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Hands-Only (Compression-Only) Cardiopulmonary Resuscitation: A Call to Action for Bystander Response to Adults Who Experience Out-of-Hospital Sudden Cardiac Arrest

A Science Advisory for the Public From the American Heart Association Emergency Cardiovascular Care Committee

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Bystanders who witness the sudden collapse of an adult should activate the emergency medical services (EMS) system and provide high-quality chest compressions by pushing hard and fast in the middle of the victim's chest, with minimal interruptions. This recommendation is based on evaluation of recent scientific studies and consensus of the American Heart Association Emergency Cardiovascular Care (ECC) Committee. This science advisory is published to amend and clarify the "2005 American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC)" for bystanders who witness an adult out-of-hospital sudden cardiac arrest.

Ten years ago, the AHA commissioned a working group of resuscitation scientists to reappraise the Association's inclusion of ventilations in the recommended sequence for bystander cardiopulmonary resuscitation (CPR). The working group evaluated peer-reviewed reports of laboratory and human research and summarized their findings in a 1997 statement.[1] The key conclusion of that statement was that "Current guidelines for performing mouth-to-mouth ventilation during CPR should not be changed at this time."[1]

In the animal studies cited in the 1997 statement, when ventricular fibrillation arrest was of short (under 6 minutes) duration, the addition of rescue ventilations to chest compressions did not improve outcome compared with chest compressions alone (LOE 6*).[2–8] Analysis of human data from a national out-of-hospital CPR registry documented no survival advantage to ventilations plus compressions compared with the provision of chest compressions alone during bystander resuscitation (LOE 4*).[9,10] Although these studies were not deemed sufficient to justify the elimination of ventilations from the bystander CPR sequence, the 1997 statement strongly encouraged further research that would focus on "*...the timing, rate, and depth* [of ventilations] *as well as conditions under which respiratory assistance should be used*." The statement also recommended "*...more research on real-world obstacles to learning, remembering, and actually performing CPR...*" In addition, the statement contained a secondary conclusion that "*...provision of chest compression without mouth-to-mouth ventilation is far better than not attempting resuscitation at all.*"[1]

The AHA's recent Guidelines for CPR and ECC have reflected the primary and secondary conclusions of the 1997 statement: "*Laypersons should be encouraged to do compression-only CPR if they are unable or unwilling to provide rescue breaths (Class IIa), although the best method of CPR is compressions coordinated with ventilations.*"[11,12] In addition, the Guidelines have recommended compression-only CPR for dispatcher-assisted instructions for untrained bystanders."[11,12]

The "2005 AHA Guidelines for CPR and ECC" noted the need to increase the prevalence and quality of bystander CPR. The Guidelines and training materials emphasized the importance of the delivery of high-quality chest compressions, that is, compressions of adequate rate and depth with full-chest recoil and minimal interruptions.[12] To limit the frequency of

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interruptions, these Guidelines recommended an increased compression-to-ventilation ratio of 30:2 for adult victims. In addition, the AHA courses increased student practice of high-quality chest compressions with interruptions (including interruptions to deliver rescue breaths) limited to 10 seconds or less.

The purpose of this science advisory is to clarify and elaborate on the "2005 AHA Guidelines for CPR and ECC," with a summary of research published since 2005. In this advisory, the studies that were reviewed in preparation for the AHA's 2000 and 2005 CPR and ECC guidelines are denoted with an asterisk (*). The peer-reviewed studies that have been published since the "2005 AHA Guidelines for CPR and ECC" update are denoted by a double asterisk (**). This advisory uses the Level of Evidence classification scheme developed for the "2005 AHA Guidelines for CPR and ECC."[12]

Efficacy of Treating Cardiac Arrest With Chest Compressions Alone

Animal Studies

In a porcine model of short-term cardiac arrest (3 minutes of untreated ventricular fibrillation arrest) comparison of chest compressions to conventional CPR has yielded varying results. Dorph et al[13] showed equivalent hemodynamics in the 2 groups during 10 minutes of CPR but reduced survival in the group that did not receive the rescue breaths (LOE 6*). Berg et al[14] reported reduced integrated coronary perfusion pressure and median left ventricular blood flow among those animals that received rescue breaths during 12 minutes of high-quality 15:2 CPR but no difference in left ventricular myocardial oxygen delivery or 24-hour, neurologically intact survival between animals receiving chest compressions alone and those receiving the conventional CPR (LOE 6*). In another swine study of simulated bystander CPR, Kern et al[15] demonstrated that 6 minutes of chest compressions alone with a clamped endotracheal tube resulted in equivalent 24-hour survival and good neurological outcomes compared with standard CPR (LOE 6*). Two animal studies[16,17] mimicking single-rescuer bystander CPR (using a 15:2 compression:ventilation ratio with 16-second pauses in compressions to provide 2 rescue breaths in 1 study and 30:2 in the other) have demonstrated better outcomes with continuous compressions compared with conventional CPR (LOE 6*, **).

It is important to acknowledge that during cardiac arrest without lung inflation and ventilation, there is a continuous decrement of blood oxygen saturation. At some point in time, the possible hemodynamic advantage conferred by continuous chest compressions (without ventilations) will be offset by this reduction in oxygen saturation, and the ultimate result will be a compromise in oxygen delivery. One porcine cardiac arrest study[18] (3 minutes of untreated ventricular fibrillation, then 12 minutes of CPR) suggests that after 4 minutes of continuous chest compressions without rescue breathing, the delivery of 2 rescue breaths every 100 compressions provides a survival advantage over chest compressions alone (LOE 6*).

Animal studies[19,20] mimicking bystander CPR with good quality compressions for asphyxia-precipitated cardiac arrests demonstrated that the addition of rescue breathing to compressions results in much better outcomes than chest compressions alone (LOE 6*). Chest compressions alone, however, were superior to no CPR at all, even with asphyxia-precipitated cardiac arrest. These studies support the need for rescue breathing as a critical component of CPR for asphyxia-precipitated cardiac arrests, such as those associated with drowning, trauma, airway obstruction, acute respiratory diseases and apnea (eg, with drug overdoses), pediatric arrests, and prolonged cardiac arrest.

Human Clinical Experience

Since the 1997 AHA ventilation statement, there have been 5 key human studies comparing the efficacy of bystander compression-only CPR with conventional CPR (Table). These studies are consistent with the animal data and the human registry data cited previously.[9,10]

In 2000, Hallstrom et al[21] demonstrated equivalent survival to hospital discharge in out-of-hospital cardiac arrest victims who were randomized to receive dispatcher-assisted bystander CPR instructions for compressions only or compressions and mouth-to-mouth ventilations (LOE 2). Waalewijn et al[22] reported that the provision of chest compressions alone did not have a negative influence on survival to hospital discharge, compared with conventional CPR (LOE 3*).

Three nonrandomized observational studies of human bystander CPR were published in 2007, and none of these 3 studies demonstrated any negative impact on survival when ventilations were omitted from the bystander sequence. Using the important end point of 30-day survival with favorable neurological outcome, it was reported[23] that survival after bystander chest compressions only did not differ from survival after conventional bystander CPR for adult patients with witnessed out-of-hospital cardiac arrests from both "cardiac" and "noncardiac" causes (LOE 4**). Iwami et al[24] reported no difference in 1-year neurologically intact survival between victims of witnessed cardiac arrest of presumed cardiac etiology who received bystander compressions only and those who received conventional CPR (LOE 4**). Bohm et al[25] also studied 1-month survival from a registry of all adult victims of out-of-hospital cardiac arrest who received bystander CPR and found no statistically significant difference between victims that received chest compressions alone and those that received conventional CPR (LOE 4**). These studies could not assess or control for the quality of bystander CPR delivered, and all bystanders were likely trained according to the recommendations published before the "2005 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations"[26] or the "2005 AHA Guidelines for CPR and ECC."[12] These 2005 publications emphasized the delivery of more effective chest compressions with minimal interruptions.

Lay Responder Performance

Hands-only (compression-only) bystander CPR may reduce the time to initiation of CPR and result in delivery of a greater

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Table. Clinical Bystander CPR Studies Comparing Chest Compression-Only CPR With Chest Compression Plus Rescue Breathing CPR

Study	Population Studied (All Are Out-of-Hospital)	Outcome Measure	No Bystander CPR (%)	CC-Only CPR (%)	CC + RB CPR (%)
Survival after out-of-hospital cardiac arrests					
10. Bossaert et al, 1989 9. Van Hoeyweghen et al, 1993	All adult cardiac arrests, cardiac and noncardiac causes, with good quality CC-CPR or good quality CC + RB-CPR or no CPR	14-day survival	123/2055 (6)	17/116 (15)	71/443 (16)
21. Hallstrom et al, 2000	Prospective, RCT of dispatcher instructions for all adult cardiac arrests, excluding poisoning/overdoses	Discharged alive from hospital	—	32/240 (15)	29/278 (10)
22. Waalewijn et al, 2001	All bystander-witnessed adult cardiac arrests with EMS resuscitation	Discharged alive from hospital	26/429 (6)	6/41 (15)	61/437 (14)
23. Nagao et al, 2007	All witnessed adult cardiac arrests–cardiac and noncardiac causes	Neurologically favorable 1-month survival	63/2917 (2)	27/439 (6)*	30/712 (4)*
24. Iwami et al, 2007	All witnessed adult cardiac arrests of presumed cardiac origin	Neurologically favorable 1-year survival	70/2817 (3)	19/441 (4)	25/617 (4)
25. Bohm et al, 2007	All cardiac arrests with bystander CPR including cardiac and noncardiac causes	1-month survival	—	591/8209 (7)	77/1145 (7)
Survival after out-of-hospital for witnessed ventricular fibrillation cardiac arrests only					
23. Nagao et al, 2007			45/549 (8)	24/124 (19)†	23/205 (11)†
24. Iwami et al, 2007			44/535 (8)	14/122 (12)	18/161 (11)

CC-only CPR indicates chest compression-only bystander CPR; CC + RB CPR refers to conventional chest compression with rescue breathing bystander CPR; RCT, randomized, controlled trial; EMS, emergency medial services.

*Outcomes were equivalent or better with CC-only CPR compared with CC + RB CPR: unadjusted odds ratio, 1.5 (95% confidence interval, 0.9–2.5), and adjusted odds ratio, 2.2 (95% confidence interval, 1.2–4.2), but many patients could not be included in the adjusted odds ratios. †Outcomes were better with CC-only CPR than CC + RB CPR: adjusted odds ratio, 2.5 (95% confidence interval, 1.2–4.9). All data are presented as number (percentage).

number of chest compressions with fewer interruptions for the first several minutes after adult out-of-hospital cardiac arrest. Several human studies suggest that trained rescuers performing traditional 1-person CPR take much longer to initiate CPR than those trained to perform hands-only CPR. This can be explained by the additional cognitive or emotional burdens associated with attempting the more complex psychomotor task of traditional CPR (LOE 6*).[27]

Studies[27,28] of basic life support providers trained before the "2005 AHA Guidelines for CPR and ECC" showed that lay rescuers and healthcare providers who performed conventional CPR interrupted chest compressions for much longer than recommended (16±1 seconds and 10±1 seconds, respectively) to provide ventilations and delivered significantly fewer compressions over time than rescuers performing continuous chest compressions (LOE 6*, **). In 1 study,[29] there was more "decay" in posttraining performance over time (18 months) among those trained in conventional CPR than among rescuers trained in chest compressions only (LOE 6*). However, the ability of bystanders to deliver adequate rate and depth of continuous chest compressions for prolonged durations is unknown and requires further study.

Reducing Barriers to Bystander Action

Although bystander CPR can more than double survival from cardiac arrest,[9,30–34] the reported prevalence of bystander CPR remains low in most cities, about 27% to 33%.[23,35–38] Reducing barriers to bystander action can be expected to substantially improve cardiac arrest survival rates. Reasons cited prospectively for the reluctance to perform CPR often include concerns about disease transmission related to performing mouth-to-mouth ventilation.[39–45] In a study of actual bystanders, Swor et al[35] reported that CPR-trained bystanders at the scene of out-of-hospital cardiac arrests most often cited panic and fear of causing harm as reasons for failing to perform CPR; only 1.4% expressed reluctance to perform mouth-to-mouth ventilation, and none cited fear of infection (LOE 3**). Hauff et al[46] also found that fear of infectious disease was not a prominent concern or obstacle when bystander CPR instructions were provided by a dispatcher (LOE 4*).

Eliminating the expectation of mouth-to-mouth contact during CPR is likely to improve esthetics and address the expressed concern of potential bystanders about infection. Simplifying CPR training also improves trainees' ability to learn and perform, among other things, proper chest compressions (LOE 6**).[47] Finally, eliminating ventilation instructions in dispatcher-assisted CPR reduces the time required to commence compressions, as observed in simulated (LOE 6*,**)[48,49] and actual out-of-hospital resuscitations (LOE 2*).[21]

Who Should Receive Hands-Only CPR From Bystanders?

The AHA ECC Committee has carefully considered the relatively low prevalence of bystander CPR and the potential

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that further simplification of CPR instructions might encourage more bystanders to take appropriate action. Furthermore, the Committee has concluded that adult victims of out-of-hospital cardiac arrest who receive bystander hands-only (compression-only) CPR *or* conventional CPR have a similar chance of survival. Thus, bystanders can use either hands-only CPR or conventional CPR to achieve the goal of providing effective chest compressions (of adequate rate and depth with minimal interruptions) to adult victims of out-of-hospital sudden cardiac arrest. This "call to action" for bystanders does NOT apply to unwitnessed cardiac arrest, cardiac arrest in children, or cardiac arrest presumed to be of noncardiac origin.

The AHA ECC Committee acknowledges that all victims of cardiac arrest will benefit from delivery of high-quality chest compressions (compressions of adequate rate and depth with minimal interruptions) but that some cardiac arrest victims (eg, pediatric victims and victims of drowning, trauma, airway obstruction, acute respiratory diseases, and apnea [such as that associated with drug overdose]) may benefit from additional interventions taught in a conventional CPR course. Therefore, the Committee continues to encourage the public to obtain training in CPR to learn the psychomotor skills required to care for a wide range of cardiovascular- and respiratory-related medical emergencies.

Limitations and Cautions

During the discussions and review of this science advisory, some experts raised concerns about basing recommendations on animal studies and limited nonrandomized observational human studies. They also raised concerns about the possibility that recommending hands-only CPR for witnessed sudden cardiac arrest will, in fact, increase the complexity of decision-making for bystanders or that unresponsive victims of noncardiac medical emergencies (eg, drowning, drug overdose) will not receive rescue breathing.[50,51] The Committee acknowledges those views but considers the hands-only CPR recommendation to be sufficiently focused on a specific, easily identified patient population and bystander group. In addition, the Committee thinks that this clarification is likely to increase the incidence of bystander action. In the studies of bystander CPR cited in this advisory, hands-only (compression-only) CPR was better than no attempt at CPR and produced survival equivalent to conventional CPR.

Many questions remain unanswered. The ECC Committee acknowledges important limitations in issuing these recommendations and the call to action. These recommendations are based on the best available evidence, but this evidence is far from complete. Although we believe that making CPR easier to perform will increase the overall performance of CPR by bystanders, this remains unproven in clinical trials. There may be situations in which ventilation alone could be life-saving but is not provided. There may be an interval after cardiac arrest when ventilations become absolutely critical for survival. There could be confusion on the part of bystanders who have been previously trained in conventional CPR. The impact of implementing these recommendations for adult victims could adversely affect some pediatric victims (if incorrectly applied) or other victims of asphyxial arrest. New teaching methods may emerge that improve the ability of bystanders to learn and perform effective compressions and ventilations during conventional CPR. After careful consideration, weighing all the known evidence, and considering the many unanswered questions, the ECC Committee held that the likely advantages in favor of this recommendation outweigh the possible disadvantages.

Recommendations and Call to Action

All victims of cardiac arrest should receive, at a minimum, high-quality chest compressions (ie, chest compressions of adequate rate and depth with minimal interruptions). To support that goal and save more lives, the AHA ECC Committee recommends the following.

When an adult suddenly collapses, trained or untrained bystanders should—at a minimum—activate their community emergency medical response system (eg, call 911) and provide high-quality chest compressions by pushing hard and fast in the center of the chest, minimizing interruptions (Class I).

- *If a bystander is not trained in CPR, then the bystander should provide hands-only CPR (Class IIa). The rescuer should continue hands-only CPR until an automated external defibrillator arrives and is ready for use or EMS providers take over care of the victim.*
- *If a bystander was previously trained in CPR and is confident in his or her ability to provide rescue breaths with minimal interruptions in chest compressions, then the bystander should provide either conventional CPR using a 30:2 compression-to-ventilation ratio (Class IIa) or hands-only CPR (Class IIa). The rescuer should continue CPR until an automated external defibrillator arrives and is ready for use or EMS providers take over care of the victim.*
- *If the bystander was previously trained in CPR but is not confident in his or her ability to provide conventional CPR including high-quality chest compressions (ie, compressions of adequate rate and depth with minimal interruptions) with rescue breaths, then the bystander should give hands-only CPR (Class IIa). The rescuer should continue hands-only CPR until an automated external defibrillator arrives and is ready for use or EMS providers take over the care of the victim.*

The ECC Committee strongly recommends that the AHA and other research funding organizations (eg, the National Institutes of Health) act aggressively in the public's interest to fund research that will answer the important unanswered questions cited in this advisory. Only with new research and additional evidence will future guidelines be able to recommend optimal methods for bystander CPR. Funding to conduct this high-impact research that directly affects so many lives should be prioritized.

The scope of this recommendation is limited to a "call to action" for bystanders as they care for an adult who has experienced a witnessed, out-of-hospital cardiac arrest of probable cardiac origin (eg, sudden collapse or collapse after signs consistent with a myocardial infarction). As such, it is meant to clarify the "2005 AHA Guidelines for CPR and ECC" on this

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topic. The science volunteers of the ECC Committee and the Basic Life Support Subcommittee continue to participate in the internationally based evaluation of resuscitation science sponsored by the International Liaison Committee on Resuscitation (ILCOR) and the AHA. As a part of both the ILCOR evaluation and ongoing AHA activities, ECC Committee members and Basic Life Support Subcommittee members will continue to monitor and evaluate peer-reviewed studies related to lay rescuer and healthcare provider resuscitation attempts for victims of all causes of cardiac arrest.[52]

Disclosures

Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
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*Modest.

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KEY WORDS: AHA Scientific Statement ■ cardiopulmonary resuscitation ■ death, sudden ■ heart arrest ■ resuscitation

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