

UC Davis

UC Davis Previously Published Works

Title

Drugs Used to Treat Pediatric Emergencies

Permalink

<https://escholarship.org/uc/item/48x030w6>

Journal

Pediatrics, 145(1)

ISSN

0031-4005

Authors

Shenoi, Rohit P
Timm, Nathan
Jones, Bridgette
et al.

Publication Date

2020

DOI

10.1542/peds.2019-3450

Peer reviewed



Drugs Used to Treat Pediatric Emergencies

Rohit P. Sheno, MD, FAAP,^a Nathan Timm, MD, FAAP,^b COMMITTEE ON DRUGS, COMMITTEE ON PEDIATRIC EMERGENCY MEDICINE

abstract

^aTexas Children's Hospital and Department of Pediatrics, Baylor College of Medicine, Houston, Texas; and ^bCincinnati Children's Hospital Medical Center and Department of Pediatrics, College of Medicine, University of Cincinnati, Cincinnati, Ohio

Clinical reports from the American Academy of Pediatrics benefit from expertise and resources of liaisons and internal (AAP) and external reviewers. However, clinical reports from the American Academy of Pediatrics may not reflect the views of the liaisons or the organizations or government agencies that they represent.

Drs Sheno and Timm prepared, reviewed, revised, and approved the final manuscript, including the drug tables and references; and all authors approved the final manuscript as submitted.

The guidance in this report does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

All clinical reports from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.

This document is copyrighted and is property of the American Academy of Pediatrics and its Board of Directors. All authors have filed conflict of interest statements with the American Academy of Pediatrics. Any conflicts have been resolved through a process approved by the Board of Directors. The American Academy of Pediatrics has neither solicited nor accepted any commercial involvement in the development of the content of this publication.

DOI: <https://doi.org/10.1542/peds.2019-3450>

Address correspondence to Rohit Sheno. E-mail: rsheno@bcm.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2020 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

To cite: Sheno RP, Timm N, AAP COMMITTEE ON DRUGS, AAP COMMITTEE ON DRUGS, AAP COMMITTEE ON PEDIATRIC EMERGENCY MEDICINE. Drugs Used to Treat Pediatric Emergencies. *Pediatrics*. 2020;145(1):e20193450

This clinical report is a revision of “Preparing for Pediatric Emergencies: Drugs to Consider.” It updates the list, indications, and dosages of medications used to treat pediatric emergencies in the prehospital, pediatric clinic, and emergency department settings. Although it is not an all-inclusive list of medications that may be used in all emergencies, this resource will be helpful when treating a vast majority of pediatric medical emergencies. Dosage recommendations are consistent with current emergency references such as the *Advanced Pediatric Life Support* and *Pediatric Advanced Life Support* textbooks and American Heart Association resuscitation guidelines.

INTRODUCTION

Most children present for emergency medical care in physicians' offices, the prehospital setting, or the emergency department (ED). Roughly 28 million (27%) of the annual ED visits in the United States are by children younger than 19 years.¹ Approximately 7% of these children reach the hospital via emergency medical services (EMS).¹ EMS agencies provide the majority of out-of-hospital emergency care to children. Of the 4800 general and short-stay hospitals with 24-hour EDs in the United States during 2006, the majority (87%) admitted children, but only 10% were children's hospitals or had PICUs. A majority (84%) of hospitals would send pediatric patients requiring intensive care to another hospital.² Approximately 30% of emergency pediatric visits occurred in children's hospitals.² Medical emergencies may occur between once or more per week and once or more per month in pediatricians' offices.^{3,4} Given the scope of pediatric emergency care in the United States and to facilitate consistency in the pharmacotherapy of medical emergencies in children, it is incumbent that all health providers who manage critically ill or injured children be knowledgeable of the medications used to treat pediatric emergencies. Changes in the pattern and scope of practice, changes in the dosages and indications of medications, availability of newer drugs, and the discontinuation of older pharmacotherapeutic agents make it necessary to stay updated.

This document will be helpful to medical practitioners in the clinic, prehospital setting, and ED. The Supplemental Information contains several tables, each listing medications used to treat pediatric emergencies on the basis of organ system or context (eg, drugs used in disasters). The indications, dosing, and practical points regarding drug administration are described. Description of medication adverse effects is limited. Some drugs may be listed in multiple places because of overlapping indications. Antimicrobial agents (except for in disaster situations), vaccines, and chemotherapeutic agents are not included. The practitioner is referred to the American Academy of Pediatrics (AAP) *Red Book: Report of the Committee on Infectious Diseases* for the treatment of infections.⁵ In addition, some drugs that are used to treat pediatric emergencies in consultation with an appropriate medical subspecialist (eg, tissue plasminogen for stroke, intravenous [IV] methylprednisolone for transverse myelitis) are not listed. Dosages are generally provided as milligrams per kilogram. The format for presented dosages is consistent with AAP recommendations for reducing medication errors.⁶ Some high-potency drugs, such as prostaglandins, vasopressors, nitroprusside, and fentanyl, have their dosages provided in μg per kilogram. The reader is referred to resources for the safe prescription, administration, and monitoring of medications in their patients.⁶

The IV route is preferred for the administration of medications in an emergency. However, when prompt IV access is not possible, emergency intraosseous administration is an acceptable alternative. The practitioner is advised to consult the pharmacist on the appropriate infusion system whenever possible. Certain drugs (lidocaine, epinephrine,

atropine, naloxone [memory aid: LEAN]) can be administered by the endotracheal tube (ET) if no vascular access can be obtained. However, intratracheal drug administration results in lower, less predictable drug concentrations than intravascular administration and is not preferred. If the ET route is used, the drug should be administered with or diluted in 1 to 5 mL of isotonic saline solution followed by manual ventilations. ET administration of naloxone is not recommended for neonates. Newer methods of drug administration in children include the intranasal and intrabuccal routes. These are especially useful in sedation, analgesia, and seizure control. When administering drugs by the intranasal route, it is preferable to use a mucosal atomizer to mist the drug rather than a syringe to drip the medication into the nostrils.

To date, the Best Pharmaceuticals for Children Act and the Pediatric Research Equity Act have resulted in expanded labeling with pediatric-specific information for more than 700 drugs.⁷ However, gaps in pediatric labeling and dosing information still exist.⁸ The reader is encouraged to consult package inserts, drug labels, and medical literature for more information. In some situations, pediatricians may need to prescribe certain medications “off label” for important illnesses. A drug’s off-label status does not imply an improper or experimental use. The decision to prescribe these medications off label should be based on expert opinion or evidence for the medication’s use in a different population. The reader is referred to the AAP policy statement “Off-Label Use of Drugs in Children”⁹ and the US Food and Drug Administration (FDA) for changes in pediatric labeling of drugs.⁷

The information in this document is based on literature review and consensus opinion. References for individual drug indications and

dosing are provided. Dosing should be individualized, taking into account the patient’s weight in kilograms, medical illness, age, concurrently administered drugs, and drug hypersensitivity history. Within each table, the drugs are listed alphabetically and not by importance of use. The selection of a particular drug may depend on practice variability and drug availability (ie, hospital formulary or drug shortages).

The committees recommend the use of current *Advanced Pediatric Life Support*¹⁰ and *Pediatric Advanced Life Support*¹¹ textbooks, updated American Heart Association guidelines,¹²⁻¹⁴ and additional references for more detailed information on pediatric resuscitation algorithms, rapid-sequence intubation (RSI), procedural sedation,¹⁵ and medical management in disasters.^{16,17} In addition, the reader is referred to published treatment guidelines¹⁸; clinical reports, technical reports, and policy statements¹⁹⁻³¹; and consensus opinion.³² Practitioners should consult the *Textbook of Neonatal Resuscitation* and updated American Heart Association guidelines for detailed information concerning the management of neonatal emergencies and appropriate drugs, dosages, and routes of administration.³³ The Neonatal Resuscitation Program is focused on care of the newly born infant, and there is no clear evidence to guide when it is appropriate to use *Advanced Pediatric Life Support* guidelines in the care of an infant. General recommendations are currently to decide which drug to use on the basis of the likely etiology of the problem. The use of preprinted weight-based medication cards and/or length-based resuscitation tapes³⁴ is recommended when treating an emergency regardless of location (prehospital, ED, hospital ward, outpatient, or community clinic).

Note that doses listed are not comprehensive, and variations in dosing may be indicated for specific patients and/or clinical situations.

LEAD AUTHORS

Rohit Sheno, MD, FAAP
Nathan Timm, MD, FAAP

COMMITTEE ON DRUGS, 2016–2019

Bridgette Jones, MD, FAAP, Chairperson
Kathleen Neville, MD, MS, MBA, FAAP, Past Chairperson
Jennifer Foster, MD, FAAP
Connie Houck, MD, FAAP
Matthew Laughon, MD, FAAP
Ian Paul, MD, FAAP
Routt J. Reigart, MD, FAAP
Rohit Sheno, MD, FAAP
Janice Sullivan, MD, FAAP
John van den Anker, MD, PhD, FAAP

LIAISONS

John J. Alexander, MD, MPH, FAAP – *Food and Drug Administration*
Janet D. Cragan, MD, MPH, FAAP – *Centers for Disease Control and Prevention*
Angela Gantt, MD – *American College of Obstetricians and Gynecologists*
Phillip Heine, MD – *American College of Obstetricians and Gynecologists*
Michael Rieder, MD, FAAP – *Canadian Paediatric Society*
Adelaide Robb, MD – *American Academy of Child and Adolescent Psychiatry*
Hari Sachs, MD, FAAP – *Food and Drug Administration*
Geert W. 't Jong, MD, PhD – *Canadian Paediatric Society*

Timothy Wilens, MD – *American Academy of Child and Adolescent Psychiatry*
Anne Zajicek, MD, PharmD, FAAP – *National Institutes of Health*
Perdita Taylor-Zapata, MD – *National Institutes of Health*

STAFF

Raymond J. Koterak, MHA
James Baumberger
Tamar Margarik Haro

COMMITTEE ON PEDIATRIC EMERGENCY MEDICINE, 2016–2019

Joseph Wright, MD, MPH, FAAP, Chairperson
Terry Adirim, MD, MPH, FAAP
James Callahan, MD, FAAP
Michael Agus, MD, FAAP
Javier Gonzalez del Rey, MD, MEd, FAAP
Toni Gross, MD, MPH, FAAP
Madeline Joseph, MD, FAAP
Natalie Lane, MD, FAAP
Lois Lee, MD, MPH, FAAP
Elizabeth Mack, MD, FAAP
Prashant Mahajan, MD, MPH, MBA, FAAP
Jennifer Marin, MD, FAAP
Suzan Mazor, MD, FAAP
Nathan Timm, MD, FAAP

LIAISONS

Elizabeth Edgerton, MD, MPH, FAAP – *US Department of Health and Human Services, Maternal and Child Health Bureau*
Andrew Eisenberg, MD, MHA – *American Academy of Family Physicians*
Mary Fallat, MD, FAAP – *American College of Surgeons and American Academy of Pediatrics Section on Surgery*

Marianne Gausche-Hill, MD, FAAP – *National Pediatric Readiness Project*
Cynthia Lightfoot – *Family Partnerships Network*
Charles Macias, MD, MPH, FAAP – *Emergency Medical Services for Children Innovation and Improvement Center*
Brian Moore, MD, FAAP – *National Association of EMS Physicians*
Diane Pilkey, RN, MPH – *US Department of Health and Human Services, Maternal and Child Health Bureau*
Katherine Remick, MD, FAAP – *National Association of Emergency Medical Technicians*
Mohsen Saidinejad, MD, MBA, FAAP – *American College of Emergency Physicians*
Sally Snow, RN, BSN – *Emergency Nurses Association*
David Tuggle, MD, FAAP – *American College of Surgeons and American Academy of Pediatrics Section on Surgery*
Cynthia Wright-Johnson, MSN, RNC – *National Association of State EMS Officials*

STAFF

Sue Tellez

ABBREVIATIONS

AAP: American Academy of Pediatrics
ED: emergency department
EMS: emergency medical services
ET: endotracheal tube
FDA: Food and Drug Administration
IV: intravenous
RSI: rapid-sequence intubation

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

REFERENCES

1. Cottrell EK, O'Brien K, Curry M, et al. Understanding safety in prehospital emergency medical services for children. *Prehosp Emerg Care*. 2014;18(3):350–358
2. Schappert SM, Bhuiya F. Availability of pediatric services and equipment in emergency departments: United States, 2006. *Natl Health Stat Rep*. 2012;(47):1–21
3. Pendleton AL, Stevenson MD. Outpatient emergency preparedness: a survey of pediatricians. *Pediatr Emerg Care*. 2015;31(7):493–495
4. Santillanes G, Gausche-Hill M, Sosa B. Preparedness of selected pediatric offices to respond to critical emergencies in children. *Pediatr Emerg Care*. 2006;22(11):694–698
5. American Academy of Pediatrics. In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. *Red Book: 2018 Report of the Committee on Infectious Diseases*, 31st ed. Itasca, IL: American Academy of Pediatrics; 2018
6. Benjamin L, Frush K, Shaw K, Shook JE, Snow SK; American Academy of Pediatrics Committee on Pediatric Emergency Medicine; American College of Emergency Physicians

- Pediatric Emergency Medicine Committee; Emergency Nurses Association Pediatric Emergency Medicine Committee. Pediatric medication safety in the emergency department. *Pediatrics*. 2018;141(3):e20174066
7. US Food and Drug Administration. New pediatric labeling information database. Available at: <http://www.accessdata.fda.gov/scripts/sda/sdNavigation.cfm?sd=labelingdatabase>. Accessed May 18, 2017
 8. Smith MC, Williamson J, Yaster M, Boyd GJC, Heitmiller ES. Off-label use of medications in children undergoing sedation and anesthesia. *Anesth Analg*. 2012;115(5):1148–1154
 9. Frattarelli DA, Galinkin JL, Green TP, et al; American Academy of Pediatrics Committee on Drugs. Off-label use of drugs in children. *Pediatrics*. 2014;133(3):563–567
 10. American Academy of Pediatrics, American College of Emergency Physicians. In: Fuchs S, Yamamoto L, eds. *The Pediatric Emergency Medicine Resource*, 5th ed. Burlington, MA: Jones and Bartlett Learning; 2012
 11. American Heart Association, Subcommittee on Pediatric Resuscitation. *PALS (Pediatric Advanced Life Support) Provider Manual*. Dallas, TX: American Heart Association; 2011
 12. de Caen AR, Berg MD, Chameides L, et al. Part 12: pediatric advanced life support: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2015;132(18, suppl 2):S526–S542
 13. Maconochie IK, de Caen AR, Aickin R, et al; Pediatric Basic Life Support and Pediatric Advanced Life Support Chapter Collaborators. Part 6: pediatric basic life support and Pediatric Advanced Life Support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation*. 2015;95:e147–e168
 14. Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: pediatric advanced life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010;122(18, suppl 3):S876–S908
 15. Coté CJ, Wilson S; American Academy of Pediatrics; American Academy of Pediatric Dentistry. Guidelines for monitoring and management of pediatric patients before, during, and after sedation for diagnostic and therapeutic procedures: update 2016. *Pediatrics*. 2016;138(1):e20161212
 16. Disaster Preparedness Advisory Council. Medical countermeasures for children in public health emergencies, disasters, or terrorism. *Pediatrics*. 2016;137(2):e20154273
 17. Foltin GL. Pediatric Terrorism and Disaster Preparedness Resource (PTDPR). Available at: <http://slideplayer.com/slide/6305475/>. Accessed April 28, 2017
 18. National Asthma Education and Prevention Program. *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. Publication 08-5846*. Bethesda, MD: National Institutes of Health, National Heart, Lung and Blood Institute; 2007
 19. Frush K; American Academy of Pediatrics Committee on Pediatric Emergency Medicine. Preparation for emergencies in the offices of pediatricians and pediatric primary care providers. *Pediatrics*. 2007;120(1):200–212
 20. Puopolo KM, Benitz WE, Zaoutis TE; Committee on Fetus and Newborn; Committee on Infectious Diseases. Management of neonates born at ≤ 34 6/7 weeks' gestation with suspected or proven early-onset bacterial sepsis. *Pediatrics*. 2018;142(6):e20182896
 21. Puopolo KM, Benitz WE, Zaoutis TE; Committee on Fetus and Newborn; Committee on Infectious Diseases. Management of neonates born at ≥ 35 0/7 weeks' gestation with suspected or proven early-onset bacterial sepsis. *Pediatrics*. 2018;142(6):e20182894
 22. Sullivan JE, Farrar HC; Section on Clinical Pharmacology and Therapeutics, Committee on Drugs. Fever and antipyretic use in children. *Pediatrics*. 2011;127(3):580–587
 23. Chun TH, Mace SE, Katz ER; American Academy of Pediatrics; Committee on Pediatric Emergency Medicine; American College of Emergency Physicians; Pediatric Emergency Medicine Committee. Executive summary: evaluation and management of children and adolescents with acute mental health or behavioral problems. Part I: common clinical challenges of patients with mental health and/or behavioral emergencies. *Pediatrics*. 2016;138(3):e20161571
 24. Bradley JS, Peacock G, Krug SE, et al; AAP Committee on Infectious Diseases and Disaster Preparedness Advisory Council. Pediatric anthrax clinical management. *Pediatrics*. 2014;133(5). Available at: www.pediatrics.org/cgi/content/full/133/5/e1411
 25. Crawford-Jakubiak JE, Alderman EM, Leventhal JM; Committee on Child Abuse and Neglect; Committee on Adolescence. Care of the adolescent after an acute sexual assault. *Pediatrics*. 2017;139(3):e20164243
 26. Workowski KA, Bolan GA; Centers for Disease Control and Prevention. Sexually transmitted diseases treatment guidelines, 2015. *MMWR Recomm Rep*. 2015;64(RR-03):1–137
 27. Bradley JS, Byington CL, Shah SS, et al. The management of community-acquired pneumonia in infants and children older than 3 months of age: clinical practice guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. *Clin Infect Dis*. 2011;53(7):e1–e52
 28. Fein JA, Zempsky WT, Cravero JP; American Academy of Pediatrics; Committee on Pediatric Emergency Medicine, Section on Anesthesiology and Pain Medicine. Relief of pain and anxiety in pediatric patients in emergency medical systems. *Pediatrics*. 2012;130(5). Available at: www.pediatrics.org/cgi/content/full/130/5/e1391
 29. Yamamoto LG, Manzi S; Committee on Pediatric Emergency Medicine. Dispensing medications at the

- hospital upon discharge from an emergency department. *Pediatrics*. 2012;129(2). Available at: www.pediatrics.org/cgi/content/full/129/2/e562
30. Rogers JJ; American College of Emergency Physicians. Policy compendium 2016 edition. Available at: <https://www.acep.org/search.aspx?searchtext=policy%20compendium>. Accessed August 15, 2016
 31. Ralston SL, Lieberthal AS, Meissner HC, et al; American Academy of Pediatrics. Clinical practice guideline: the diagnosis, management, and prevention of bronchiolitis. *Pediatrics*. 2014;134(5). Available at: www.pediatrics.org/cgi/content/full/134/5/e1474
 32. Dart RC, Goldfrank LR, Erstad BL, et al. Expert consensus guidelines for stocking of antidotes in hospitals that provide emergency care. *Ann Emerg Med*. 2018;71(3):314–325.e1
 33. Wyckoff MH, Aziz K, Escobedo MB, et al. Part 13: neonatal resuscitation: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2015;132(18, suppl 2):S543–S560
 34. Resources for Management of Circulatory Emergencies. *Pediatric Advanced Life Support (PALS) Provider Manual*. Dallas, TX: American Heart Association. Elk Grove Village, IL: American Academy of Pediatrics; 2016:237–238