Pediatric Resuscitation is No Small Matter

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Disclosures

- No financial interests
- Lara Rappaport
  - Involved in many of the studies
- I don't like Peter

Pediatric Myths

- Pain management is bad

Myth

- Epinephrine should be feared
  - It should not!
    - Anaphylaxsis
    - Asthma
      - Remember the IM is better than SQ!

Myth

- Kids don't have blood pressures
  - They do!

Myth

- Children are not little adults
  - They are!

Adults Are Just Big Kids

Kids ARE Small Adults

- History and physical exam are key
- ABCs
- Develop a relationship with your patient
  - It will be worth your time
- Fear doesn't work

Dispelling the Myths

- "Kids can't come back from cardiac arrest"
  - Significant improvements in
    - Out of hospital cardiac arrest survival in adults
    - In-hospital cardiac arrest survival in kids

Perspective

Pediatric Cardiac Arrest Statistics

Part 14: Pediatric Advanced Life Support
2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Monica E. Kleinman, Chair; Leon Chameides; Stephen M. Schexnayder; Ricardo A. Samson; Mary Fran Hazinski; Dianne L. Atkins; Marc D. Berg; Allan R. de Caen; Ericka L. Fink; Eugene B. Freid; Robert W. Hickey; Bradley S. Marino; Vinay M. Nadkarni; Lester T. Proctor; Faiqa A. Qureshi; Kennith Sartorelli; Alexis Topjian; Elise W. van der Jagt; Arno L. Zaritsky

In contrast to adults, cardiac arrest in infants and children does not usually result from a primary cardiac cause. More often it is the terminal result of progressive respiratory failure or shock, also called an asphyxial arrest. Asphyxia begins with a variable period of systemic hypoxemia, hypercapnea, and acidosis, progresses to bradycardia and hypotension, and culminates with cardiac arrest.[1]

Another mechanism of cardiac arrest, ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT), is the initial cardiac rhythm in approximately 5% to 15% of pediatric in-hospital and out-of-hospital cardiac arrests; it is reported in up to 27% of pediatric in-hospital arrests at some point during the resuscitation. The incidence of VF/pulseless VT cardiac arrest rises with age. Increasing evidence suggests that sudden unexpected death in young people can be associated with genetic abnormalities in myocyte ion channels resulting in abnormalities in ion flow (see "Sudden Unexplained Deaths," below).

Since 2010 marks the 50th anniversary of the introduction of cardiopulmonary resuscitation (CPR), it seems appropriate to review the progressive improvement in outcome of pediatric resuscitation from cardiac arrest. Survival from in-hospital cardiac arrest in infants and children in the 1980s was around 9%. Approximately 20 years later, that figure had increased to 17%, and by 2006, to 27%. In contrast to those favorable results from in-hospital cardiac arrest, overall survival to discharge from out-of-hospital cardiac arrest in infants and children has not changed substantially in 20 years and remains at about 6% (3% for infants and 9% for children and adolescents).

It is unclear why the improvement in outcome from in-hospital cardiac arrest has occurred, although earlier recognition and management of at-risk patients on general inpatient units and more aggressive implementation of evidence-based resuscitation guidelines may have played a role. Implementation of a formal pediatric medical emergency team (MET) or rapid response team (RRT) as part of an emergency response system for a deteriorating inpatient has been shown to significantly decrease the incidence of cardiac and respiratory arrests, as well as hospital mortality rates in some large children's hospitals. Such teams, often consisting of providers with expertise in assessment and initial management of acutely ill patients (critical-care nurses, respiratory therapists, and critical-care physicians), decreased the number of cardiac and respiratory arrests by as much as 72% and hospital mortality by as much as 35% in institutions where the effect was studied. Although it is possible that most of the impact is due to a decrease in respiratory arrests, this cannot be confirmed by the available published data. Implementation of a pediatric MET/RRT may be beneficial in facilities where children with high risk illnesses are present on general inpatient units (Class IIa, LOE B).

Despite the improved outcome of in-hospital CPR, a majority of children with in-hospital cardiac arrest and an even larger percentage of children with out-of-hospital cardiac arrest do not survive, or they are severely incapacitated if they do. Several studies, discussed later in this document, showed that the presence of family members during resuscitation has helped them deal with the inevitable trauma and grief following the death of a child. Therefore, whenever possible, provide family members with the option of being present during resuscitation of an infant or child (Class I, LOE B).

BLS Considerations During PALS

Pediatric advanced life support (PALS) usually takes place in the setting of an organized response in an advanced healthcare environment. In these circumstances, multiple responders are rapidly mobilized and are capable of simultaneous coordinated action. Resuscitation teams may also have access to invasive patient monitoring that may provide additional information during the performance of basic life support (BLS).

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In Hospital

Improved

1980 - 9%

2000 - 17%

2006 - 27%

Out of Hospital

Unchanged in 20 years

Infants 3%

Children & Adolescents 9%

Part 14: Pediatric Advanced Life Support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2010;122:S876-S908

CPR

- Bystander CPR rates remain low in kids
  - Sasson et al
    - Circulation, 2013
- Bystander CPR makes a difference
  - Naim et al
    - JAMA Peds, 2017

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Resuscitation
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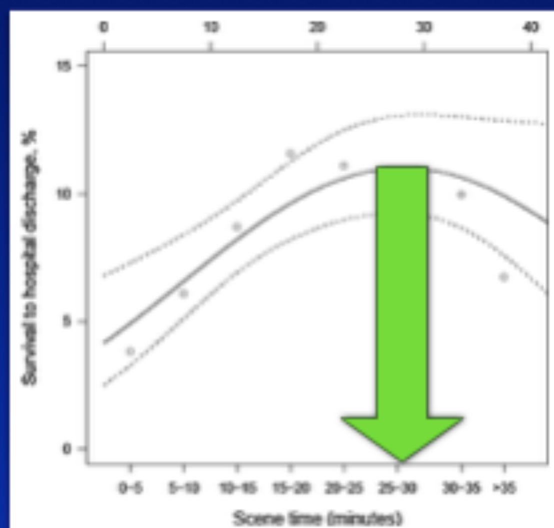
EUROPEAN RESUSCITATION COUNCIL

Clinical paper

Time on the scene and interventions are associated with improved survival in pediatric out-of-hospital cardiac arrest☆

Janice A. Tijssen[a,b,*], David K. Prince[c], Laurie J. Morrison[d,e], Dianne L. Atkins[f],

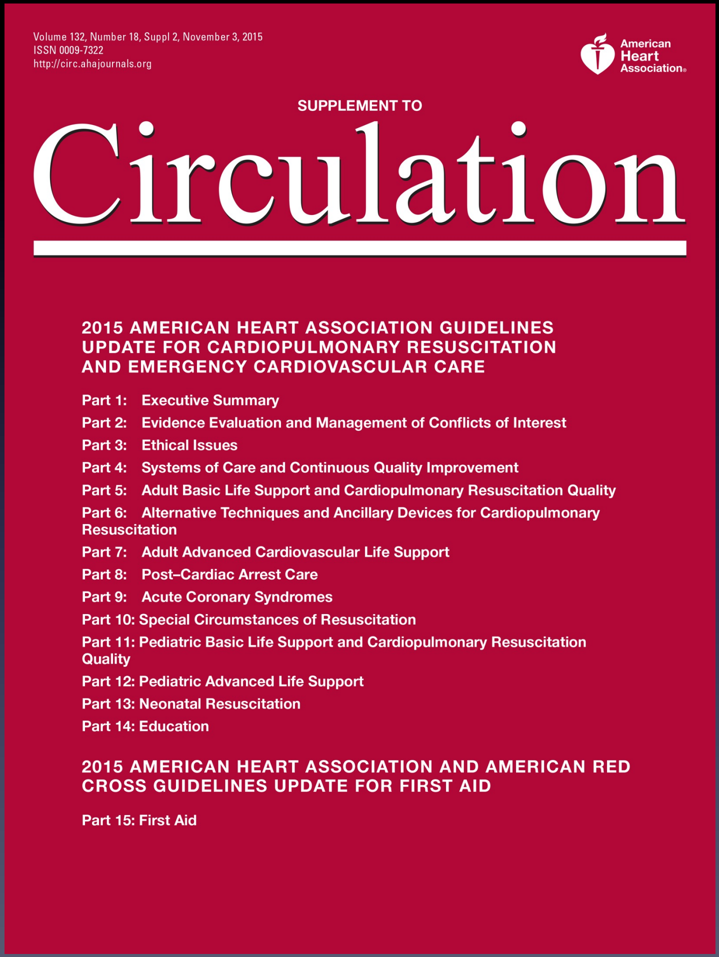


25-30
Minutes
On Scene

Highest Survival
to Discharge

2015 AHA/ECC Guidelines

- Update from 2010
- Pre-arrest
  - Fluids for septic shock
    - At least 20 cc/kg
  - No atropine for intubation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American Heart Association®

SUPPLEMENT TO

Circulation

2015 AMERICAN HEART ASSOCIATION GUIDELINES UPDATE FOR CARDIOPULMONARY RESUSCITATION AND EMERGENCY CARDIOVASCULAR CARE

Part 1: Executive Summary
Part 2: Evidence Evaluation and Management of Conflicts of Interest
Part 3: Ethical Issues
Part 4: Systems of Care and Continuous Quality Improvement
Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality
Part 6: Alternative Techniques and Ancillary Devices for Cardiopulmonary Resuscitation
Part 7: Adult Advanced Cardiovascular Life Support
Part 8: Post–Cardiac Arrest Care
Part 9: Acute Coronary Syndromes
Part 10: Special Circumstances of Resuscitation
Part 11: Pediatric Basic Life Support and Cardiopulmonary Resuscitation Quality
Part 12: Pediatric Advanced Life Support
Part 13: Neonatal Resuscitation
Part 14: Education

2015 AMERICAN HEART ASSOCIATION AND AMERICAN RED CROSS GUIDELINES UPDATE FOR FIRST AID

Part 15: First Aid

Pediatric Cardiac Arrest

- Intra-arrest:
  - $ETCO_2$ to evaluate CPR
  - Poor predictors of OHCA
    - Prolonged duration of arrest
      - Without CPR
    - Nonshockable rhythm

Part 12: Pediatric Advanced Life Support

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

Allan R. de Caen, Chair; Marc D. Berg; Leon Chameides; Cheryl K. Gooden; Robert W. Hickey; Halden F. Scott; Robert M. Sutton; Janice A. Tijssen; Alexis Topjian; Élise W. van der Jagt; Stephen M. Schexnayder; Ricardo A. Samson

Introduction

Over the past 13 years, survival to discharge from pediatric in-hospital cardiac arrest (IHCA) has markedly improved. From 2001 to 2013, rates of return of spontaneous circulation (ROSC) from IHCA increased significantly from 39% to 77%, and survival to hospital discharge improved from 24% to 36% to 43% (Girotra et al[1] and personal communication with Paul Chan, MD, MSc, April 3, 2015). In a single center, implementation of an intensive care unit (ICU)–based interdisciplinary debriefing program improved survival with favorable neurologic outcome from 29% to 50%.[2] Furthermore, new data show that prolonged cardiopulmonary resuscitation (CPR) is not futile: 12% of patients receiving CPR in IHCA for more than 35 minutes survived to discharge, and 60% of the survivors had a favorable neurologic outcome.[3] This improvement in survival rate from IHCA can be attributed to multiple factors, including emphasis on high-quality CPR and advances in post-resuscitation care. Over the past decade, the percent of cardiac arrests occurring in an ICU setting has increased (87% to 91% in 2000 to 2003 to 94% to 96% in 2004 to 2010).[4] While rates of survival from pulseless electrical activity and asystole have increased, there has been no change in survival rates from in-hospital ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT).

Conversely, survival from out-of-hospital cardiac arrest (OHCA) has not improved as dramatically over the past 5 years. Data from 11 US and Canadian hospital emergency medical service systems (the Resuscitation Outcomes Consortium) during 2005 to 2007 showed age-dependent discharge survival rates of 3.3% for infants (less than 1 year), 9.1% for children (1 to 11 years), and 8.9% for adolescents (12 to 19 years).[5] More recently published data (through 2012) from this network demonstrate 8.3% survival to hospital discharge across all age groups, with 10.5% survival for children aged 1 to 11 years and 15.8% survival for adolescents aged 12 to 18 years.[6]

Evidence Evaluation Process Informing This Guidelines Update

The American Heart Association (AHA) Emergency Cardiovascular Care (ECC) Committee uses a rigorous process to review and analyze the peer-reviewed published scientific evidence supporting the AHA Guidelines for CPR and ECC, including this update. In 2000, the AHA began collaborating with other resuscitation councils throughout the world, via the International Liaison Committee on Resuscitation (ILCOR), in a formal international process to evaluate resuscitation science. This process resulted in the publication of the International Consensus on CPR and ECC Science With Treatment Recommendations (CoSTR) in 2005 and 2010.[7,8] These publications provided the scientific support for AHA Guidelines revisions in those years.

In 2011, the AHA created an online evidence review process, the Scientific Evidence Evaluation and Review System (SEERS), to support ILCOR systematic reviews for 2015 and beyond. This new process includes the use of Grading of Recommendations Assessment, Development, and Evaluation (GRADE) software to create systematic reviews that will be available online and used by resuscitation councils to develop their guidelines for CPR and ECC. The drafts of the online reviews were posted for public comment, and ongoing reviews will be accessible to the public (https://volunteer.heart.org/apps/pico/Pages/default.aspx).

The AHA process for identification and management of potential conflicts of interest was used, and potential conflicts for writing group members are listed at the end of each Part of the *2015 AHA Guidelines Update for CPR and ECC*. For additional information about this systematic review or management of the potential conflicts of interest, see "Part 2: Evidence Evaluation and Management of Conflicts of Interest" in this supplement and the related article "Part 2: Evidence Evaluation and Management of Conflict of Interest" in the 2015 CoSTR publication.[9,10]

This update to the *2010 AHA Guidelines for CPR and ECC* for pediatric advanced life support (PALS) targets key questions related to pediatric resuscitation. Areas of update were selected by a group of international pediatric resuscitation experts from ILCOR, and the questions encompass resuscitation topics in prearrest care, intra-arrest care, and postresuscitation care. The ILCOR Pediatric Life Support Task Force experts reviewed the topics addressed in the 2010 Guidelines

The American Heart Association requests that this document be cited as follows: de Caen AR, Berg MD, Chameides L, Gooden CK, Hickey RW, Scott HF, Sutton RM, Tijssen JA, Topjian A, van der Jagt E, Schexnayder SM, Samson RA. Part 12: pediatric advanced life support: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2015;132(suppl 2):S526–S542.
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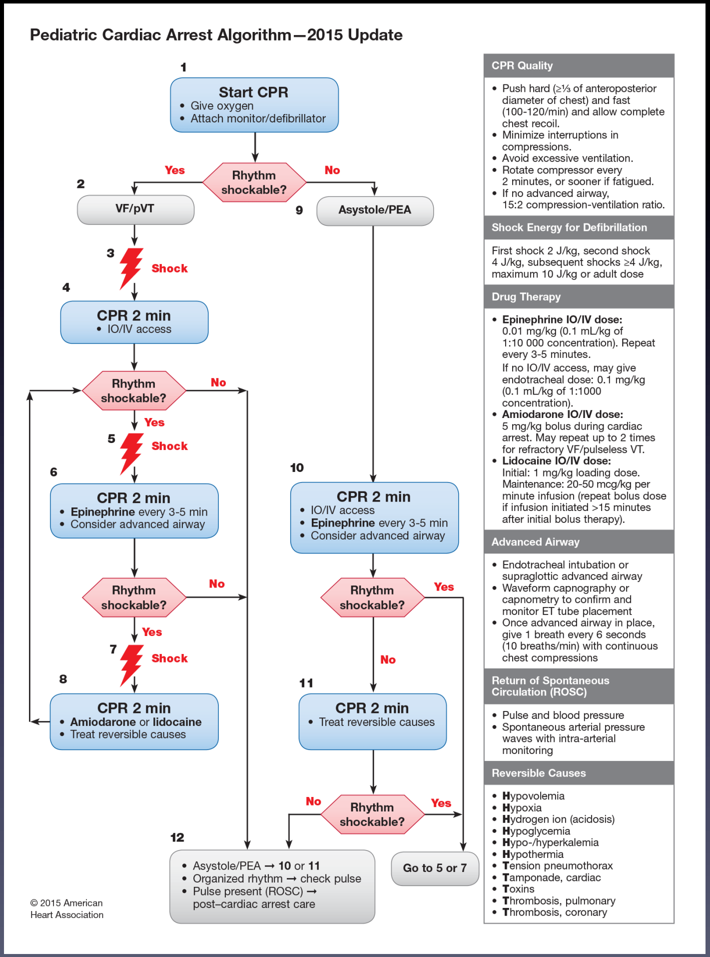
(*Circulation*. 2015;132[suppl 2]:S526–S542. DOI: 10.1161/CIR.0000000000000266.)

Pediatric Cardiac Arrest

- No demonstrated effectiveness of vasopressors
  - Epinephrine is reasonable

Pediatric Cardiac Arrests

- Amiodarone or lidocaine for refractory VF/VT



Post-Cardiac Arrest

- Hypothermia (32 to 34 degrees) may be reasonable
- Normoxemia, rather than hyperoxemia, is the likely goal

ACLS and PALS

Adult Algorithm	Etiology	Pediatric Algorithm
Epinephrine	Asystole / PEA	Epinephrine
Electricity + Epi + Amio	Ventricular Fibrillation	Electricity + Epi + Amio
Electricity + Epi + Amio	Pulseless V-Tach	Electricity + Epi + Amio
Adenosine	SVT	Adenosine
Benzodiazepine	Seizure	Benzodiazepine
Dextrose	Hypoglycemia	Dextrose
Epi 1:1000 IM + H2 + Steroid	Anaphylaxis	Epi 1:1000 IM + H2 + Steroid
Beta agonist + Steroid + Mag	Asthma	Beta agonist + Steroid + Mag

National Prehospital Guidelines for Pediatric Seizure and Traumatic Pain Management Do Not Concur with Information on the Broselow-Luten Length Based Tape

Kathleen Adelgais, Karl Marzc, Toni Gross, Lara Rappaport. 2015

NAEMSP Abstracts

Abstracts for the 2015 NAEMSP Scientific Assembly

National Prehospital Guidelines for Pediatric Seizure and Traumatic Pain Management Do Not Concur with Information on the Broselow-Luten Length Based Tape

Kathleen M. Adelgais, Karl Marzec, Toni Gross, Lara D. Rappaport, University of Colorado School of Medicine

Background: The Ambulance Equipment List includes the pediatric length/weight-based tape. The Broselow-Luten Pediatric Emergency Tape (Broselow LBT) has assessment tools, equipment selection, and medication doses. Recent prehospital evidence-based guidelines (EBG) provide pediatric-specific recommendations for seizure and traumatic pain management. The purpose of this study was to examine the ability of the Broselow LBT to facilitate care per these two EBGs. We hypothesize that the Broselow LBT can correctly facilitate only a few EBG recommendations.

Methods: A critical review of the pediatric seizure and traumatic pain EBGs identified specific recommendations related to assessment tools, equipment size, and medication dose. Four study investigators examined the Broselow LBT (2011, Edition A) using a standardized scoring sheet to classify each recommendation: "CAN be followed" (stratified by correct and incorrect information), and "CAN NOT be followed" (no information listed). To validate the scoring process, investigators utilized a modified Delphi iteration with a target for consensus of >90%. The primary outcome was the number of recommendations for which Broselow LBT provided correct information to facilitate management.

Results: Pediatric seizure and traumatic pain EBGs contained 8 and 11 relevant recommendations; respectively. Target consensus for classifying recommendations was achieved after 2 iterations. The Broselow LBT provided correct information for 3 recommendations on the seizure guideline (dextrose and lorazepam dose; size of IV/IO catheters). The Broselow LBT stated dose for midazolam was 3 times that recommended on the EBG. For 3 non-parenteral doses of midazolam (first-line EBG treatment recommendation), no information was available. For the traumatic pain EBG, only 1 recommendation (size of BP cuff to assess for hypotension), could be correctly followed per the Broselow LBT. Broselow LBT listed incorrect information for 3 recommendations, end-tidal CO2 equipment and IV fentanyl dose options; the only dose of IV Fentanyl being 3-fold that recommended for pain management. Most recommendations (7/11), could not be followed, including dose of intranasal fentanyl and morphine, assessment of pain score, Glasgow Coma Scale, and pulse-oximetry equipment

Conclusion: Few prehospital EBGs recommendations can be accurately followed by information on the Broselow LBT. Additional tools to facilitate pediatric care according to prehospital EBG recommendations may be necessary.

Poster Presentation NAEMSP; January 2015
Prehospital Emergency Care 2015;19:162

An Evidence-Based Guideline for Prehospital Analgesia in Trauma

Marianne Gausche-Hill, MD, Kathleen M. Brown, MD, Zoë J. Oliver, MD, CCFP (EM), Comilla Sasson, MD, MS, Peter S. Dayan, MD, MSc, Nicholas M. Eschmann, EMT-P, MS (Epidemiology), Tasmeen S. Weik, DrPh, MPH, Benjamin J. Lawner, DO, EMT-P, FAAEM, Ritu Sahni, MD, MPH, Yngve Falck-Ytter, Joseph L. Wright, MD, MPH, Knox Todd, MD, MPH, Eddy S. Lang, MDCM, CCFP (EM)

1. Size of BP Cuff

An Evidence-Based Guideline for Pediatric Prehospital Seizure Management Using GRADE Methodology

Manish I. Shah, MD, Charles G. Macias, MD, MPH, Peter S. Dayan, MD, MSc, Tasmeen S. Weik, DrPh, MPH, Kathleen M. Brown, MD, Susan M. Fuchs, MD, Mary E. Fallat, MD, Joseph L. Wright, MD, MPH, Eddy S. Lang, MDCM, CCFP (EM)

1. **Dextrose Dose**
2. **Lorazepam**
3. **IV Catheter Size**

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Handtevy System

Option 1 -USE ACTUAL AGE (IF STANDARD SIZED CHILD) Option 2 -ESTIMATE AGE USING HANDTEVY LENGTH BASED TAPE (HEAD TO HEEL)	5YR

Denver Paramedics — 20 KG IDEAL WEIGHT

DRUG	CONC	VOL	RT	DOSE/KG	AMOUNT
Adenosine (1st)	12 mg/4 mL	0.67 mL	IV/IO	0.1 mg/kg	2 mg
Adenosine (2nd)	12 mg/4 mL	1.3 mL	IV/IO	0.2 mg/kg	4 mg
Albuterol	2.5 mg/3 mL	6 mL	NEB	Dose =	5 mg
Amiodarone	150 mg/3 mL	2 mL	IV/IO	5 mg/kg	100 mg
Atropine	1 mg/10 mL	4 mL	IV/IO	0.02 mg/kg	0.4 mg
Atrovent	0.5 mg/2.5 mL	2.5 mL	NEB	Dose =	0.5 mg
Bicarb 8.4%	50 mEq/50 mL	20 mL	IV/IO	1 mEq/kg	20 mEq
Calcium Gluconate	1 g/10 mL	10 mL	IV/IO	Dose =	1 g
D25W	(D50W - 25 mL) + 25 mL NS	40 mL	IV/IO	0.5 g/kg	10 g
Diazepam	10 mg/2 mL	0.8 mL	IV/IO	0.2 mg/kg	4 mg
Diphenhydramine	50 mg/mL	0.4 mL	IV/IO	1 mg/kg	20 mg
Epi 1:1,000 IM	1 mg/mL	0.2 mL	IM	0.01 mg/kg	0.2 mg
Epi 1:10,000 IV	1 mg/10 mL	2 mL	IV/IO	0.01 mg/kg	0.2 mg
Epi IV Anaphylaxis	1:100,000	10 mL	IV	Dose =	0.1 mg
Fentanyl	100 mcg/2 mL	0.4 mL	IV/IO	1 mcg/kg	20 mcg
Fentanyl Intranasal	100 mcg/2 mL	0.5 mL	IN	1 mcg/kg	20 mcg
Glucagon	1 mg/mL	1 mL	IM	Dose =	1 mg
Methylprednisolone	125 mg/2 mL	0.64 mL	IV	2 mg/kg	40 mg
Midazolam IM/IN	5 mg/mL	0.8 mL	IM/IN	0.2 mg/kg	4 mg
Midazolam IV	5 mg/mL	0.4 mL	IV/IO	0.1 mg/kg	2 mg
Morphine	4 mg/mL	0.5 mL	IV/IO/IM	0.1 mg/kg	2 mg
Naloxone	2 mg/2 mL	0.5 mL	IV/IO	Dose =	0.5 mg
Normal Saline Bolus	0.9%	400 mL	IV/IO	20 mL/kg	400 mL
Ondansetron IV	2 mg/mL	2 mL	IV	Dose =	4 mg
Ondansetron ODT	4 mg/tab	1 tab	PO	Dose =	4 mg
Racemic Epi	Add 2 mL NS	0.5 mL	NEB	Dose =	0.5 mL

LIFEPAK	JOULES/KG	1ST	2ND	3RD	4TH
Defibrillation	2 → 4 → 6 → 8	50	70	125	150
Cardioversion	0.5 → 1 → 2 → 2	10	20	50	50

ET TUBE	DISTANCE AT LIP	KING	EZ-IO
5.5 (U) Stylet 10	16.5 cm	2.5	25 mm

VITALS	SBP	80 - 115	HR	70 - 115	RR	20 - 24

Results

- Since implementation
  - 85% greater likelihood of getting pain medication
  - 50% greater likelihood of getting treatment for seizures and anaphylaxis
  - Increased scene time
    - 100% CPR
    - 100% Epi

Take Home

- Kids are little adults
- It is a paradigm shift
  - But a good one
- Pediatric resuscitation should look more like adult resuscitation
- Result has been
  - More pain/seizure/anaphylaxis meds
  - Longer scene times
  - Much more enthusiasm

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