Part 11: Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality

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

Dianne L. Atkins, Chair; Stuart Berger; Jonathan P. Duff; John C. Gonzales; Elizabeth A. Hunt; Benny L. Joyner; Peter A. Meaney; Dana E. Niles; Ricardo A. Samson; Stephen M. Schexnayder

Introduction

This 2015 American Heart Association (AHA) Guidelines Update for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC) section on pediatric basic life support (BLS) differs substantially from previous versions of the AHA Guidelines.1 This publication updates the 2010 AHA Guidelines on pediatric BLS for several key questions related to pediatric CPR. The Pediatric ILCOR Task Force reviewed the topics covered in the 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations and the 2010 council-specific guidelines for CPR and ECC (including those published by the AHA) and formulated 3 priority questions to address for the 2015 systematic reviews. In the online version of this document, live links are provided so the reader can connect directly to those systematic reviews on the International Liaison Committee on Resuscitation (ILCOR) Scientific Evidence Evaluation and Review System (SEERS) website. These links are indicated by a superscript combination of letters and numbers (eg, Peds 709). We encourage readers to use the links and review the evidence and appendices.

A rigorous systematic review process was undertaken to review the relevant literature to answer those questions, resulting in the 2015 International Consensus on CPR and ECC Science With Treatment Recommendations, “Part 6: Pediatric Basic Life Support and Pediatric Advanced Life Support.”2,3 This 2015 Guidelines Update covers only those topics reviewed as part of the 2015 systematic review process. Other recommendations published in the 2010 AHA Guidelines remain the official recommendations of the AHA ECC scientists (see Appendix). When making AHA treatment recommendations, we used the AHA Class of Recommendation and Level of Evidence (LOE) systems. This update uses the newest AHA Class of Recommendation and LOE classification system, which contains modifications of the Class III recommendation and introduces LOE B-R (randomized studies) and B-NR (nonrandomized studies) as well as LOE C-LD (limited data) and LOE C-EO (consensus of expert opinion).

Outcomes from pediatric in-hospital cardiac arrest (IHCA) have markedly improved over the past decade. From 2001 to 2009, rates of pediatric IHCA survival to hospital discharge improved from 24% to 39%.4 Recent unpublished 2013 data from the AHA’s Get With The Guidelines®-Resuscitation program observed 36% survival to hospital discharge for pediatric IHCA (Paul S. Chan, MD, personal communication, April 10, 2015). Prolonged CPR is not always futile, with 12% of patients who receive CPR for more than 35 minutes surviving to discharge and 60% of those survivors having a favorable neurologic outcome.5

Unlike IHCA, survival from out-of-hospital cardiac arrest (OHCA) remains poor. Data from 2005 to 2007 from the Resuscitation Outcomes Consortium, a registry of 11 US and Canadian emergency medical systems, showed age-dependent discharge survival rates of 3.3% for infants (younger than 1 year), 9.1% for children (1 to 11 years), and 8.9% for adolescents (12 to 19 years).6 More recently published data from this network demonstrate 8.3% survival to hospital discharge across all age groups.7

For the purposes of these guidelines:

- Infant BLS guidelines apply to infants younger than approximately 1 year of age.
- Child BLS guidelines apply to children approximately 1 year of age until puberty. For teaching purposes, puberty is defined as breast development in females and the presence of axillary hair in males.
- Adult BLS guidelines apply at and beyond puberty (see “Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality” in this supplement regarding the use of the automated external defibrillator (AED) and methods to achieve high-quality CPR).

The following subjects are addressed in this 2015 pediatric BLS guidelines update:

• Pediatric BLS Healthcare Provider Pediatric Cardiac
  Arrest Algorithms for a single rescuer and for 2 or more
  rescuers
• The sequence of compressions, airway, breathing
  (C-A-B) versus airway, breathing, compressions (A-B-C)
• Chest compression rate and depth
• Compression-only (Hands-Only) CPR

Pediatric Advanced Life Support topics reviewed by the
ILCOR Pediatric Task Force are covered in “Part 12: Pediatric
Advanced Life Support.”

Algorithms
Algorithms for 1- and 2-person healthcare provider CPR have
been separated to better guide rescuers through the initial
stages of resuscitation (Figures 1 and 2). In an era where cel-
lar telephones with speakers are common, this technology
can allow a single rescuer to activate the emergency response
system while beginning CPR. These algorithms continue to
emphasize the high priority for obtaining an AED quickly in a
sudden, witnessed collapse, because such an event is likely to
have a cardiac etiology.

Sequence of CPR
C-A-B Versus A-B-C
Historically, the preferred sequence of CPR was A-B-C
(Airway-Breathing-Compressions). The 2010 AHA
Guidelines recommended a change to the C-A-B sequence
(Compressions-Airway-Breathing) to decrease the time to
initiation of chest compressions and reduce “no blood flow”
time. The 2015 ILCOR systematic review addressed evidence
to support this change.2,3

Pediatric cardiac arrest has inherent differences when
compared with adult cardiac arrest. In infants and chil-
dren, asphyxial cardiac arrest is more common than cardiac
arrest from a primary cardiac event; therefore, ventilation
may have greater importance during resuscitation of
children. Data from animal studies8,9 and 2 pediatric stud-
ies10,11 suggest that resuscitation outcomes for asphyxial
arrest are better with a combination of ventilation and chest
compressions.

Manikin studies demonstrated that starting CPR with 30
chest compressions followed by 2 breaths delays the first ven-
tilation by 18 seconds for a single rescuer and less (by about
9 seconds or less) for 2 rescuers. A universal CPR algorithm
for victims of all ages minimizes the complexity of CPR and
offers consistency in teaching CPR to rescuers who treat
infants, children, or adults. Whether resuscitation beginning
with ventilations (A-B-C) or with chest compressions (C-A-
B) impacts survival is unknown. To increase bystander CPR
rates as well as knowledge and skill retention, the use of
the same sequence for infants and children as for adults has poten-
tial benefit.

2015 Evidence Summary
No human studies with clinical outcomes were identified
that compared C-A-B and A-B-C approaches for initial man-
agement of cardiac arrest. The impact of time to first chest
compression for C-A-B versus A-B-C sequence has been
evaluated. Adult12,13 and pediatric14 manikin studies showed a
significantly reduced time to first chest compression with the
use of a C-A-B approach compared with an A-B-C approach.
Data from 2 of these 3 studies demonstrated that time to
first ventilation is delayed by only approximately 6 seconds
when using a C-A-B sequence compared with an A-B-C sequence.12,14

2015 Recommendation—New
Because of the limited amount and quality of the data, it may be
reasonable to maintain the sequence from the 2010 Guidelines
by initiating CPR with C-A-B over A-B-C sequence (Class
IIb, LOE C-EO). Knowledge gaps exist, and specific research
is required to examine the best approach to initiating CPR in
children.

Components of High-Quality CPR
The 5 components of high-quality CPR are
• Ensuring chest compressions of adequate rate
• Ensuring chest compressions of adequate depth
• Allowing full chest recoil between compressions
• Minimizing interruptions in chest compressions
• Avoiding excessive ventilation

The ILCOR Pediatric Task Force systematic review
addressed the optimal depth of chest compressions in infants
and children. Because there was insufficient evidence for a
systemic review of chest compression rate in children, the
ILCOR Pediatric Task Force and this writing group reviewed
and accepted the recommendations of the ILCOR BLS Task
Force regarding chest compression rate so that the recom-
manded compression rate would be consistent for victims of
all age groups.

Chest Compression Rate and Depth

2015 Evidence Summary
Insufficient data were available for a systematic review of
chest compression rate in children. As noted above, the
writing group reviewed the evidence and recommenda-
tions made for adult BLS and agreed to recommend the
same compression rate during resuscitation of children.
For the review of chest compression rate in adults, see
“Part 5: Adult Basic Life Support and Cardiopulmonary
Resuscitation Quality.”

Limited pediatric evidence suggests that chest compres-
sion depth is a target for improving resuscitation. One obser-
vational study demonstrated that chest compression depth is
often inadequate during pediatric cardiac arrest.15 Adult data
have demonstrated the importance of adequate chest compres-
sion depth to the outcome of resuscitation,16 but such data in
children are very limited. A case series of 6 infants with heart
disease examined blood pressure during CPR in relation to
chest compression depth and observed a higher systolic blood
pressure during CPR in association with efforts to increase
chest compression depth.17 Another report of 87 pediatric
resuscitation events, most involving children older than 8
years, found that compression depth greater than 51 mm for
more than 60% of the compressions during 30-second epochs.
within the first 5 minutes was associated with improved 24-hour survival.\textsuperscript{18}

\textbf{2015 Recommendations—New}

For simplicity in CPR training, in the absence of sufficient pediatric evidence, it is reasonable to use the adult BLS-recommended chest compression rate of 100/min to 120/min for infants and children (Class IIa, LOE C-END). Although the effectiveness of CPR feedback devices was not reviewed by this writing group, the consensus of the group is that the use of feedback devices likely helps the rescuer optimize adequate chest compression rate and depth, and we suggest their use when available (Class IIb, LOE C-END; see also “Part 14: Education”).

It is reasonable that for pediatric patients (birth to the onset of puberty) rescuers provide chest compressions that depress the chest at least one third the anterior-posterior diameter of the chest. This equates to approximately 1.5 inches (4 cm) in infants to 2 inches (5 cm) in children (Class IIa, LOE C-END). Once children have reached puberty, the recommended adult compression depth of at least 5 cm, but no more than 6 cm, is used for the adolescent of average adult size (Class I, LOE C-END).\textsuperscript{16}

\textbf{Compression-Only CPR 414}

The 2015 ILCOR pediatric systematic review addressed the use of compression-only CPR for cardiac arrest in infants and children. Compression-only CPR is an alternative for lay rescuer CPR in adults.

\textbf{2015 Evidence Summary}

In a large observational study examining data from a Japanese national registry of pediatric OHCA, the use of compression-only CPR, when compared with conventional CPR, was
associated with worse 30-day intact neurologic survival.\textsuperscript{10} When analyzed by arrest etiology, although the numbers are small, in patients with presumed nonasphyxial arrest (ie, a presumed arrest of cardiac etiology), compression-only CPR was as effective as conventional CPR. However, in patients with presumed asphyxial cardiac arrest, outcomes after compression-only CPR were no better than for patients receiving no bystander CPR.

A second large observational study using a more recent data set from the same Japanese registry examined the effect of dispatcher-assisted CPR in pediatric OHCA. In this study, the use of compression-only CPR was associated with worse 30-day intact neurologic survival compared with patients who received conventional CPR.\textsuperscript{11} Although not stratified for etiology of arrest, outcomes after compression-only CPR were no better than for patients who received no bystander CPR.

**2015 Recommendations—New**

Conventional CPR (chest compressions and rescue breaths) should be provided for pediatric cardiac arrests (Class I, LOE B-NR). The asphyxial nature of the majority of pediatric cardiac arrests necessitates ventilation as part of effective CPR. However, because compression-only CPR is effective in patients with a primary cardiac event, if rescuers are unwilling or unable to deliver breaths, we recommend rescuers perform compression-only CPR for infants and children in cardiac arrest (Class I, LOE B-NR).
## Disclosures

**Part 11: Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality: 2015 Guidelines Update Writing Group Disclosures**

<table>
<thead>
<tr>
<th>Writing Group Member</th>
<th>Employment</th>
<th>Research Grant</th>
<th>Other Research Support</th>
<th>Speakers' Bureau/ Honoraria</th>
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**Consultants**

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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be “significant” if (a) the person receives $10,000 or more during any 12-month period, or 5% or more of the person’s gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10,000 or more of the fair market value of the entity. A relationship is considered to be “modest” if it is less than “significant” under the preceding definition.

*Modest.
†Significant.
## 2015 Guidelines Update: Part 11 Recommendations

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<th>Year Last Reviewed</th>
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<th>Recommendation</th>
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<td>2015</td>
<td>Components of High-Quality CPR: Chest Compression Rate and Depth</td>
<td>To maximize simplicity in CPR training, in the absence of sufficient pediatric evidence, it is reasonable to use the adult chest compression rate of 100/min to 120/min for infants and children (Class IIa, LOE C-E0).</td>
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<td>2015</td>
<td>Components of High-Quality CPR: Compression-Only CPR</td>
<td>Conventional CPR (rescue breathing and chest compressions) should be provided for pediatric cardiac arrests (Class I, LOE B-NR).</td>
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<td>updated for 2015</td>
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The following recommendations were not reviewed in 2015. For more information, see the 2010 AHA Guidelines for CPR and ECC, “Part 13: Pediatric Basic Life Support.”

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<tr>
<td>2010</td>
<td>Check for Breathing</td>
<td>Formal training as well as “just in time” training, such as that provided by an emergency response system dispatcher, should emphasize how to recognize the difference between gasping and normal breathing; rescuers should be instructed to provide CPR even when the unresponsive victim has occasional gasps (Class IIa, LOE C.</td>
<td>not reviewed in 2015</td>
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<tr>
<td>2010</td>
<td>Start Chest Compressions</td>
<td>For an infant, lone rescuers (whether lay rescuers or healthcare providers) should compress the sternum with 2 fingers placed just below the intermammary line (Class IIb, LOE C).</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>Start Chest Compressions</td>
<td>There are no data to determine if the 1- or 2-hand method produces better compressions and better outcome (Class IIb, LOE C). Because children and rescuers come in all sizes, rescuers may use either 1 or 2 hands to compress the child’s chest.</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>Start Chest Compressions</td>
<td>After each compression, allow the chest to recoil completely (Class IIb, LOE B-LD) because complete chest reexpansion improves the flow of blood returning to the heart and thereby blood flow to the body during CPR.</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>Open the Airway and Give Ventilations</td>
<td>Open the airway using a head tilt–chin lift maneuver for both injured and uninjured victims (Class I, LOE B).</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>Open the Airway and Give Ventilations</td>
<td>In an infant, if you have difficulty making an effective seal over the mouth and nose, try either mouth-to-mouth or mouth-to-nose ventilation (Class IIb, LOE C).</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>Open the Airway and Give Ventilations</td>
<td>In either case make sure the chest rises when you give a breath. If you are the only rescuer, provide 2 effective ventilations using as short a pause in chest compressions as possible after each set of 30 compressions (Class IIIa, LOE C).</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>BLS Sequence for Healthcare Providers and Others Trained in 2-Rescuer CPR</td>
<td>It is reasonable for healthcare providers to tailor the sequence of rescue actions to the most likely cause of arrest. For example, if the arrest is witnessed and sudden (eg, sudden collapse in an adolescent or a child identified at high risk for arrhythmia or during an athletic event), the healthcare provider may assume that the victim has suffered a sudden VF–cardiac arrest and as soon as the rescuer verifies that the child is unresponsive and not breathing (or only gasping) the rescuer should immediately phone the emergency response system, get the AED and then begin CPR and use the AED (Class IIIa LOE C).</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>Pulse Check</td>
<td>If, within 10 seconds, you don’t feel a pulse or are not sure if you feel a pulse, begin chest compressions (Class IIa, LOE C).</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>Inadequate Breathing With Pulse</td>
<td>Reassess the pulse about every 2 minutes (Class IIa, LOE B) but spend no more than 10 seconds doing so.</td>
<td>not reviewed in 2015</td>
</tr>
<tr>
<td>2010</td>
<td>Ventilations</td>
<td>For healthcare providers and others trained in 2-person CPR, if there is evidence of trauma that suggests spinal injury, use a jaw thrust without head tilt to open the airway (Class IIb LOE C).</td>
<td>not reviewed in 2015</td>
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References


KEY WORDS: automated external defibrillator ■ cardiopulmonary resuscitation ■ pediatrics


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