AHA Science Advisory

Increasing Cardiopulmonary Resuscitation Provision in Communities With Low Bystander Cardiopulmonary Resuscitation Rates

A Science Advisory From the American Heart Association for Healthcare Providers, Policymakers, Public Health Departments, and Community Leaders

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There are approximately 360 000 out-of-hospital cardiac arrests (OHCAs) in the United States each year, accounting for 15% of all deaths.[1] Striking geographic variation in OHCA outcomes has been observed, with survival rates varying from 0.2% in Detroit, MI,[2] to 16% in Seattle, WA.[3] Survival variation can be explained in part by differing rates of bystander cardiopulmonary resuscitation (CPR), a vital link in improving survival for victims of OHCA. For every 30 people who receive bystander CPR, 1 additional life is saved.[4] Communities that have increased rates of bystander CPR have experienced improvements in OHCA survival[5,6]; therefore, a promising approach to increasing OHCA survival is to increase the provision of bystander CPR.

Yet provision of bystander CPR varies dramatically by locale, with rates ranging from 10% to 65% in the United States.[7,8] On average, however, bystander CPR is provided in only approximately one fourth of all OHCA events in the United States despite public education campaigns and promotion of CPR as a best practice by organizations such as the American Heart Association and American Red Cross.[9–11] Internationally, similar variation exists, with rates of bystander CPR reported to be as low as 1%[12] and as high as 44%.[13] Therefore, it is important to understand why certain communities have low bystander CPR rates and to provide recommendations for how to increase bystander CPR provision in these communities.

Critical Steps in the Provision of Bystander CPR

Four critical steps are involved in providing bystander CPR as part of a coordinated community emergency response (Figure 1). First, the potential rescuer must recognize that the victim needs assistance. Early recognition may include the bystander recognizing that the victim has had a cardiac arrest, or simply that the victim needs assistance from emergency

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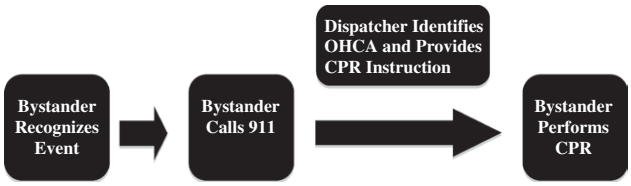

Figure 1. Four critical steps to the performance of cardiopulmonary resuscitation (CPR) by a bystander. OHCA indicates out-of-hospital cardiac arrest.

medical services (EMS). Second, the rescuer must call 9-1-1 (or the equivalent universal access number) promptly. Third, the call is routed to a dispatcher, who must identify that a cardiac arrest event has occurred and dispatch an appropriate EMS response. The dispatcher may provide "just-in-time" CPR instruction that guides the rescuer in performing CPR. Finally, the rescuer starts and continues CPR on the OHCA victim until help arrives.

Emergency Response: Barriers to Performing Bystander CPR

Significant delays in each step of activating 9-1-1, obtaining EMS assistance, and performing CPR are common (Figure 2). Issues include challenges in recognizing a cardiac arrest,[14] expecting someone else in a group to act first,[15] uncertainty about how to perform CPR, fear of performing CPR incorrectly,[16,17] quality of CPR delivered, and the perceived need to breathe into a person's mouth.[18,19] Location of the arrest may also be a barrier to the performance of bystander CPR. People who experience a cardiac arrest in public locations (eg, airports or casinos)[20,21] are more likely to have CPR performed than those in private residences.[22] Language barriers or physical disabilities may also contribute to delays caused by ineffective communication between the caller and the dispatcher.[14,23] Some groups may have additional barriers that inhibit activation of the emergency response system. For example, in the US Latino community, there may be a misperception that EMS providers will ask for proof of residency status before assisting the victim.[24] There may be distrust of local government authority, especially if the bystander has fears of contacting the police. The neighborhood can also affect the bystander's likelihood of stopping to assist a person in need. For example, people who reside in high-crime neighborhoods may not want to get involved in a situation in which they may put themselves or their families in danger.[25] There may also be barriers such as reluctance to have contact with the opposite sex in some cultures.[26] Finally, there may be concerns, real or perceived, that a Good Samaritan might be subject to legal action if the outcome is not favorable.[15,27]

Facilitators to Increase Bystander CPR

Scientific statements by the American Heart Association have highlighted the importance of community efforts to increase rates of bystander CPR by increasing the use of hands-only CPR for bystanders,[28] changing the paradigm of educational campaigns (eg, brief educational videos, community awareness programs),[29] implementing school-based training,[30] and increasing effective dispatcher-assisted CPR.[31]

In 2008, the American Heart Association changed its guidelines to recommend hands-only CPR without rescue breathing as an acceptable alternative to traditional CPR for bystanders.[28] The shift toward hands-only CPR is relevant to 2 commonly cited barriers: fear of performing CPR incorrectly and fear of infection from providing mouth-to-mouth ventilation.[18] Hands-only CPR is being promoted through widespread public education campaigns, the use of nontraditional educational materials such as the CPR Anytime Kit,[32,33] and social media campaigns. The CPR Anytime Kit is a brief (30-minute) educational video that describes both traditional and hands-only CPR. In addition, an inflatable mannequin is included in the kit so that users can practice performing CPR.

The conventional paradigms of CPR training and performance have also changed. Brief messaging may be an equally effective and significantly more cost-efficient tool than a longer conventional training course to disseminate CPR awareness to large numbers of people.[34] Another successful community strategy has been the promotion of brief, widely disseminated CPR education as part of broader public safety and "community awareness" programs.[34] This model incorporates the resources of existing entities involved in public safety, such as municipal fire, law enforcement, and public safety departments.

No single CPR training approach is comprehensive, and an optimal community approach will incorporate all these strategies. For example, an effective approach could be one that combines brief CPR familiarization with a structured, standardized, dispatcher-assisted telephone CPR program that provides "just-in-time" CPR instructions. Effective dispatcher-assisted CPR may therefore engage rescuers in emergency bystander CPR who have not been trained recently, do not immediately identify the cardiac arrest event, lack confidence, are panicked, or have cultural or linguistic barriers to performing CPR.[35]

Disparities in CPR Provision and OHCA Survival at the Individual and Neighborhood Level

In the United States, compared with whites, Latinos and blacks are at higher risk for OHCA rhythms with a poor prognosis (such as asystole and pulseless electrical activity).[36–38] This relative

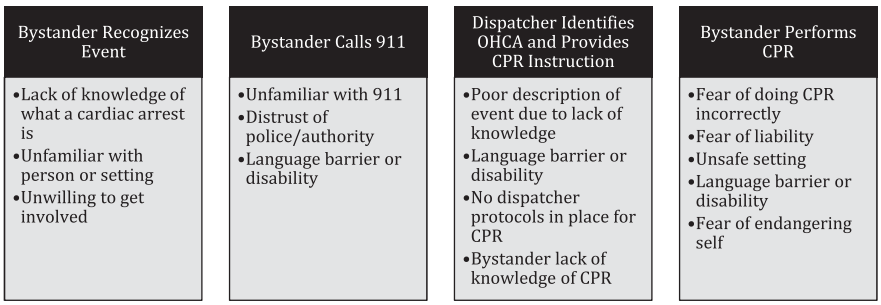

Figure 2. Barriers to the performance of cardiopulmonary resuscitation (CPR) by a bystander. OHCA indicates out-of-hospital cardiac arrest.

predominance of nonshockable rhythms among ethnic minority groups may reflect, in part, a delayed response by rescuers and the emergency medical system (eg, a shockable rhythm may have degenerated into asystole by the time EMS arrives). The neighborhood where OHCA occurs can also affect the likelihood of receiving CPR and subsequent survival.[8,39–42] Residents of neighborhoods that are primarily Latino, black, poor, or non–English speaking are less likely to receive bystander CPR and are consequently less likely to survive.[36,43–46] Given this relationship between neighborhood and CPR, neighborhoods are an important target for public health interventions to increase bystander CPR use and improve health outcomes.

Public Health Surveillance: An Essential Tool to Evaluate the Effectiveness of Community CPR

Ongoing, systematic collection and analysis of data about OHCA and bystander CPR is essential to the planning, implementation, and evaluation of effective CPR programs. There are a number of large-scale existing data collection efforts that are used to monitor prehospital and bystander resuscitation efforts. Examples include the Cardiac Arrest Registry to Enhance Survival (CARES),[47] the National EMS Information System (NEMSIS),[48] the Resuscitation Outcomes Consortium (ROC) Epistry,[49] and the Pan Asian Resuscitation Outcomes Study (PAROS).[12] Each registry collects somewhat different data elements from reporting agencies with varied data collection strategies and quality assurance processes. Although these registries are not identical with regard to information or data processes, they each provide a useful approach to the systematic recording of bystander CPR and provide the foundation for programmatic improvement. Registries are a way to collect data using standardized definitions across many stakeholders, with the key functionality of providing individualized feedback against national benchmarks. Better integration of these data collection systems may be valuable for comparing CPR rates across states, regions, and systems; identifying opportunities for improvement; and systematically evaluating community-based CPR interventions.

The Role of Geographic Information Systems in Public Health Surveillance

Geographic information system methods capture, manage, analyze, and display geographically referenced information. They allow researchers to view, understand, question, and interpret data to reveal relationships, patterns, and trends in the form of maps. These methods have been used in EMS systems as a tool for optimizing OHCA response by decreasing response times[50] and defining more efficient service areas.[51]

Geographic information systems can serve an even larger role in OHCA care by enabling researchers to explore the links between neighborhood environments and bystander CPR.[52] In fact, a growing body of evidence suggests significant neighborhood-level variation in the provision of bystander CPR and OHCA survival.[39,41] These geographic differences in health services and health outcomes may be related to differences in the people who live in these places (composition), the physical or social environment (contextual), or both.[53] Contextual differences in OHCA can also include system differences at the dispatcher, EMS, and hospital levels. In addition, variation in health outcomes may be influenced by complex interrelationships between characteristics of people and their environment.

Race/ethnicity has been associated with CPR provision and outcome, and this association may be mediated by neighborhood characteristics.[8,54] There may be several explanations for these findings, including a lack of CPR training opportunities in low-income areas, a relative lack of social capital (distrust of neighbors, social isolation), and perhaps fear of acquiring a communicable disease from mouth-to-mouth ventilation (perceived as a higher probability in low-income areas).[25] An understanding of the sociodemographic and cultural context of the neighborhood may be crucial to improve OHCA survival when designing, implementing, and evaluating CPR interventions and to improve access to intervention resources.[55]

Traditional methods to increase CPR have used generic training programs that are employment-, school-, or event-based.[30,56–58] However, these approaches to CPR training have not been as successful in US communities of blacks, Latinos, those with limited English proficiency, and the poor—all groups with a high incidence of OHCA and low survival.[36,43–46] Traditional CPR training approaches may not be as successful in these populations because they do not target groups based on needs and are not tailored to these specific social or cultural groups. This historical approach to CPR training often fails to consider (1) who is getting trained, (2) the setting in which the training occurs, and (3) how the training is delivered. An alternative approach to increase community CPR may be to work closely in partnership with community organizations in "high-risk" neighborhoods to develop tailored CPR training programs targeted to these neighborhoods' specific contexts and needs. This type of tailored approach has been implemented successfully in churches[59] and hair salons[60] to increase organ donation in minority populations and may serve as a model for community-based CPR programs.

Measuring Success at the Community, EMS, and Individual Level

The accurate evaluation of the effectiveness of community-based CPR programs and identification of gaps in the delivery of CPR require standardized metrics at the community, EMS, neighborhood, and individual levels (Table). These issues are especially important to improve CPR programs for minority populations. The EMS-level metrics include all dispatchers who answer 9-1-1 calls, as well as the EMS providers who arrive on-scene and assist with resuscitation efforts. Neighborhood-level metrics are defined based on the community but entail a smaller geographic area (eg, census tract or zip code) so that small area variations in OHCA incidence, survival, and bystander CPR can be explored. Finally, individual-level characteristics of the person who had the OHCA event, as well as the bystander(s) who assisted, are also important in understanding and improving bystander CPR. Some metrics are the highest priority and constitute core measures that should be used in a community, whereas other metrics (eg, language, race/ethnicity of bystander, and type of CPR provided) may be more difficult to ascertain and hence may be considered a lower priority. However, in sites that are already doing well in the provision of bystander CPR, this level of granularity

Table. Metrics for Evaluation of Community-Based CPR Training Program

Metric	Level of Measurement	Priority
OHCA incidence*	Community, neighborhood	High
Bystander CPR prevalence†	Community, neighborhood	High
Return of spontaneous circulation before emergency department arrival	Individual, community, neighborhood	High
OHCA survival‡	Individual, community, neighborhood	High
Neurological status at discharge§	Individual, community, neighborhood	High
Dispatcher characteristics	EMS	
Time of call to recognition of OHCA		High
Time of call to EMS dispatch		High
Time delays for non–English speaking callers		High
Were just-in-time CPR instructions given? (If not, why?)		High
Time bystander CPR is started		High
Type of CPR performed (hands-only vs traditional)		High
Response times	EMS	
Call to EMS arrival		High
EMS on-scene time		High
Address of arrest		High
Location of arrest (eg, private residence, airport, etc)		High
Transport from scene to hospital		High
EMS characteristics	EMS	
Proportion of resuscitations not worked		High
Proportion of resuscitations terminated on-scene		High
Proportion of arrests witnessed by EMS		High
Bystander characteristics	Individual	
Age		Low
Race/ethnicity		Low
Sex		Low
Native language		Low
Relationship to victim		Low
Prior CPR training		Low
Type of CPR provided		Low
OHCA patient characteristics	Individual	
Age		High
Race/ethnicity		High
Sex		High
Native language		Medium
Community/neighborhood characteristics (per census data)	Community, neighborhood	
Age		Medium
Race/ethnicity		Medium
English as a second language		Medium
Living below poverty line		Medium
With no access to car		Medium

CPR indicates cardiopulmonary resuscitation; EMS, emergency medical services; and OHCA, out-of-hospital cardiac arrest.
*Number of unworked and worked OHCA events per population at risk.
†Number of worked OHCA events with an arrest before EMS arrival and that did not occur at a medical facility.
‡Number of OHCA survivors discharged from hospital per total number of worked OHCA events.
§Defined by Cerebral Performance Category Score.

may elucidate important disparities and possible areas for improvement when available. Important metrics should be measured over time, benchmarked with past performance, and refined as part of a community resuscitation system of care.

Traditionally, the providers of community-based CPR training programs have defined a successful program as the number of individuals trained. This assumes that the individuals being trained are (1) present at cardiac arrest events, (2) able

to recognize the cardiac arrest, (3) able and willing to perform CPR when necessary, and that (4) formal CPR training is the only (or even optimal) method of relaying information to the lay public. A more meaningful metric is to track the delivery of CPR via bystanders to OHCA victims. In addition, standardized measurement of key time intervals (eg, time of 9-1-1 call, recognition of OHCA by dispatcher, CPR time) should also be captured, because these time intervals significantly impact OHCA survival.

Knowledge Gaps and Special Considerations

There are a number of key challenges to our understanding of bystander CPR. First, the scope of the CPR training deficit is not well characterized. For example, although numerous studies have demonstrated that bystander CPR is not provided in ≈60% to 80% of OHCA events,[61] the prevalence of CPR knowledge and training in the population is unknown. Second, the complete array of barriers to CPR delivery among those who are trained remains unclear. Some investigations have suggested that delays in recognition,[14] panic,[16] fear of mouth-to-mouth ventilation,[18,19] and fear of performing CPR incorrectly[16,17] play important roles in limiting CPR delivery by trained bystanders. However, studies of barriers have been limited by small sample sizes and focused on particular populations, thus limiting their generalizability. More research is needed on cultural and societal barriers to bystander CPR, especially from an international perspective. A third major challenge rests in our understanding of legal issues and concerns surrounding CPR. Although versions of Good Samaritan laws exist in all 50 US states and the District of Columbia,[62] these laws are not uniform in what classes of rescuers are protected and under what circumstances. Unfounded legal concerns may contribute to hesitancy to learn or perform CPR.

The quality of bystander CPR delivered in the community is also not well characterized. Although several studies have documented variable CPR quality by trained providers,[63–65] only 1 study has quantitatively evaluated CPR by laypersons.[66] As technologies to capture CPR performance are disseminated, studies should evaluate how bystander CPR is provided in actual practice. Such studies would inform educational efforts and messaging to correct for actual rather than assumed deficiencies.

In addition to knowledge gaps surrounding implementation and performance in the public at large, there are specific unstudied issues that pertain to special subgroups. For example, preliminary data suggest that bystander CPR delivery and subsequent cardiac arrest survival are lower in the rapidly growing US Latino population.[38] The extent to which CPR training prevalence among Latinos is limited by socioeconomic, language, or cultural barriers remains poorly understood. Similar statements can be made about CPR training among blacks and other ethnic groups within the US population, particularly immigrant communities who have limited English proficiency (eg, Cambodian, Vietnamese, Chinese).[14,67]

Besides race/ethnicity and culture, CPR education has also largely ignored considerations of a trainee's age. Considerable efforts have been made to implement CPR training in schools and in the workplace, which suggests that important disparities in training prevalence may exist among the middle-aged or elderly. Whether older members of the public can be reasonably expected to provide CPR or whether CPR education should be tailored to different ages is unknown. In a similar vein, CPR materials for children should be adapted in a developmentally appropriate manner. One approach to CPR among children, like other health curricular issues, may rest in staged approaches, in which the topic of CPR training is introduced in a limited fashion to younger children, with expanded iterations of teaching in subsequent school years. Another approach is to develop applications for smartphones that can provide easily accessible CPR information.

Broad evidence exists to suggest that layperson CPR can improve survival from OHCA. The optimization of training in the community, a domain of implementation science, remains a central focus that demands concentrated research effort. What is the optimal environment for broad CPR training? Efforts have been made to study implementation in schools[68] and hospitals,[69] as well as at mass training events. The relative impact of these strategies on CPR training prevalence or cardiac arrest outcomes is unclear. Initial work has suggested that CPR training can be performed adequately by brief video-only approaches,[34] which suggests new broad approaches to dissemination, including public service announcements on television or in venues such as airports or train stations. Also relatively untapped are newer approaches that use social media. Internet-based tools, such as Twitter and Facebook, merit serious investigation as methods to spread CPR awareness and training materials. Initial efforts are currently under way to use such methods to identify the location of public automated external defibrillators.[70]

More research is also needed internationally to understand the disease of OHCA around the world, identify high-risk communities with underpenetration of bystander CPR, and characterize local barriers to CPR delivery. Examples of international OHCA registry efforts include PAROS,[12] the proposed European cardiac arrest registry (EuReCa),[71] and the International Resuscitation Network Registry.[72] Strategies to increase bystander CPR must consider cultural and societal factors in different countries.

Clinical Considerations: Recommendations to Decrease OHCA Disparities

- Communities should use public health surveillance tools such as registries to collect standardized data on OHCA, including the provision of bystander CPR and survival from OHCA. Metrics need to be developed, refined, and benchmarked as part of a community resuscitation system of care. A standardized process of continuous quality improvement and feedback of information to providers and community should also be included in all community-based CPR programs.
- Data should be collected and analyzed to better characterize health disparities in bystander CPR and OHCA survival, including how they vary across community and neighborhood levels.
- Cardiac arrest locations can be analyzed with geographic information systems and spatial epidemiology methods to identify and target "high-risk" neighborhoods within a community on which to focus public health resources.

- A combination approach should be used to increase community bystander CPR. This should consist of a public education campaign that is focused in the neighborhoods with the highest need and is culturally sensitive, along with a structured, standardized, dispatcher-assisted telephone CPR program that provides "just-in-time" CPR instructions to rescuers who may be willing but unsure of their abilities to perform CPR.
- Novel methods that use social media and the internet should be explored to disseminate information to community members and increase awareness of CPR.
- More research is needed to understand local cultural and societal barriers to bystander CPR.

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*Modest.

†Significant.

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†Significant.

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KEY WORDS: AHA Scientific Statements ■ cardiopulmonary resuscitation ■ emergency cardiovascular care ■ resuscitation