2017 American Heart Association Focused Update on Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality

An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

ABSTRACT: This focused update to the American Heart Association guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiovascular care follows the Pediatric Task Force of the International Liaison Committee on Resuscitation evidence review. It aligns with the International Liaison Committee on Resuscitation's continuous evidence review process, and updates are published when the International Liaison Committee on Resuscitation completes a literature review based on new science. This update provides the evidence review and treatment recommendation for chest compression–only CPR versus CPR using chest compressions with rescue breaths for children <18 years of age. Four large database studies were available for review, including 2 published after the "2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care." Two demonstrated worse 30-day outcomes with chest compression–only CPR for children 1 through 18 years of age, whereas 2 studies documented no difference between chest compression–only CPR and CPR using chest compressions with rescue breaths. When the results were analyzed for infants <1 year of age, CPR using chest compressions with rescue breaths was better than no CPR but was no different from chest compression–only CPR in 1 study, whereas another study observed no differences among chest compression–only CPR, CPR using chest compressions with rescue breaths, and no CPR. CPR using chest compressions with rescue breaths should be provided for infants and children in cardiac arrest. If bystanders are unwilling or unable to deliver rescue breaths, we recommend that rescuers provide chest compressions for infants and children.

Dianne L. Atkins, MD, FAHA, Chair
Allan R. de Caen, MD
Stuart Berger, MD, FAHA
Ricardo A. Samson, MD
Stephen M. Schexnayder, MD
Benny L. Joyner, Jr, MD, MPH
Blair L. Bigham, MD, MSc
Dana E. Niles, MS
Jonathan P. Duff, MD, MEd
Elizabeth A. Hunt, MD, MPH, PhD
Peter A. Meaney, MD, MPH

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This focused update to the American Heart Association guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiovascular care follows the Pediatric Task Force of the International Liaison Committee on Resuscitation's evidence review published simultaneously with this update.[1] It aligns with the International Liaison Committee on Resuscitation's continuous evidence review process, and updates are published when the International Liaison Committee on Resuscitation completes a literature review based on new science. A description of the evidence review process is available in the "2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary,"[1] and a glossary of terms is available in that document. The International Liaison Committee on Resuscitation's Grading of Recommendations Assessment, Development, and Evaluation assessments were converted to the American College of Cardiology/American Heart Association Classes of Recommendations and Levels of Evidence (Table).[2]

This update provides the summary of evidence and treatment recommendation for chest compression–only CPR versus CPR using chest compressions with rescue breaths for children <18 years of age. For the purposes of these guidelines, the following holds:

- Infant basic life support guidelines apply to infants younger than ≈1 year of age.
- Child basic life support guidelines apply to children ≈1 year of age until puberty. For teaching purposes, puberty is defined as breast development in girls and the presence of axillary hair in boys.
- Adult basic life support guidelines apply at and beyond puberty.[3]

All other recommendations and algorithms published in the "2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" and the "2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care"[4] remain the official recommendations of the American Heart Association.

COMPONENTS OF HIGH-QUALITY CPR: CHEST COMPRESSION–ONLY CPR

The "2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary"[1] addresses the comparison of chest compression–only CPR and CPR using chest compressions with rescue breaths for cardiac arrest in infants and children. It includes 2 additional out-of-hospital cardiac arrest studies published after 2015 that further expand the evidence base used to develop the 2015 guidelines update. A brief summary of each study included in the review is provided below.

2017 Summary of Evidence

A large observational study from the All-Japan Utstein Registry[5] compared bystander-administered chest compression–only CPR and CPR using chest compressions with rescue breaths from 2005 through 2007, a period when guidelines transitioned from a compression-to-ventilation ratio of 15:2 to 30:2 for postpubertal children and adults. Favorable neurological outcome and survival at 1 month were observed less frequently with chest compression–only CPR. When the results were stratified by age, children 1 through 17 years of age had worse outcomes with chest compression–only CPR, whereas no statistical difference between chest compression–only CPR and CPR using chest compressions with rescue breaths was observed in infants <1 year of age. When further stratified by arrest cause, there was no difference between chest compression–only CPR and CPR using chest compressions with rescue breaths in patients with a presumed cardiac cause.

A subsequent study examined dispatch-assisted CPR in children using the same national Japanese database but with a later time interval, 2008 through 2010.[6] CPR using chest compressions with rescue breaths was generally offered by dispatchers, but chest compression–only CPR could be offered depending on the skill and knowledge of the rescuer.

Chest compression–only CPR resulted in worse 1-month survival and worse 1-month survival with favorable neurological outcome compared with CPR using chest compressions with rescue breaths. Chest compression–only CPR was no different from no CPR.

A large observational study from the US-based CARES registry (Cardiac Arrest Registry to Enhance Survival) evaluated the association of bystander CPR with overall and favorable neurological survival. The CARES registry is an emergency medical services–based, voluntary data set that includes a catchment area of 90 million people from 37 states within the United States. The authors compared bystander-administered chest compression–only CPR and CPR using chest compressions with rescue breaths.[7] The cohort was analyzed on the basis of age: <1 or 1 to 18 years. For infants, CPR using chest compressions with rescue breaths was better than no CPR but was no different from chest compression–only CPR for favorable neurological outcome. CPR using chest compressions with rescue breaths had higher survival to discharge than either no CPR or chest compression–only CPR. For children 1 to 18 years of age, CPR using chest compressions with rescue breaths was better than no CPR but was no different from chest compression–only CPR for both survival to hospital discharge and favorable neurological status. Of note, out-

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Table. ACC/AHA Recommendation System: Applying Class of Recommendation and Level of Evidence to Clinical Strategies, Interventions, Treatments, or Diagnostic Testing in Patient Care* (Updated August 2015)

CLASS (STRENGTH) OF RECOMMENDATION

CLASS I (STRONG) — **Benefit >>> Risk**

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

CLASS IIa (MODERATE) — **Benefit >> Risk**

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

CLASS IIb (WEAK) — **Benefit ≥ Risk**

Suggested phrases for writing recommendations:
- May/might be reasonable
- May/might be considered
- Usefulness/effectiveness is unknown/unclear/uncertain or not well established

CLASS III: No Benefit (MODERATE) — **Benefit = Risk**
(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

CLASS III: Harm (STRONG) — **Risk > Benefit**

Suggested phrases for writing recommendations:
- Potentially harmful
- Causes harm
- Associated with excess morbidity/mortality
- Should not be performed/administered/other

LEVEL (QUALITY) OF EVIDENCE‡

LEVEL A
- High-quality evidence‡ from more than 1 RCT
- Meta-analyses of high-quality RCTs
- 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 I and IIa; 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.

comes were statistically better in both bystander CPR strategies compared with no bystander CPR, as opposed to the Kitamura et al[5] and Goto et al[6] reports.

The most recent study originated from Japan with the use of the All-Japan Utstein Registry. The authors directly compared bystander chest compression–only CPR and CPR using chest compressions with rescue breaths in children >1 year of age who had cardiac arrest, including traumatic arrest, during 2011 and 2012.[8] A national dispatch-assisted instruction protocol was in use, and CPR guidelines recommended a compression-to-ventilation ratio of 30:2. Chest compression–only CPR and CPR using chest compressions with rescue breaths were associated with improved survival at 1 month and favorable neurological survival at 1 month compared with no bystander CPR. There was no dif-

ference between chest compression–only CPR and CPR using chest compressions with rescue breaths.

2017 Recommendations—Updated

1. **CPR using chest compressions with rescue breaths should be provided for infants and children in cardiac arrest (*Class I; Level of Evidence B-NR*). Based on a growing evidence base since the 2015 guidelines update publication, this recommendation reinforces the 2015 guideline.**
2. **If bystanders are unwilling or unable to deliver rescue breaths, we recommend that rescuers provide chest compressions for infants and children (*Class I; Level of Evidence B-NR*).**

We weighed the survival benefits of CPR using chest compressions with rescue breaths against the convenience of aligning with the adult recommendation for chest compression–only CPR and concluded that the incremental benefit of rescue breaths justified a different recommendation.

2017 Focused Update: Pediatric BLS Recommendations

Year Last Reviewed	Topic	Recommendation	Comments
2017	Components of high-quality CPR: chest compression–only CPR	Chest compressions with rescue breaths should be provided for infants and children in cardiac arrest (*Class I; Level of Evidence B-NR*).	Updated for 2017
2017	Components of high-quality CPR: chest compression–only CPR	If bystanders are unwilling or unable to deliver rescue breaths, we recommend that rescuers provide chest compressions for infants and children (*Class I; Level of Evidence B-NR*).	Updated for 2017

BLS indicates basic life support; and CPR, cardiopulmonary resuscitation.

FOOTNOTES

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

This focused update was approved by the American Heart Association Science Advisory and Coordinating Committee on September 15, 2017, and the American Heart Association Executive Committee on October 9, 2017. A copy of the document is available at http://professional.heart.org/statements by using either "Search for Guidelines & Statements" or the "Browse by Topic" area. To purchase additional reprints, call 843-216-2533 or e-mail kelle.ramsay@wolterskluwer.com.

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DISCLOSURES

Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Dianne L. Atkins	University of Iowa	None	None	None	None	None	None	None
Stuart Berger	Medical College of Wisconsin	None	None	None	None	None	None	None
Blair L. Bigham	St. Michael's Hospital, University of Toronto	None	None	None	None	None	None	None
Allan R. de Caen	University of Alberta, Stollery Children's Hospital Pediatrics	None	None	None	None	None	None	None
Jonathan P. Duff	University of Alberta, Stollery Children's Hospital	None	None	None	None	None	None	None

(*Continued*)

Writing Group Disclosures Continued

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Elizabeth A. Hunt	Johns Hopkins University	NIH (coinvestigator on NIH grant)*	None	None	None	None	Zoll Medical Corp*	None
Benny L. Joyner, Jr	University of North Carolina	None	None	None	None	None	None	None
Peter A. Meaney	Children's Hospital of Philadelphia	None	None	None	2017, Defense, ICU care for diagnosis and management of graft vs host disease*	None	None	None
Dana E. Niles	Children's Hospital of Philadelphia	None	None	None	None	None	None	None
Ricardo A. Samson	Children's Heart Center–Nevada	None	None	None	None	None	None	None
Stephen M. Schexnayder	University of Arkansas/ Arkansas Children's Hospital	None	None	None	Defense expert*	None	Course development and scientific editing consultant†	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 $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

Reviewer Disclosures

Reviewer	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Marc Auerbach	Yale University	None	None	None	None	None	None	None
Aarti Bavare	Baylor College of Medicine	None	None	None	None	None	None	None
Silvia M. Hartmann	Seattle Children's Hospital	pediRES-Q Collaborative (received research funding by enrolling patients after a cardiac arrest that can be used to fund other research projects)*	None	None	None	None	None	None
Georg Schmölzer	Royal Alexandra Hospital (Canada)	None	None	None	None	None	None	None

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*Modest.

REFERENCES

1. Olasveengen TM, de Caen AR, Mancini ME, Maconochie IK, Aickin R, Atkins DL, Berg RA, Bingham R, Brooks SC, Castrén M, Chung SP, Considine J, Couto TB, Escalante R, Gazmuri RJ, Guerguerian AM, Hatanaka T, Koster RW, Kudenchuk PJ, Lang E, Lim SH, Løfgren B, Meaney PA, Montgomery WH, Morley PT, Morrison LJ, Nation KJ, Ng KC, Nadkarni VM, Nishiyama C, Nuthall G, Ong YKG, Perkins GD, Reis AG, Ristagno G, Sakamoto T, Sayre MR, Schexnayder SM, Sierra A, Singletary EM, Shimizu N, Smyth MA, Stanton D, Tijssen JA, Travers AH, Vaillancourt C, Van de Voorde P, Hazinski MF, Nolan JP; on behalf of the ILCOR Collaborators. 2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations summary. *Circulation*. 2017;136:XXX–XXX. doi: 10.1161/CIR.0000000000000541.

2. Halperin JL, Levine GN, Al-Khatib SM, Birtcher KK, Bozkurt B, Brindis RG, Cigarroa JE, Curtis LH, Fleisher LA, Gentile F, Gidding S, Hlatky MA, Ikonomidis J, Joglar J, Pressler SJ, Wijeysundera DN. Further evolution of the ACC/AHA clinical practice guideline recommendation classification system: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation*. 2016;133:1426–1428. doi: 10.1161/CIR.0000000000000312.
3. Kleinman ME, Goldberger ZD, Rea T, Swor RA, Bobrow BJ, Brennan EE, Terry M, Hemphill R, Gazmuri RJ, Hazinski MF, Travers AH. 2017 American Heart Association focused update on adult basic life support and cardiopulmonary resuscitation quality: an update to the American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2017;136:XXX–XXX. doi: 10.1161/CIR.0000000000000539.
4. Atkins DL, Berger S, Duff JP, Gonzales JC, Hunt EA, Joyner BL, Meaney PA, Niles DE, Samson RA, Schexnayder SM. Part 11: pediatric basic life support and cardiopulmonary resuscitation quality: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2015;132(suppl 2):S519–S525. doi: 10.1161/CIR.0000000000000265.
5. Kitamura T, Iwami T, Kawamura T, Nagao K, Tanaka H, Nadkarni VM, Berg RA, Hiraide A; on behalf of the Implementation Working Group for All-Japan Utstein Registry of the Fire and Disaster Management Agency. Conventional and chest-compression-only cardiopulmonary resuscitation by bystanders for children who have out-of-hospital cardiac arrests: a prospective, nationwide, population-based cohort study. *Lancet*. 2010;375:1347–1354. doi: 10.1016/S0140-6736(10)60064-5.
6. Goto Y, Maeda T, Goto Y. Impact of dispatcher-assisted bystander cardiopulmonary resuscitation on neurological outcomes in children with out-of-hospital cardiac arrests: a prospective, nationwide, population-based cohort study. *J Am Heart Assoc*. 2014;3:e000499. doi: 10.1161/JAHA.113.000499.
7. Naim MY, Burke RV, McNally BF, Song L, Griffis HM, Berg RA, Vellano K, Markenson D, Bradley RN, Rossano JW. Association of bystander cardiopulmonary resuscitation with overall and neurologically favorable survival after pediatric out-of-hospital cardiac arrest in the United States: a report from the Cardiac Arrest Registry to Enhance Survival Surveillance Registry. *JAMA Pediatr*. 2017;171:133–141. doi: 10.1001/jamapediatrics.2016.3643.
8. Fukuda T, Ohashi-Fukuda N, Kobayashi H, Gunshin M, Sera T, Kondo Y, Yahagi N. Conventional versus compression-only versus no-bystander cardiopulmonary resuscitation for pediatric out-of-hospital cardiac arrest. *Circulation*. 2016;134:2060–2070. doi: 10.1161/CIRCULATIONAHA.116.023831.