Recent Updates and A Look to the Near Future

Guidelines for CPR and Emergency Cardiovascular Care

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**PRESENTER DISCLOSURE INFORMATION**

**FINANCIAL**

Current Research Support:
- NIH NHLBI (PI R01 – clinical)
- NIH NICHD (Co-I R21 – large animal)
- Mallinckrodt Pharma (Co-I – large animal)

Past Research Support:
- NIH NICHD (PI K23)
- Laerdal Foundation / Laerdal Corporation
- Zoll medical

**OTHER**

Intellectual Conflicts:
Invited scientific expert for the American Heart Association (GWTG-R Peds Research Task Force) and the International Liaison Committee on Resuscitation
2015 and 2018 PALS writing group member
2018 AHA and ECC Systems of Care Committee

Speaking Honoraria:
Zoll Medical for Pediatric CPR Quality Talk
IF YOU WANT TO READ ON YOUR OWN...

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

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. 2018;137:e7–e13.

OBJECTIVES

• At the conclusion of this presentation, participants will be able to:
  o Understand recent updates as published in the 2017 AHA Focused Update on Adult and Pediatric Basic Life Support and CPR Quality
  o Recall some important changes in the 2015 Guidelines
  o Understand the concept, the targets, and the practical application of physiologic-directed CPR
UPDATED RECOMMENDATIONS: PEDIATRIC BLS AND CPR QUALITY

2015 REEMPHASIS OF HIGH QUALITY CPR

• Push hard (more to follow)
• Push fast (more to follow)
• Minimize interruptions
• Avoid excessive ventilation
  • Slight modification of advanced airway ventilation rate
• Allow full chest recoil
**PEDIATRIC BLS: CHEST COMPRESSION RATE AND DEPTH**

**Recommendation**
- Compression rate 100-120 per minute
- Depth: At least 1/3 the AP diameter of the chest
  - Infants: approximately 1.5” (4cm)
  - Children: approximately 2” (5 cm)
- Adolescents (beyond puberty): at least 2” (5 cm), but no greater than 2.4” (6 cm)

**Why?**
- Consistency when possible with adult recommendations

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**2015: VENTILATION DURING CPR WITH AN ADVANCED AIRWAY: UPDATED**

**Recommendation:**
- May be reasonable to deliver 1 breath every 6 seconds (10 breaths/min) while continuous chest compressions are being performed (infants, children and adults)

**Why?**
- Simplified from range of 1 breath every 6-8 seconds (8-10 breaths/min)
- Should be easier to learn, remember, and perform
Recommendation for chest compression-only CPR vs. CPR with chest compressions with rescue breaths for children < 18 years

- 4 large database studies (2 after 2015 release)
- Reaffirmed that compressions + ventilation should be provided for infants and children
- Bystanders who are unwilling or unable to deliver breaths should perform compressions

ALL-JAPAN UTSTEIN REGISTRY – BYSTANDER CPR

<table>
<thead>
<tr>
<th></th>
<th>2005-2007</th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>NO</td>
<td>YES</td>
<td>Vs.</td>
<td>CC</td>
<td>CC+RB</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>1654</td>
<td>599</td>
<td>1055</td>
<td>1293</td>
</tr>
<tr>
<td>Age 1-12yrs</td>
<td>1293</td>
<td>1004</td>
<td>380</td>
<td>624</td>
<td>60.4%</td>
</tr>
<tr>
<td>ROSC before hospital arrival</td>
<td>60.4%</td>
<td>82.8%</td>
<td>1.97 (1.35-2.87)</td>
<td>20.5%</td>
<td>62.9%</td>
</tr>
<tr>
<td>1-month survival</td>
<td>81.6%</td>
<td>133.1%</td>
<td>131.2%</td>
<td>2.69 (1.55-2.08)</td>
<td>34.8%</td>
</tr>
<tr>
<td>Neurologically favorable 1-month</td>
<td>20 (1.5%)</td>
<td>31 (5.1%)</td>
<td>4.32 (3.27-7.32)</td>
<td>6 (1.6%)</td>
<td>45 (7.2%)</td>
</tr>
<tr>
<td></td>
<td>799</td>
<td>785</td>
<td>289</td>
<td>496</td>
<td>339</td>
</tr>
<tr>
<td>Age 1-12yrs</td>
<td>339</td>
<td>440</td>
<td>158</td>
<td>282</td>
<td>24.7%</td>
</tr>
<tr>
<td>ROSC before hospital arrival</td>
<td>24 (7.1%)</td>
<td>52 (11.8%)</td>
<td>1.49 (0.84-2.64)</td>
<td>18 (11.4%)</td>
<td>34 (12.1%)</td>
</tr>
<tr>
<td>1-month survival</td>
<td>36 (10.4%)</td>
<td>71 (15.1%)</td>
<td>2.41 (1.86-2.30)</td>
<td>26 (15.1%)</td>
<td>45 (16.0%)</td>
</tr>
<tr>
<td>Neurologically favorable 1-month</td>
<td>14 (4.1%)</td>
<td>47 (9.5%)</td>
<td>2.21 (1.08-4.54)</td>
<td>14 (8.8%)</td>
<td>28 (9.9%)</td>
</tr>
</tbody>
</table>

Data are number of patients (%), unless otherwise indicated. Data for type of CPR by bystander not available for 12 (2.1%) children. CPR=cardiopulmonary resuscitation. ROSC=return of spontaneous circulation. NA=not analysed. *Adjusted odds ratio (95% CI).

Table 4: Age-stratified outcomes after paediatric out-of-hospital cardiac arrests of non-cardiac and cardiac origin by type of bystander CPR

Kitamura, Lancet 2010
N=3900, 1411 with BCPR type

### Summary – Reinforces the 2015 Recommendation

#### 2017 Focused Update: Pediatric BLS Recommendations

<table>
<thead>
<tr>
<th>Year Last Reviewed</th>
<th>Topic</th>
<th>Recommendation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>Components of high-quality CPR; chest compression–only CPR</td>
<td>Chest compressions with rescue breaths should be provided for infants and children in cardiac arrest (Class I, Level of Evidence B-NR).</td>
<td>Updated for 2017</td>
</tr>
<tr>
<td>2017</td>
<td>Components of high-quality CPR; chest compression–only CPR</td>
<td>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).</td>
<td>Updated for 2017</td>
</tr>
</tbody>
</table>

BLS indicates basic life support; and CPR, cardiopulmonary resuscitation.
UPDATED RECOMMENDATIONS: ADULT BLS AND CPR QUALITY

Recommendation:
• Compress at least 2 inches (5cm) for average adult
• Avoid excessive compression depth
  – greater than 2.4 inches [6cm]
  – 2010 recommendation was at least 2 inches

Why?
• In one study of 170 patients injuries occurred more often with depths greater than 2.4 inches (6cm). (Hellevuo, Resuscitation, 2013)
DEPTH:  WHY THE UPPER LIMIT?

Depth Categories
< 50mm 50-60mm >60mm
injured 29% 33% 63%

Hellevuo, Resuscitation 2013

PUSH HARD

2017 ADULT UPDATE

• Recommendations for:
  • Dispatcher assisted CPR
  • Bystander CPR
  • Continuous vs. interrupted chest compressions by EMS providers
  • CPR with an advanced airway
  • Chest compression-only (hands-only) CPR vs. CPR with chest compressions and ventilations for both OHCA and IHCA
DISPATCHER ASSISTED CPR

No new studies reviewed for this topic

Updated 2017 recommendation:

• We recommend that when dispatchers’ instructions are needed, dispatchers should provide chest compression only CPR instruction to callers for adults with suspected OCHA

Bystander CPR

Updated 2017 recommendation:

• For adults in OHCA, untrained lay rescuers should provide chest compression-only CPR with or without dispatcher instructions.

• For trained lay rescuers, we recommend they do what they were trained to do:
  • Compression only = do compressions only
  • CPR with ventilations = do CPR with ventilations
Evaluation of the nationwide impact of CCCPR (n=816385)

Unadjusted analysis of crude data
CCC vs. CC plus ventilations:

- ROSC (OR 0.8, CI95 0.78-0.82)
- 1-mo survival (OR 0.75, CI95 0.73-0.78)
- 1-mo good neuro (OR 0.72, CI95 0.69-0.76)

EMS-DELIVERED CPR

Updated 2017 recommendation:

- Prior to an advanced airway, it is reasonable for EMS providers to:
  - Perform CPR with cycles of 30:2.
  - Perform asynchronous ventilation with CCC at a rate of 10 bpm
- Does not preclude 2015 recommendation that a reasonable alternative for EMS systems that have adopted bundles of care is the initial use of minimally interrupted CC (delayed ventilation) for witnessed shockable OHCA
Resuscitation Outcomes Consortium
Cluster-randomized trial
N= 23,711

Intervention = CCC
Control = Interrupted 30:2

CONTINUOUS VS. INTERRUPTED CC AFTER AN ADVANCED AIRWAY

No new studies were reviewed

Updated 2017 recommendation:

- Whenever an advanced airway is inserted during CPR, it may be reasonable for providers to perform CCC with positive-pressure ventilation delivered without pausing compressions.

- It may be reasonable for the provider to deliver 1 breath every 6 seconds (10 bpm) while continuous chest compressions are being performed.
CHEST COMPRESSION-TO-VENTILATION RATIO

No new studies were reviewed

Updated 2017 recommendation:

• It is reasonable for rescuers trained in CPR using CC and ventilations to provide a CV ratio of 30:2 for adults

SUMMARY – REINFORCES 2015 RECOMMENDATIONS
Physiologic-Directed CPR: The Future of CPR is Now

Who or What Should We Be Monitoring

Rescuer Performance Meeting the metrics?
- Depth
- Rate
- CCF
- Release Velocity

Time to Shift the Focus?

Patient Physiology “Look up”
- CoPP
- DBP
- ETCO₂
- NIRS
Monitor the patient’s response to the resuscitation effort

- Coronary perfusion pressure > 20mmHg
- Diastolic pressure > 25mmHg
- End Tidal Carbon Dioxide > 20mmHg

AHA Consensus Statement

CPR Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital
A Consensus Statement From the American Heart Association
Endorsed by the American College of Emergency Physicians

Meaney Circulation 2013
CoPP Higher in Patients with ROSC

Maximal Coronary Perfusion Pressure

N=100
Pre-hospital and ED arrests
No ROSC CPP < 15mmHg

Probability of Survival

Mean Diastolic Blood Pressure

DBP Higher in Kids Who Survive

164 Children with an ICU arrest (25/30 mmHg)
Survival more than doubled when DBP cutoffs achieved

Optimal DBP: 34 mmHg

Paradis, JAMA 1990
Berg, Circulation 2017
HEMODYNAMIC-DIRECTED CPR (HD-CPR)

Asphyxial Period
- ETT Clamp
- CPR Period
- Both Groups: VF Induced and manual CPR started
  - Standard Care: Depth = 1/3 anterior-posterior chest diameter
  - HD-CPR: Depth titrated to SBP 90/100 mmHg
- Dosing order: Epinephrine → Epinephrine → Vasopressin (0.4U/kg) if CoPP < 20
  - Dosing Interval: 1 min. after Epinephrine; 2 min. after Vasopressin
- Standard Care: Epinephrine (0.02mg/kg)
- First Defibrillation Attempt
- Experiment end if no ROSC
- HD-CPR: First vasopressor given if CoPP < 20 mmHg
  - Dosing Interval: 1 min. after Epinephrine; 2 min. after Vasopressin

CPR (Rate 100 min⁻¹, ventilations 6-10 min⁻¹, 100% FiO₂) and Vasopressors

Fluid Titration of CPR to BP: HD-CPR

CPP low = Drug
CPP OK = No drug
Depth of CC to SBP

HD-CPR = CPPs

Adolescent Asphyxial Model

<table>
<thead>
<tr>
<th>Survival [n (%)]</th>
<th>Depth 51 (n=10)</th>
<th>CPP-20 (n=10)</th>
<th>p</th>
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<tbody>
<tr>
<td>45 Minute ICU Survival</td>
<td>1 (10)</td>
<td>9 (90)</td>
<td>p = 0.001</td>
</tr>
<tr>
<td>24 Hour Survival</td>
<td>0 (0)</td>
<td>8 (80)</td>
<td>p = 0.001</td>
</tr>
<tr>
<td>Good Neurological Outcome</td>
<td>0 (0)</td>
<td>7 (70)</td>
<td>p = 0.003</td>
</tr>
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</table>

Sutton, Resus 2013; Friess, CCM 2013; Sutton, AJRCCM 2014; Naim, CCM 2016; Morgan, AJRCCM 2017; Morgan, Resus 2017
Hemodynamic-Directed Training Tools

Collaboration with Biomedical Engineers

Monitoring and Titrating to a **Clinical** Endpoint makes sense to **Clinical** Care Providers

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95% CI</th>
<th>P</th>
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<tbody>
<tr>
<td>Acquisition</td>
<td>5.2</td>
<td>1.3-21.2</td>
<td>0.02</td>
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<tr>
<td>Posttraining</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retention²</td>
<td>4.4</td>
<td>1.3-14.9</td>
<td>0.018</td>
</tr>
<tr>
<td>12 h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 mo</td>
<td>4.1</td>
<td>1.2-13.9</td>
<td>0.023</td>
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</tbody>
</table>

**ETCO₂ in Adult IHCA / OHCA**

N=34 patents

Average end tidal CO₂

Resuscitated  Nonresuscitated

Sanders, JAMA 1989
End Tidal CO₂ Guided Cardiopulmonary Resuscitation

Feedback optimized

ETCO₂ Guided

Hamrick, JAHA 2014; PCCM 2017

End Tidal CO₂ Guided CPR: Neonatal Asphyxial Arrest

Hamrick, JAHA 2014; PCCM 2017
Cerebral Oximetry During Cardiac Arrest: A Multicenter Study of Neurologic Outcomes and Survival*

5 sites (US and UK)
N=183

No ROSC  CPC 3-5  CPC 1-2

Percent Time rSO₂ > 50% During CPR

Disclaimer

The interpretation of the literature / opinions rendered by me do not necessarily reflect the official policy or position of the American Heart Association, its volunteers, the city of Pittsburgh or Philadelphia, or anyone else for that matter.
G2025: IHCA

**First 2 Minutes**
- “Standard” ACLS
  - High Quality CPR
  - Shock if VF
  - Epi at 1 min
- Draw ABG (q6 min)
- Apply NIRs
- PEA -> early echo

**Assess hemodynamic goals**
- CVP < 10
  - 1. Add ITD
  - 2. Rapid Infusion NSS bolus
- CVP 10-20
  - No change
- CVP > 20
  - Consider early echocardiogram

**The Next Cycle (2 Minutes)**
- DBP < 30 (25 infants)
  - 1. Epi up to q1min
  - 2. Consider Epi infusion
  - 3. Vasopressin (3rd dose)
- SBP < 100 (60 infants)
  - 1. Increase CC Depth / Rate
  - 2. Consider Epi if not for DBP
  - 3. Enter echocardiogram box

**The “Next” Cycle**
- pH < 7.2, paCO2 > 70 -> vent rate 50%
- NIRS > 50% and paO2 > 200 -> FIO2 50%

**Assess Ventilation & Oxygenation (if hemo goals met)**

**Take Home Points**
- High Quality CPR still important
- Rescuers should provide the type of CPR they are trained to do
- Pediatric patients still need breaths
  - But providers should just do something
- Physiology coming into play
  - ETCO2 and BP during arrest
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