Stayin’ Alive: Pediatric Advanced Life Support (PALS) Updated Guidelines

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Disclosures
I have nothing to disclose concerning possible financial or personal relationships with commercial entities (or their competitors) mentioned in this presentation.

Objectives
1. Review the updated recommendations in pre‐arrest, intra‐arrest, and post‐arrest care in PALS with a focus on medication management
2. Evaluate the level of evidence behind the 2015 recommendations
3. Apply the updated guidelines to a patient case

Pediatric In‐Hospital Cardiac Arrest
• Survival to discharge has improved
  – 24 to 43%
• Increase in survival is multifactorial
  – Emphasis on high‐quality cardiopulmonary resuscitation (CPR)
  – Advances in post‐resuscitation care
• Rates of survival from pulseless electrical activity and asystole have increased
• No change in survival rates from in‐hospital ventricular fibrillation or pulseless ventricular tachycardia

PALS Guideline Development
Historically, CPR and Emergency Cardiovascular Care developed by American Heart Association

2000: International Collaboration through International Liaison of Resuscitation (ILCOR)
International Consensus on CPR and ECC Science and Treatment Recommendations (CoSTR) published in 5 year cycles

2015: ILCOR Pediatric Life Support Task Force developed PALS updates

PALS Focus in 2015
• Updated areas in the 2015 PALS guidelines selected by a group of international pediatric resuscitation experts from ILCOR
  – Formulated 18 questions focused in advanced life support for further systematic evaluation
  – Updates are divided into pre‐arrest, intra‐arrest, and post‐arrest care
Degree of Evidence

- All guidelines are labeled with a class of recommendation (COR) and a level of evidence (LOE)

2015 Updates to COR and LOE

Prearrest Care

- Pediatric medical emergency team/rapid response team systems may be considered in facilities where children with high risk illnesses are cared for on general in-patient units (Class IIb, LOE C-LD)
- The use of pediatric early warning score (PEWS) may be considered, but its effectiveness in the in-hospital setting is not well established (Class IIb, LOE C-LD)
- Venoarterial (VA) ECMO use may be considered in patients with acute fulminant myocarditis who are at high risk of imminent cardiac arrest (Class IIb, LOE C-LD)
  - Optimal outcomes from ECMO in setting with existing ECMO protocols, expertise, and equipment
  - Review restricted analysis to patients with myocarditis and did not include VADs (ventricular assist devices)

Approach to Fluid Resuscitation

- Widely accepted approach of initiating early fluid resuscitation to prevent progression of shock
- Therapeutic elements addressed
  - Utilization of bolus fluids
  - Type of fluid utilized (non-crystalloid versus crystalloid)

Impact of Fluid Restriction Based on Presenting Illness

- Use of restrictive volume of intravenous fluid resuscitation compared with non-restrictive volume, by presenting illness and volume.
- Volume indicates that dehydration or benefit to restricting fluid volume. No benefit indicates that there is no benefit to restricting fluid volume, and Trend indicates that there is harm associated with restricting fluid volume. No studies available in most variables or fluid combinations.

- Initial Assessment

- Utilization of pediatric early warning score (PEWS) may be considered, but its effectiveness in the in-hospital setting is not well established (Class IIb, LOE C-LD)
- Venoarterial (VA) ECMO use may be considered in patients with acute fulminant myocarditis who are at high risk of imminent cardiac arrest (Class IIb, LOE C-LD)
  - Optimal outcomes from ECMO in setting with existing ECMO protocols, expertise, and equipment
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Crystalloid versus Non-crystalloid

Fluid Resuscitation Management
- Provide initial fluid bolus of 20ml/kg for shock, severe sepsis (Class IIa, LOE C-LD), severe malaria and Dengue (Class IIb, LOE B-R)
- Caution administering fluid bolus to children with severe febrile illness in settings with limited critical care resources due to potential for harm (Class IIb, LOE B-R)
- Reassessment of patient should occur after every fluid bolus (Class I, LOE C-EO)
- No preference of initial fluid choice with regards to effectiveness (Class IIa, LOE B-R)

Emergency Intubation
- Bradycardia as a side effect of intubation
  - Vagal
  - Reflexive
  - Pharmacologic
- Role of pre-intubation atropine
  - Prior support from observational/anecdotal experience to blunt bradycardic effect
  - Observational data that increases likelihood of survival to ICU discharge in children >28 days
  - Conflicting data on reduction in incidence of arrhythmias or post-intubation shock
- Prior guidelines suggested minimum dose (0.1mg) due to paradoxical bradycardia reported in infants receiving low doses

Pre-intubation Atropine
- Consideration in situations where a higher risk of bradycardia exists (Class IIb, LOE C-LD)
- Utilize 0.02mg/kg dose without a minimum as a pre-medication for emergency intubation (Class IIb, LOE C-LD)
  - Does not apply to other situations where atropine may be given

Assessment Question 1
True or False
With regards to pre-arrest care, the new 2015 PALS guidelines recommend to give fluid boluses in increments of 20ml/kg to infants and children with shock until they reach 60ml/kg and then reassess.
Intra-Arrest Care

Role of Extracorporeal Membrane Oxygenation (ECMO)

- Observational studies evaluating the combination of CPR with ECMO versus CPR without ECMO did not show an overall benefit
  - Caveat for patients with surgical cardiac diagnoses
- Improved outcome in children with underlying cardiac disease who receive CPR plus ECMO during cardiac arrest
  - Long-term survival (even after more than 50 minutes of conventional CPR) seen when initiated in a critical care setting
- Consider CPR plus ECMO for patients with cardiac diagnoses who have in-hospital cardiac arrest in settings with existing protocols (Class IIb, LOE C-LD)

Predictors of Poor Patient Outcomes

In-hospital cardiac arrest (IHCA)
- Age greater than 1 year
- Longer duration of cardiac arrest

Outside-hospital cardiac arrest (OHCA)
- Age less than 1 year
- Longer duration of cardiac arrest
- Presentation with a non-shockable rhythm

Multiple variables should be used when attempting to prognosticate outcomes during cardiac arrest (Class I, LOE C-LD)

Monitoring Parameters

- Lack of evidence for end tidal CO2 monitoring on improved outcomes after cardiac arrest in pediatrics
  - End-tidal CO2 monitoring to guide quality of chest compressions can be considered but specific values have not been established in children (Class IIb, LOE C-LD)
- Utilizing waveforms from arterial catheters to adjust chest compression technique showed an increased likelihood of ROSC and survival in animal studies
  - No human data exists in targeting specific systolic blood pressure
  - For patients with invasive hemodynamic monitoring in place at the time of cardiac arrest, it may be reasonable for resucers to use blood pressure to guide CPR quality (Class IIb, LOE C-E)

Vasopressors

- No pediatric studies demonstrating the effectiveness of any vasopressors
- Randomized controlled trial in adults with out-of-hospital cardiac arrest showed epinephrine was associated with increased ROSC and survival to hospital admission
  - No improvement in survival to hospital discharge
- Reasonable to administer epinephrine in pediatric cardiac arrest (Class IIa, LOE C-LD)

Anti-arrhythmic in VF or pVT

- Previous guidelines recommend amiodarone over lidocaine
- Improved ROSC with the use of lidocaine compared to amiodarone
  - Lidozone versus no lidocaine was significantly associated with an increased likelihood of ROSC
  - No association between lidocaine or amiodarone use and survival to hospital discharge
- For shock-refractory VF or pVT, either amiodarone or lidocaine may be used (Class IIb, LOE C-LD)
Manual Defibrillation

- Currently a range of 2-4J/kg exists for pediatric manual defibrillation in VF/pVT
  - Higher initial doses were less effective in achieving ROSC
  - No benefit in achieving ROSC with a specific initial energy dose
  - No survival to discharge advantage of any dose compared with initial 2-4J/kg dosing
- Reasonable to use an initial dose of 2 to 4J/kg for defibrillation (Class IIa, LOE C-LD)
  - Initial shock: 2J/kg (Class IIb, LOE C-EO)
  - Second shock: 4J/kg (Class IIa, LOE C-LD) in refractory VF
  - Subsequent shocks: 4J/kg shocks may be reasonable with higher energy levels considered not to exceed 10J/kg or adult maximum (Class IIb, LOE C-LD)

Assessment Question 2

The following variable(s) have been associated with a negative predictive factors in children with IHCA as compared to OHCA
A. Age greater than 1 year
B. Age less than 1 year and presentation with a non-shockable rhythm
C. Age less than 1 year and longer duration of cardiac arrest
D. Presentation with a non-shockable rhythm

Postarrest Care

Targeted Measures to Improve Outcomes

- Temperature
  - Majority of studies have showed no difference in targeted temperature with regards to ICU duration, neurologic outcomes, and mortality
  - Small study showed improvement in mortality at hospital discharge but no difference in neurologic outcomes

Targeted Measures to Improve Outcomes

- Cooling
  - Infants or children remaining comatose after outside hospital cardiac arrest
  - Maintain 5 days of continuous normothermia or 2 days of initial continuous hypothermia (32C – 34C) followed by 3 days of continuous normothermia (Class IIa, LOE B-R) with continuous temperature measurement (Class I, LOE B-NR)
  - Insufficient evidence to recommend cooling over normothermia in infants or children remaining comatose after in-hospital cardiac arrest
  - Fever should be aggressively treated after ROSC (Class I, LOE B-NR)
Targeted Measures to Improve Outcomes

• Partial Pressure of O₂ (PaO₂)
  – Conflicting data on effects of hyperoxemia and outcome
  – Three small observational pediatric studies did not show association
  – Larger observational pediatric study showed improved survival to pediatric ICU discharge in normoxemia patients compared to hyperoxemia (PaO₂ >300mmHg)
  – Reasonable to target normoxemia after ROSC (Class IIb, LOE B-NR)
  – General O₂ saturation goal 94-99%

• Partial Pressure of Carbon Dioxide (PaCO₂)
  – Adult data has shown post-ROSC hypocapnia is associated with worse patient outcomes
  – Conflicting data from observational studies on effects of hypo and hypercapnia and outcome in pediatric cardiac arrest
  – Reasonable to target a PaCO₂ after ROSC that is specific to patient condition and limit exposure to severe hypercapnia or hypocapnia (Class IIb, LOE C-LD)

• Blood pressure
  – Worse survival to hospital discharge demonstrated in children exposed to post-ROSC hypotension (systolic less than 5th percentile for age)
  – IV fluids and/or inotropes or vasoactives are recommended post-ROSC to maintain systolic blood pressure above 5th percentile for age (Class I, LOE C-LD)
  – No specific recommendations on agents
  – Continuous arterial pressure monitoring is recommended to identify and treat hypotension as available (Class I, LOE C-EO)

Prediction of Outcomes

• Role of EEG
  – EEGs (within the first 7 days) help to support prognostication of neurologic outcome post-ROSC at the time of hospital discharge (Class IIb, LOE C-LD)
  – Continuous and reactive tracing on EEG in the first 7 days post arrest had a higher likelihood of good neurological outcome at hospital discharge
  – Discontinuous or isoelectric tracing was associated with a poorer neurologic outcome at hospital discharge
  – Not sole determinant of neurologic outcome

Specific post-cardiac arrest factors

• Pupillary response, presence of hypotension, serum neurologic biomarkers, and serum lactate
• Multiple factors should be considered when predicting outcomes after cardiac arrest due to the lack of reliability in any one variable (Class I, LOE C-LD)

Assessment Question 3

An appropriate approach to temperature management for patients remaining comatose after CHCA is as follows:
A. Maintain 5 days of continuous normothermia
B. Maintain 3 days of continuous normothermia followed by 2 days of continuous hypothermia
C. Maintain 5 days of continuous hypothermia
D. Maintain 3 days of continuous hypothermia followed by 2 days of continuous normothermia
Assessment Question 3
An appropriate approach to temperature management for patients remaining comatose after OHCA is as follows:
A. Maintain 5 days of continuous normothermia
B. Maintain 3 days of continuous normothermia followed by 2 days of continuous hypothermia
C. Maintain 5 days of continuous hypothermia
D. Maintain 3 days of continuous hypothermia followed by 2 days of continuous normothermia

Post-Lecture Questions

Post-Lecture Test Question 1
• Which of the following statements is accurate with regards to medication in the updated 2015 PALS guidelines?
  – A. A minimum dose (0.1mg) of atropine for pre-intubation use is recommended to avoid paradoxical bradycardia
  – B. Epinephrine is no longer recommended in pediatric cardiac arrest due to the lack of improvement in survival to hospital discharge
  – C. Amiodarone or lidocaine is recommended in shock-refractory VF and pVT; however amiodarone showed improved ROSC in new pediatric observational data
  – D. Inotropes or vasoactive drugs should be used to maintain a systolic blood pressure greater than fifth percentile for age post-ROSC, but no specific agents have been evaluated in studies

Post-Lecture Test Question 2
• A majority of the evidence presented in the 2015 PALS update is Class IIb, LOE C-LD which means:
  – A. The strength of recommendation states benefit is moderate and the quality is based on 1 or more well designed, well executed non-randomized studies, observational studies or registry studies
  – B. The strength of recommendation states harm is strong and the quality is based on randomized or non-randomized observation or registry studies with limitations of design of execution
  – C. The strength of recommendation states benefit is weak and the quality is based on randomized or non-randomized observation or registry studies with limitations of design of execution
  – D. The strength of recommendation states benefit is weak and the quality is based on 1 or more well designed, well executed non-randomized studies, observational studies or registry studies

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Post-Lecture Test Question 3

- 4 year old male found down unresponsive by a neighbor is brought to the hospital via EMS with CPR in progress. Based on the current recommendations in the 2015 PALS guidelines, the best response is
  - A. To target a partial pressure end tidal CO2 of 15mmHg or more to demonstrate adequate CPR quality
  - B. To utilize ECMO plus CPR if the patient is found to have an underlying cardiac diagnoses
  - C. To provide 2J/kg of energy as the initial shock dose if the rhythm is determined to be shockable (VF or pVT)
  - D. To target a systolic blood pressure greater than the 5th percentile during CPR using invasive hemodynamic monitoring

Questions?