in the field. However, practices for managing OHCA vary across communities, particularly regarding decisions about when to transport patients to a medical center—whether during ongoing resuscitation efforts or after achieving sustained ROSC. Transporting patients during active resuscitation can compromise the quality of CPR provided^{1,2} and introduce safety risks for both patients and EMS clinicians.^{3,4} It is also known that EMS transport under emergency settings (ie, lights and sirens) is associated with an increased risk of motor vehicle collisions.⁵ On-scene resuscitation often ends with field TOR, requiring that EMS clinicians perform death notifications. Death notification training, which teaches skills for communication and providing families with resources, improves the confidence and competence of EMS personnel.⁶ The ethics of TOR in adults is discussed elsewhere (refer to “Part 3: Ethics”).⁷ Emerging evidence indicates that select patients with OHCA might benefit from early transport to a facility capable of providing ECMO. Specific recommendations regarding ECMO are detailed in a separate section of the guidelines. Additional examples may be found where remaining on scene is less beneficial,

such as the example of circulatory arrest due to trauma. These exceptions should be made on a case-by-case basis.

Recommendation-Specific Supportive Text

1. Field TOR provides an ethical framework for resource triage, enhances clinician and community safety by reducing unnecessary lights-and-siren transports, and alleviates additional distress for grieving survivors.⁸ Both pediatric and adult TOR clinical decision rules have demonstrated reliability in determining when continued resuscitation efforts are unlikely to succeed.^{8,9} EMS systems implementing TOR protocols, particularly for pediatric patients, should collaborate with local government and community stakeholders to address and mitigate concerns regarding public perception. Proper training for EMS clinicians in TOR and death notification has been associated with reduced burnout and improved emotional resilience in navigating these challenging situations.¹⁰
2. In secondary analyses of the Resuscitation Outcomes Consortium, intra-arrest transport was not linked to improved survival in adults or children.^{11–13} Survival to discharge was twice as high without intra-arrest transport in adults¹² and infants aged under 1 year old.¹³ Higher agency rates of intra-arrest transport were associated with a stepwise decrease in survival.¹¹

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PUBLIC ACCESS DEFIBRILLATION

Recommendation for Public Access Defibrillation

COR	LOE	Recommendation
1	B-NR	1. We recommend that public access defibrillation (PAD) programs be implemented in communities at high risk of OHCA.

Synopsis

Early defibrillation significantly increases survival rates from OHCA.^{1–4} Studies have found that lay rescuer application of an AED is associated with improved survival to hospital discharge and 30-day and 1-year survival after OHCA, including studies in children.^{5–18} Public access defibrillation (PAD) programs are designed to reduce time to defibrillation by placing AEDs in public places and training community members in how to use them. Prior literature on PAD includes studies that (1) examined the effectiveness of a public AED program (ie, PAD program) in communities to improve OHCA outcomes and (2) examined the association of lay rescuer AED application with OHCA survival compared with defibrillation performed by EMS. The writing committee focused the current review on studies that examined the effectiveness of a PAD program in improving OHCA survival. Despite widespread implementation of AEDs in public spaces, use of public access defibrillators by lay rescuers remains low.^{12,19}

Recommendation-Specific Supportive Text

1. In the PAD Trial implementation of a structured emergency response system that included training of lay volunteers in CPR and AED use led to a doubling of OHCA survival compared with CPR training alone (30 survivors in 107 arrests versus 15 survivors in 128 arrests, respectively; risk ratio, 2.0; 95% CI, 1.07–3.77; $P=0.03$).²⁰ These findings are also supported by multiple observational studies and systematic reviews.^{21,22} Although the quality of evidence from observational studies remains low, these studies have found improved rates of survival to discharge,^{5,7,10} 30 days,^{6,8,9,11,13,14} and 1 year,⁷ including studies in children.^{11,15–17} The 2022 ILCOR scientific statement on PAD addresses key interventions (early detection, optimizing availability, signage, novel delivery methods, public awareness, device registration, mobile apps for AED retrieval, and personal access defibrillation).²³ The incremental cost-effectiveness ratio of PAD has ranged from US \$37 200 to \$1 152 400 per quality-adjusted life-year,²² whereas a recent study found a high probability that public AEDs are cost effective at traditional willingness to pay thresholds of up to \$150 000 per quality-adjusted life year.²⁴

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RECOMMENDATION FOR CARDIAC ARREST CENTERS

Cardiac Arrest Centers

COR	LOE	Recommendation
2b	B-R	1. Transport of resuscitated patients to specialized cardiac arrest centers when comprehensive postarrest care is not available at local facilities may be reasonable.

Synopsis

Regionalized coordination of care improves outcomes for acute critical conditions, such as ST-segment elevation myocardial infarction¹ and cerebrovascular ischemic events.² Expedited transfer to a center capable of providing specialized interventions, such as primary percutaneous coronary intervention, provides incremental benefit over care at the nearest hospital that cannot provide such care.³ Analogous pathways for cardiac arrest patients have been proposed in the form of cardiac arrest centers (CACs). These CACs lack universal definitions but most commonly have been defined as those with around-the-clock temperature control and percutaneous coronary intervention capability and less consistently as centers with access to formal neuroprognostication protocols, mechanical circulatory support, and hemodynamic targeted protocols. Alternatively, CACs have been defined based on the volume of cardiac arrest cases. Studies of CACs also vary on setting (rural versus urban) and whether transport to the CAC occurs at the time of arrest or by subsequent interfacility transport. Transport of acutely resuscitated persons to a CAC must weigh the potential benefit of a higher level of care against risk of decompensation during transport and subsequent distance from loved ones.

Recommendation-Specific Supportive Text

1. We identified 1 new RCT that demonstrated no difference in 30-day all-cause mortality when patients were transported to designated CACs—defined as centers that had around-the-clock availability of interventional cardiology, cardiac surgery, and specialist intensive-care facilities—compared with the geographically closest emergency department.⁴ This trial was conducted in a metropolitan area, and control hospitals were high-functioning, providing temperature control, delayed neuroprognostication, and protocolized hemodynamic management. The findings of this RCT contrast with observational studies that have demonstrated benefit associated with regionalized

CACs.^{5,6} Three new systematic reviews of observational studies demonstrated improved neurologically favorable survival with care provided at CACs of varying definitions.^{7–9} No studies have identified specific components of a CAC associated with clinical benefit, and several components used to define CACs have not demonstrated benefit when studied in isolation. These interventions include temperature control¹⁰ or immediate coronary angiography in patients without ST-segment elevation myocardial infarction.^{11–15} The association between CAC volume and outcomes also varies.^{16–18} Additional observational studies found greater benefit of direct¹⁹ or interfacility transport¹⁷ to CACs when the patient was coming from a smaller population center or lower-volume emergency room.

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EXTRACORPOREAL CPR SOC

Recommendations for ECPR SOC

COR	LOE	Recommendations
2a	C-LD	1. It is reasonable that centers with ECPR programs develop and frequently reassess patient selection criteria to maximize cardiac arrest survival, ensure equitable access, and limit futility.

COR	LOE	Recommendations
2a	C-LD	2. It is reasonable that clinicians performing adult peripheral ECPR cannulation be experienced in percutaneous technique.
2a	C-LD	3. A regionalized approach to ECPR is reasonable to optimize outcomes and resource utilization.
2b	B-R	4. Rapid intra-arrest transport for the purposes of ECPR may be considered for limited, highly selected adult OHCA patients.

Synopsis

The use of ECMO for refractory cardiac arrest, or ECPR, has grown substantially¹ and may benefit selected patients with IHCA or OHCA.² Many of the SOC needed to support ECPR are similar regardless of whether cases result from IHCA or OHCA. Present guidelines recommend the use of ECPR “in select patients when provided within an appropriately trained and equipped system of care.”³ However, RCTs of ECPR, recruiting exclusively adult OHCA patients, have shown mixed results.^{4–7} This heterogeneity in outcomes may be related to differences in the SOC, patient selection, center experience, and trial design across studies. Extracorporeal CPR is a highly resource-intensive intervention that requires significant experience and expertise in both the cannulation process and specialized intensive care management and is associated with a high rate of morbidity and mortality.^{2,8–11} The ethics of patient selection, equitable distribution, and resource allocation are discussed elsewhere (refer to the Advanced Therapies section in “Part 3: Ethics”).¹²

Recommendation-Specific Supportive Text

1. Patient selection for ECPR affects survival and program success. Prudent patient selection with defined inclusion criteria is necessary so that all individuals with potential benefit from the therapy are considered while clear exclusion criteria ensure mindful resource utilization and avoidance of aggressive and costly therapy in futile circumstances.¹³ Considerations for patient selection may differ between IHCA and OHCA. No specific criteria can be recommended with the current state of evidence, but patient characteristics that have been associated with survival include lay rescuer CPR receipt, intermittent ROSC, shockable rhythm, intermittent signs of life during CPR, and short low-flow times.^{14–18} Age cutoffs and metabolic criteria suggesting futility, such as high lactate, low end-tidal carbon dioxide, and low pH, have been identified in retrospective analyses and used as selection criteria in RCTs.^{6,19,20} System protocols that consider a consistent set of predefined variables in determining which patients to select for ECPR, along with routine reevaluation of these variables as additional local and external data evolve, are important components of an ECPR SOC.
2. Adult peripheral ECPR cannulation carries a risk of significant complications, including bleeding, vascular injury, limb ischemia, and cannulation failure, especially in the emergent setting with ongoing CPR.^{4,5,21} Retrospective observational data suggest that percutaneous cannulation under ultrasound guidance, compared with vascular cut-down, may result in faster

time to cannulation without significant differences in cannulation-related complications.^{22–24} One of these studies, an Extracorporeal Life Support Organization registry review, also reported less brain death or diffuse cerebral ischemia with percutaneous cannulation.²⁴ The optimal training path to master ECPR cannulation has not been established.

3. There are no prospective randomized trials that have assessed regionalization or specialty ECPR centers. Multiple observational studies demonstrate an association between increasing ECPR volume and improved patient outcomes, although these findings are limited by confounding.^{25–27} Among RCTs, the positive Advanced Reperfusion Strategies for Patients With Out-of-Hospital Cardiac Arrest and Refractory Ventricular Fibrillation (ARREST) trial was conducted at a single high-volume ECPR center,⁶ which contrasts with the neutral results from the Early Initiation of Extracorporeal Life Support in Refractory OHCA (INCEPTION) trial, which spanned 10 Dutch cardiosurgical centers, 5 of which cannulated 2 or fewer patients.⁵ Variation across these studies precludes a specific definition of a specialized ECPR center. However, given the relatively low frequency of ECPR events (<1% of all cardiac arrests)²⁸ as well as the nuanced complexities of cannulating and caring for these patients, it may be reasonable to match patients to specialized, experienced centers.
4. One single-center RCT randomized OHCA patients to rapid intra-arrest transport coupled with in-hospital ECPR compared with ongoing CPR at the scene.⁴ This study did not show a statistically improved survival with good neurologic outcome at 180 days post-OHCA; however, it was stopped prematurely with a trend favoring ECPR (difference, 9.5%; 95% CI, –1.3% to 20.1%; $P=0.09$), which raises the question of whether the study was sufficiently powered. Two other OHCA ECPR RCTs randomized patients following intra-arrest transport. One was stopped early for benefit,⁶ whereas the other found no difference between ECPR and standard ACLS.⁵ Intra-arrest transport poses significant risks, including delays in BLS and ACLS interventions, ineffective compressions, and safety risks to EMS professionals and the public with high-speed emergency vehicle operations. Monitoring outcomes at the level of the entire community is important to account for changes in resuscitation quality that may occur with rapid transport during ongoing resuscitation. Moreover, there is no direct evidence assessing the allowable diversion distance or time past a non-ECPR-capable receiving facility.^{4–7}

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ORGAN DONATION AFTER CARDIAC ARREST

Recommendations for Organ Donation After Cardiac Arrest

COR	LOE	Recommendations
1	B-NR	1. We recommend that all patients who are resuscitated from cardiac arrest but who subsequently meet neurologic criteria for death or have planned withdrawal of life-sustaining therapies be evaluated for organ donation.
1	C-EO	2. Institutions should develop SOC focused on facilitating and evaluating organ donation after cardiac arrest consistent with local legal and regulatory requirements.
2b	B-NR	3. Patients who do not have ROSC after resuscitation efforts and who would otherwise have termination of resuscitation efforts may be considered candidates for donation in settings where such programs exist.

Synopsis

There are over 100 000 people awaiting a transplant in the United States, with dozens dying each day due to a donor shortage.¹ Nonsurvivors of cardiac arrest could represent an underrecognized source of lifesaving organs. As in other settings, donation after cardiac arrest occurs after confirmation of circulatory or brain death. Donation after circulatory death (DCD) is further divided into controlled and uncontrolled donation. Controlled DCD typically occurs following planned withdrawal of life-sustaining therapies. Uncontrolled DCD occurs immediately after cessation of resuscitative efforts. Although ethical considerations (refer to “Part 3: Ethics”)² and local regulations dictate the circumstances and settings in which organ donation is appropriate, multiple studies across the globe reinforce that cardiac arrest nonsurvivors represent an effective donor allograft source.

Recommendation-Specific Supportive Text

1. Numerous observational studies have documented comparable allograft function and recipient outcomes when transplanted organs are recovered from donors who have suffered cardiac arrest.^{3–7} This includes donation after brain death and controlled DCD, including among donors resuscitated via ECPR or otherwise supported on ECMO.^{8,9}
2. A 2023 ILCOR scientific statement focused on the importance of increasing organ availability after cardiac arrest.¹⁰ Specific interventions and SOC targeting organ donation may help facilitate its acceptance and performance following cardiac arrest, potentially expanding the donor pool.^{11,12} It is vital that such programs adhere to local laws and regulations governing determination of death and organ donation.^{13,14} Metrics of interest for such systems may include organ

referrals and donor conversion rates or the percentage of eligible donors who go on to successful organ donation.

3. Uncontrolled DCD is less commonly performed; however, several studies have demonstrated acceptable kidney and liver allograft function and recipient outcomes following uncontrolled DCD among centers with established uncontrolled DCD programs.^{6,15–17}

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DATA REGISTRIES TO IMPROVE SYSTEM PERFORMANCE

Recommendation for Data Registries to Improve System Performance

COR	LOE	Recommendation
1	B-NR	1. Organizations that treat cardiac arrest patients should collect processes-of-care data and outcomes to guide system improvement.

Synopsis

Measurement is the cornerstone of evaluating performance and identifying opportunities for improvement. For cardiac arrest, measurement may be at the local, regional, or national level through participation in data registries that collect information on processes (CPR performance data, defibrillation times, adherence to guidelines) and outcomes (ROSC, survival) of care. Ideally, data registries are based on the Utstein template, which standardizes core and supplemental elements across participating sites.^{1–3} In the United States, the AHA's Get With The Guidelines–Resuscitation registry and the Cardiac Arrest Registry to Enhance Survival are examples of initiatives that capture data related to processes and outcomes for IHCA and OHCA, respectively. More recently, an expert panel convened by ILCOR and the AHA for IHCA and the Global Resuscitation Alliance for OHCA identified participation in a registry as a key step for improving cardiac arrest survival.^{4–6} Systematic collection of cardiac arrest data within registries is used to identify gaps in care quality that inform quality improvement interventions. They are also used to determine whether quality improvement initiatives are successful in improving care and outcomes.

Recommendation-Specific Supportive Text

1. Consistent with prior studies, recent observational studies demonstrate improved survival and adherence to key performance indicators (CPR process measures, defibrillator application, adherence to guidelines) over time.^{7–10} In the population-based OHCA registries from Japan and Korea, survival to discharge and favorable neurological survival for OHCA patients have steadily increased since the inception of these registries, with improvements attributable to structured interventions guided by systematic data collection.^{8,10} These findings are consistent with prior studies from established registries in other countries, highlighting the importance of registries in improving survival.^{11–13} For IHCA, an observational study found notable improvement in ROSC from 61% to 73.5% ($P=0.03$) following the implementation of a quarterly CPR training program.⁹ In a separate study from Singapore, the initiation of a multipronged quality improvement program that focused on CPR training and communication, improved staffing, audit and feedback was also associated with a significant improvement in ROSC (OR, 2.05; 95% CI, 1.04–4.05; $P=0.04$) but not survival to discharge.⁷

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IMPROVING CARDIAC ARREST RECOVERY

Recommendation for Improving Cardiac Arrest Recovery

COR	LOE	Recommendation
2a	B-R	1. The recovery and long-term functional outcomes of cardiac arrest survivors are likely to benefit from the use of integrated systems that assess patients prior to discharge, reassess their needs after discharge, and address these needs on an ongoing basis during recovery.

Synopsis

Recovery after cardiac arrest encompasses many facets beyond the acute event and resuscitation, affects many individuals beyond the survivor, and spans long after the initial hospitalization.¹ Patients are often laden with new diagnoses and treatments for the underlying cause of their cardiac arrest. They may also deal with new neurologic, physical, or psychosocial impairments that present challenges to reintegration to work, leisure, and society.² Finally, friends, family, lay rescuers, and emergency personnel, appropriately recognized as cosurvivors, suffer a critical toll after experiencing a resuscitation—whether successful or not—which is increasingly being appreciated.³ Previous guidelines and scientific statements have shed light on the importance of building SOC and science to optimize the recovery, survivorship, and cosurvivorship process.^{1,3} Indeed, the creation of such SOC is considered an ethical responsibility for organizations that provide care for cardiac arrest survivors (refer to the Impact on Survivors section in “Part 3: Ethics”).⁴

Recommendation-Specific Supportive Text

1. In an RCT where semistructured cognitive, medical, and psychosocial support offered to adult OHCA and IHCA survivors for 6 months after discharge

was compared with no intervention, survivors had significant improvement in multiple domains of quality of life at 12 months.⁵ This intervention was found to be potentially cost effective at the 1-year followup.⁶ Other RCTs have evaluated the effectiveness of biofeedback and cognitive behavioral therapy⁷ and a structured telephone follow-up⁸ in cardiac arrest survivors, demonstrating improvements in long-term survival and quality of life, respectively. However, a recent systematic review of RCTs and observational studies of rehabilitation following cardiac arrest found significant heterogeneity of treatment effects.⁹ Provision of integrated recovery services, and prevention of loss to follow-up, requires the presence of a multidisciplinary system that spans the inpatient and outpatient domains.^{10–12}

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KNOWLEDGE GAPS AND PRIORITIES FOR RESEARCH

Resuscitation science continues to evolve, with a growing understanding of how integrated SOC impact clinical outcomes as new literature emerges. Although many areas still require further study, the writing group felt that the following items represented the most important knowledge gaps in SOC, therefore deserving the highest priority for future research:

1. Although the clinical effectiveness of community CPR and AED programs is well established, defining the cost effectiveness of implementation in specific populations and settings requires further study.
2. Mobile technologies hold considerable promise as a means to engage lay rescuers in CPR and AED use, however, the optimal implementation of these technologies requires further research.
3. As mobile technologies are implemented, potential risks to privacy, liability, and personal safety during lay rescuer CPR in an unknown location need to be understood.
4. Preliminary studies on drone delivery of AEDs are promising. However, the use of a drone network as part of a community cardiac arrest SOC requires cost-effectiveness analysis and research to define its application in real-world situations and its impact on patient outcomes.
5. Further research is needed to better comprehend the barriers, challenges, and benefits of integrating out-of-hospital and in-hospital datasets as part of quality improvement programs within SOC.
6. While growing evidence supports the benefits of regionalized SOC for time-sensitive emergencies (eg, stroke, ST-segment elevation myocardial infarction), CACs require better definition, including research to identify which components confer benefit and to determine whether delivery of these components justifies the requisite transport time.
7. Further studies are needed to understand how telecommunicators can better recognize cardiac arrest, particularly in pediatric patients, and how their instructions can be delivered to optimize lay rescuer participation and delivery of high-quality CPR. Research to identify age cutoffs and etiologies for which

individuals in cardiac arrest benefit from full CPR with breaths, as opposed to compression-only CPR, is needed.

8. The timing, methods, and specific components of feedback or debriefing after attempted cardiac arrest resuscitation require further study.
9. Research is needed to identify which patients warrant transport to a hospital with ongoing CPR and to define the safest means to do so while maintaining high-quality CPR.
10. Further research is needed to identify the patient characteristics wherein RRT/MET programs provide the greatest outcome benefits, which interventions are most efficacious, and whether RRT/MET programs should be linked to an automated EWS.
11. Research is needed on how to apply behavior and leadership skill training to code teams and EMS systems to optimize resuscitation.
12. Compression-only CPR is easier to implement because of its simplicity and reduced contact but may be less efficacious than CPR with breaths in some etiologies of OHCA (eg, opioid-associated OHCA). Research is needed to define whether specific etiologies of OHCA warrant distinct telecommunicator instructions.