Pediatric Cardiac Arrest

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FINANCIAL DISCLOSURE:
None

UNLABELED/UNAPPROVED USES DISCLOSURE:
None
Epidemiology of Pediatric Cardiac Arrest

- Relatively uncommon compared with adult cases
- ~16,000 children in the United States experience an OHCA each year
- ~5,800 experience an IHCA each year
  - >10-fold higher rate if cardiovascular disease.
  - Higher rates in CICUs (4% to 6% of admissions) than in PICUs (2% to 4%)
- ~2000 patients younger than 25 years will die from a sudden cardiac event each year in the United States

Immediate cause of arrest

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrhythmia (VF, ventricular tachycardia,</td>
<td>21 (19)</td>
</tr>
<tr>
<td>supraventricular tachycardia)</td>
<td></td>
</tr>
<tr>
<td>Hypotension/hypoperfusion</td>
<td>51 (46)</td>
</tr>
<tr>
<td>Hypoxia/respiratory decompression</td>
<td>62 (54)</td>
</tr>
</tbody>
</table>
Epidemiology of Pediatric Cardiac Arrest

Fig. 1. In-hospital cardiac arrest (IHCA) and mortality rates in children for each cohort from 1997 through 2012.


Paul A. Martinez, Balagangadhar R. Totapalli.
High Quality CPR

1. Chest compression rate
2. Appropriate depth
3. Full recoil of the chest
4. Limited time off the chest
5. Avoid hyperventilation

Abella BS. Circ 2005; 111:428-34
High Quality CPR
1. Chest compression rate
2. Appropriate depth
3. **Full recoil of the chest**
4. Limited time off the chest
5. Avoid hyperventilation

[Image: Almost half of patients had residual pressure in chest after recoil]

(Afterheide T, Resus 2005, 64:353-)

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High Quality CPR
1. Chest compression rate
2. Appropriate depth
3. Full recoil of the chest
4. **Limited time off the chest**
5. Avoid hyperventilation

[Image: Coronary Perfusion pressure (Ao diastolic - RA diastolic)]
Chest compression quality metrics often do not meet 2015 American Heart Association guidelines. Guideline compliance for rate and depth in children less than 18 years is poor, with the greatest difficulty in achieving chest compression depth targets in younger children. (Pediatr Crit Care Med 2018; 19:421–432)

2015 PALS Updates

- Targeting a specific end-tidal CO2 (ETCO2) threshold to improve chest compression technique
- Use of invasive hemodynamic monitoring during
- CPR to titrate to a specific systolic/diastolic blood pressure to improve outcomes
- Reliability of intra-arrest prognostic factors to predict outcome
2015 PALS Updates

• Targeting ETCO2 threshold
• Invasive hemodynamic monitoring
• Intra-arrest prognostic factors

ETCO2 monitoring may be considered to evaluate the quality of chest compressions, but specific values to guide therapy have not been established in children.

• Minimizes interruptions of CPR for pulse checks
• If ETCO2 is <15 mm Hg, efforts should focus on improving CPR quality, particularly improving chest compressions and ensuring that the victim does not receive excessive ventilation.

2015 PALS Updates

• Targeting ETCO2 threshold
• **Invasive hemodynamic monitoring**
• Intra-arrest prognostic factors

• For patients with invasive hemodynamic monitoring in place at the time of cardiac arrest, it may be reasonable for rescuers to use blood pressure to guide CPR quality (Class IIb, LOE C-EO).

• Mean diastolic blood pressure ≥25 mm Hg during CPR in infants and ≥30 mm Hg in children ≥1 year old was associated with 70% greater likelihood of survival to hospital discharge and 60% higher likelihood of survival with a favorable neurological outcome.
2015 PALS Updates

• Targeting ETCO2 threshold
• Invasive hemodynamic monitoring
• Intra-arrest prognostic factors

• Worse prognosis with OHCA,
  • age less than 1 year
  • longer durations of cardiac arrest
  • presentation with a nonshockable rhythm
• Worse prognosis with IHCA,
  • age greater than 1 year
  • longer durations

When conventional resuscitation fails... ECPR

• Sustained or repetitive arrest events without ROSC for > 20 minutes?
Pediatric CCPR vs. ECPR

- Age:
  - <1 year for both groups
- Underlying diagnosis:
  - E-CPR - surgical cardiac illness
  - C-CPR - medical noncardiac illness
- First documented rhythm:
  - E-CPR - PEA (41% versus 32%)
  - C-CPR - bradycardia (49% versus 32%).

Post-resuscitation care

- Use of **targeted temperature management** to improve outcomes
- Use of a **targeted Pao2 strategy** to improve outcomes
- Use of a **specific Paco2 target** to improve outcomes
- Use of **parenteral fluids and inotropes and/or vasopressors** to maintain targeted measures of perfusion such as blood pressure to improve outcomes
- Use of **electroencephalograms (EEGs)** to accurately predict outcomes
- Use of **any specific post–cardiac arrest factors** to accurately predict outcomes
Post-resuscitation care

- **Targeted temperature management**
  - Targeted Pao2
  - Targeted Paco2
  - Targeted measures of perfusion
  - EEG
  - Post–cardiac arrest factors

- No difference in survival with good functional with therapeutic hypothermia compared to normothermia
- Fever (temperature 38°C or higher) should be aggressively treated after ROSC (Class I, LOE B-NR).

- Normoxemia (Pao2 > 60 mm Hg but < 300 mm Hg) when compared with hyperoxemia (Pao2 > 300 mm Hg) after ROSC was associated with improved survival to pediatric ICU discharge.
- Goal SpO2 >94%, <100%
Post-resuscitation care

• Targeted temperature management
• Targeted Pao2
• **Targeted Paco2**
  • Targeted measures of perfusion
  • EEG
  • Post–cardiac arrest factors

• Hypercapnia (Paco2 >50 mm Hg) was associated with worse survival to hospital discharge.
• In other types of pediatric brain injury, hypocapnia is associated with worse clinical outcomes.

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Post-resuscitation care

• Targeted temperature management
• Targeted Pao2
• Targeted Paco2
• **Targeted measures of perfusion**
  • EEG
  • Post–cardiac arrest factors

• Three small observational studies involving pediatric IHCA and OHCA demonstrated worse survival to hospital discharge when children were exposed to post-ROSC hypotension.
• After ROSC, we recommend that parenteral fluids and/or inotropes or vasoactive drugs be used to maintain a SBP > 5% for age.
• When appropriate resources are available, continuous arterial pressure monitoring is recommended to identify and treat hypotension.
## Post-resuscitation care

- Targeted temperature management
- Targeted Pao2
- Targeted Paco2
- Targeted measures of perfusion
- **EEG**
- Post–cardiac arrest factors

**EEGs performed within the first 7 days after pediatric cardiac arrest may be considered in prognosticating neurologic outcome at the time of hospital discharge but should not be used as the sole criterion.**

**Post–cardiac arrest factors**

- Pupillary reactivity and lower lactate levels at 12-24h are associated with improved survival.
- The reliability of any 1 variable for prognostication in children after cardiac arrest has not been established. Practitioners should consider multiple factors when predicting outcomes in infants and children who achieve ROSC after cardiac arrest.
Outcomes of Pediatric Cardiac Arrest

• Outcomes after OHCAs are better among children than adults, but still poor.
  • ~20% of children had ROSC prior to ED arrival (~8% for infants to ~35% for adolescents)
  • ~10% survived to hospital discharge and infants with lowest survival rates
  • Survival did not improve from 2007-2012

• Survival in children with an IHCA have improved significantly from 2000-2009 (~15% to 35%-43%)
  • ~80% with a favorable neurological outcome
  • Survival to hospital discharge is higher for surgical cardiac patients (37%-52%) than medical cardiac (28%-43%) or noncardiac (23%) patients

Outcomes of Pediatric Cardiac Arrest

• 29% of patients survived to hospital discharge
  • 27% for C-CPR patients compared with 40% in the E-CPR group
  • Favorable neurological outcome occurred in 18% of the C-CPR patients and 27% of the E-CPR patients

• Survival rates decrease over the first 15 minutes of CPR, yet patients who received E-CPR had no difference in survival across CPR durations.
  • Survival for patients receiving >35 minutes of C-CPR was only 15.9% (compared to <15 minutes was 44.1%).
  • ~25% of surgical cardiac patients survived to discharge after >35 minutes of C-CPR compared with only 10% of medical noncardiac patients
Thank you! And don’t do this

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References

• Lasa et al. Extracorporeal cardiopulmonary resuscitation (E-CPR) during pediatric in-hospital cardiopulmonary arrest is associated with improved survival to discharge. Circulation. 2016;133:165-176.
• Abella BS et al. Quality of Cardiopulmonary Resuscitation During In-Hospital Cardiac Arrest. JAMA. 2005 Jan 19;293(3):305-10.