PEDIATRIC INJECTABLE DRUGS

PEDIATRIC INJECTABLE DRUGS

The Teddy Bear Book

12th Edition

STEPHANIE J. PHELPS, BScPharm, PharmD, FAPhA, FCCP, FNAP, FPPA

Professor Emeritus
Clinical Pharmacy and Translational Sciences and Pediatrics
The University of Tennessee Health Science Center
Colleges of Pharmacy and Medicine
Memphis, Tennessee

TRACY M. HAGEMANN, PharmD, MS, FCCP, FPPA

Professor & Associate Dean
Clinical Pharmacy and Translational Sciences
The University of Tennessee Health Science Center
College of Pharmacy
Nashville, Tennessee

KELLEY R. LEE, PharmD, BCPS AQ-ID

Clinical Pharmacy Specialist—Antimicrobial Stewardship
Le Bonheur Children's Hospital &
Professor
The University of Tennessee Health Science Center
College of Pharmacy
Memphis, Tennessee

ashp®

Any correspondence regarding this publication should be sent to the publisher, American Society of Health-System Pharmacists, 4500 East-West Highway, suite 900, Bethesda, MD 20814, attention: Special Publishing.

The information presented herein reflects the opinions of the contributors and advisors. It should not be interpreted as an official policy of ASHP or as an endorsement of any product.

Because of ongoing research and improvements in technology, the information and its applications contained in this text are constantly evolving and are subject to the professional judgment and interpretation of the practitioner due to the uniqueness of a clinical situation. The editors and ASHP have made reasonable efforts to ensure the accuracy and appropriateness of the information presented in this document. However, any user of this information is advised that the editors and ASHP are not responsible for the continued currency of the information, for any errors or omissions, and/or for any consequences arising from the use of the information in the document in any and all practice settings. Any reader of this document is cautioned that ASHP makes no representation, guarantee, or warranty, express or implied, as to the accuracy and appropriateness of the information contained in this document and specifically disclaims any liability to any party for the accuracy and/or completeness of the material or for any damages arising out of the use or non-use of any of the information contained in this document.

Senior Vice President, Professional Development and Publishing Office: Daniel J. Cobaugh, PharmD, DABAT, FAACT

Editorial Director, Special Publishing: Ryan E. Owens, PharmD, BCPS

Editorial Coordinator, Special Publishing: Güneş Turhanlı, MA

Director, Production and Platform Services, Publishing Operations: Johnna M. Hershey, BA

Cover Design: DeVall Advertising

Page Design: DeVall Advertising

ISSN 2164-0432 (Online)
ISSN 2998-7865 (Print)

Print ISBN: 978-1-58528-718-5

PDF ISBN: 978-1-58528-719-2

ePub ISBN: 978-1-58528-720-8

DOI: 10.37573/9781585287192

10 9 8 7 6 5 4 3 2 1

DEDICATION

This edition is dedicated to those neonates, infants, children, and adolescents who we have been privileged to serve across our collective 107 years of practice. We have devoted our careers to ensuring these individuals receive the safest and most effective medications available. We have been fortunate to practice in institutions that value interprofessional care and we are grateful to our colleagues who freely shared their wisdom and experiences. We would be remiss to not thank our various local pharmacy families, including our residents and fellows. What we learned from you informed the practitioners we became, and we have been blessed to call you colleagues.

Stephanie J. Phelps
Tracy M. Hagemann
Kelley R. Lee

TABLE OF CONTENTS

DOI 10.37573/9781585287192.FM

ABOUT THE AUTHORS

STEPHANIE J. PHELPS, PharmD, FAPhA, FCCP, FNAP, FPPA, received her baccalaureate pharmacy degree from Samford University and a doctor of pharmacy degree from The University of Tennessee Health Science Center (UTHSC), Memphis, TN. She subsequently completed postdoctoral training in pediatrics at Le Bonheur Children's Medical Center and UTHSC. Dr. Phelps is currently a Professor Emeritus of Clinical Pharmacy and Translational Science and Pediatrics at UTHSC. She is an elected Fellow of the American College of Clinical Pharmacy (ACCP), the American Pharmacists Association (APhA), the National Academies of Practice (NAP), and the Pediatric Pharmacy Association (PPA). Dr. Phelps has held elected offices in AACP, ASHP, and NAP and has served on the Board of Directors of the American Society of Parenteral and Enteral Nutrition and the PPA. She is a past chair of the Pharmacy Academy of the National Academies of Practice. She has received several awards including the APhA Academy of Student Pharmacists (ASP) Outstanding Chapter Advisor Award, the 2016 APhA Linwood F. Tice Friend of APhA–ASP Award, the 2009 Tennessee Society of Hospital Pharmacy's Distinguished Service Award, the 2011 Helms Award for Excellence in Pediatric Pharmacy Practice from PPAG, the 2013 ACCP Education Award, and the 2020 Piocoro Pioneer in Pediatric Pharmacy Award from the University of Kentucky. During her career, she has participated in the education of five postdoctoral fellows and over 70 pediatric pharmacy residents. She served as editor-in-chief of the *Journal of Pediatric Pharmacology and Therapeutics* for almost two decades and has published numerous manuscripts, book chapters, and reviews that focus on pediatric pharmacotherapy.

TRACY M. HAGEMANN, PharmD, MS, FCCP, FPPA, received her doctor of pharmacy degree from the University of Missouri–Kansas City School of Pharmacy. She completed a pharmacy practice residency at the Regional Medical Center in Memphis, TN, followed by a pediatric specialty residency at the University of Oklahoma and Children's Hospital at OU Medical Center in Oklahoma City, OK. Dr. Hagemann is currently Professor and Associate Dean at The University of Tennessee College of Pharmacy, Nashville Campus. Previously, she was faculty at The University of Oklahoma College of Pharmacy, with an active practice in pediatric hematology and oncology at The Children's Hospital at OU Medical Center. Her focus of practice and research is in pediatric hematology and oncology. She is an elected fellow of both the American College of Clinical Pharmacy (ACCP) and the Pediatric Pharmacy Association (PPA). She is an active member of various national pharmacy organizations and has held elected offices at PPA and ACCP, as well as the Oklahoma Society of Health-System Pharmacists. Dr. Hagemann has published book chapters in pediatric sickle cell disease, and her teaching and research have resulted in the publication of over 70 peer-reviewed journal articles and over 100 scientific abstracts.

KELLEY R. LEE, PharmD, BCPS, received her doctor of pharmacy degree from The University of Tennessee Health Science Center (UTHSC). She completed a two-year residency in pediatric pharmacotherapy at Le Bonheur Children's Hospital and UTHSC. After residency training, Dr. Lee served as a Clinical Pharmacy Specialist and then the Clinical Pharmacy Manager at Le Bonheur Children's Hospital and part-time Professor of Clinical Pharmacy at UTHSC. She now focuses on infectious diseases and is currently a Clinical Pharmacy Specialist in Antimicrobial Stewardship at Le Bonheur Children's Hospital. Her practice and research interests have primarily been the appropriate use of medications in pediatric patients, particularly with the use of antibiotics. Dr. Lee has participated in training pediatric pharmacy residents throughout her career and has recently helped establish a pediatric infectious diseases residency program and helped create an antibiotic stewardship rotation for Pediatric Infectious Diseases Fellows. In addition to serving as both an author and a contributing writer for several editions of this book, she has published numerous manuscripts, abstracts, and letters-to-the-editor on pediatrics.

DOI 10.37573/9781585287192.FM

PREFACE

Pediatric patients have been considered "therapeutic orphans" since Dr. Harry Shirkey first used the term in the 1960s. Since that time, the Pediatric Research Equity Act, the Best Pharmaceuticals for Children Act, and the Pediatric Rule have greatly improved the labeling of new drugs for children. But pediatric-specific information continues to be lacking in older drugs, some of which are commonly used. And, we still frequently encounter dilemmas in medication use in children, particularly in our youngest populations. The FDA reports that, of the 1043 drugs labeled for use in pediatrics, only 57 have been studied in neonates. The "gold standard" of randomized clinical trials in the pediatric population are still often not available, so we must rely on evidence from adult trials, expert opinions, and case reports. Often there is little to no published information with which to guide drug therapy.

The vast majority of medications continue to be used off-label in children. Off-label use does not necessarily imply that use of the drugs in this population is improper, or that there is no evidence to support administration to children. Rather, it means that either the available evidence has not met regulatory standards for FDA approval or that evidence for safety and efficacy in pediatrics has not been submitted to the FDA for review.

The 12th edition of *Pediatric Injectable Drugs: The Teddy Bear Book* has been revised to include over 270 parenteral medications. Forty one new monographs, some of which are recently marketed drugs, have been added since the 11th edition. Previously published monographs have been extensively reviewed and updated to include the most recent literature available. This new edition has been reformatted to standardize the locations of information to increase ease of use. Additional information on conditions requiring dosage adjustment (ECMO, obesity, renal dysfunction, etc.) has been provided when available. Information included in this text was compiled from the primary literature including case reports, observational reports, and comparative trials. Evidence-based guidelines and recommendations from authoritative national and international organizations were included when available. Limited information exists for some of the frequently used older drugs, in which case recommendations may come from textbooks. Importantly, the references allow readers to access the sources of all information provided and make independent decisions related to their specific patients. Review of the published evidence and consideration for the likely benefit to our individual patients should always guide decisions for our patients. All doses and dosage calculations were verified for accuracy by an independent, third-party pharmacist. Some references from previous editions have been removed from this edition. The reference numbers are not sequential on monographs where this is applicable.

Pediatric Injectable Drugs: The Teddy Bear Book is also available as an eBook. The eBook version is available through ASHP (store.ashp.org), Amazon, and other retailers.

We hope this text will help decrease your pediatric medication dilemmas and provide you the confidence to safely and effectively use medications in pediatric patients of all ages. And we ultimately hope this text will improve the lives of our "therapeutic orphans."

Stephanie J. Phelps
Tracy M. Hagemann
Kelley R. Lee
2024

DOI 10.37573/9781585287192.FM

INTRODUCTION

This 12th edition of ASHP's *Pediatric Injectable Drugs* was developed to provide a single source of information regarding the safe and effective use of parenteral medications in the pediatric population. Each monograph includes data that were derived from prescribing information, available guidelines, organizational recommendations, and primary literature available at the time the monograph was written. New section headings, along with specific subheadings, have been added and are strategically placed within each monograph to enhance accessibility. The manufacturer's labeling and specialized references have been used in making recommendations. References that support information contained in the text are located at the end of each monograph.

The table below highlights the various section headings and subheadings that were evaluated for each monograph. Background information has been added to describe what type of information appears in each section, and additional explanations have been included regarding the impact of specific subheadings on medication therapy. While all section headings appear in each monograph, subheadings may vary depending on the drug and clinical information available.

All recommendations should be individualized in accordance with the clinical situation for a specific patient and within the confines of institutional requirements and protocols.

	Section Headings	Section Subheadings
1	**Pronunciation**	Pronunciations included are based on the *USP Dictionary of United States Adopted Names (USAN) and International Drug Names*.
2	**Drug Names**	Common U.S. brand names and, if applicable, other names (synonyms) are listed.
3	**Safety Issues**	**High-alert Medication:** If the drug was included in the ISMP's List of High-Alert Medications, it will be noted. **Look-alike, Sound-alike Drug Names:** ISMP's List of Confused Drug Names or the USP's Findings of Look-alike and/or Sound-alike Drug Errors are noted in this section. **Tall Man Lettering:** FDA and ISMP's recommendations are included in this section. **KIDs List:** The section highlights any drug or formulation issues noted in the list that are considered potentially inappropriate for prescribing in all or a select subgroup of pediatric patients. **ASHP Safety Standard:** The document is used if there is a national standardized concentration for IV medications in hospitals. This section also highlights recommended dosing units and potential for dose and concentration mismatch. **Other:** This section may include drug or formulation information not listed above that may contribute to medication errors and/or safe use of the medication in pediatric patients.
4	**Therapeutic and Pharmacologic Categories**	This section is based on information included in the AHFS Pharmacologic-Therapeutic Classification System. AHFS classifications may change as drug assignments are regularly updated; please visit the following website for the latest information: https://ahfsdruginformation.com/ahfs-classification-drug-assignments/
5	**Contraindications and Warnings**	Although information included in this section is derived from prescribing information at the time the monographs were written, it is recommended that current product labeling be reviewed. When possible, the section has been tailored to include information pertinent to pediatric patients. **U.S. Boxed Warnings:** This section notes information that is required by the U.S. FDA for certain medications that carry serious safety risks. Often these warnings communicate rare but potential adverse effects causing significant harm, or they may be used to communicate important instructions for safe use of the drug. **Contraindications:** This section describes contraindications applicable to pediatric patients. While it may be noted in the monographs, it is understood that a drug would generally be contraindicated in a patient who has experienced a prior anaphylaxis or type I hypersensitivity reaction. Not all contraindications are absolute; hence, use in specific conditions/diseases should be guided by a consideration of risk versus benefit.

DOI 10.37573/9781585287192.FM

	Contraindications and Warnings (*continued*)	**Warnings:** This section describes warnings deemed noteworthy or applicable to pediatric patients and may not be the complete list of warnings included in the manufacturer's labeling. **Additive Alert:** This section does not contain all additives that are included as a component of a parenteral formulation but highlights those possessing the potential for toxicity or adverse effects. Many of these effects are unique to pediatric patients, especially neonates. Components of a formulation may be specific to a particular brand, therefore the reader should review the specific product used in their respective institution. Appendix C contains specific information, including management when applicable, on common additives with a potential for toxicity or adverse effects.
6	**Dosage**	Unless otherwise noted, age groups used to define dosing are as follows: **Neonates:** Up to 1 month of age (specific dosing for premature neonates was included when available). **Infants:** > 1–24 months **Children:** > 2–12 years **Adolescents:** > 12–18 years **Adults:** When applicable, dosing is also provided. It may be noted when these groups are defined by other age ranges. While these age groups provide general guidelines for therapy in pediatric patients, it should be noted that changes in development, which affect drug pharmacokinetics and pharmacodynamics and, hence, dosing recommendations, are not confined to the limits of these defined age groups. When indicated, dosages may be presented irrespective of age group. When administered via continuous infusion, dosing units recommended in the ASHP Safety Standard are usually applied. Dosage is often expressed as *X* mg/kg/day or mg/m^2/day divided q *Y–Z* hr, where the total daily dose *(X)* is given in equally divided doses at evenly spaced intervals. A calculation of BSA as determined from height and mass can be found in Appendix A.
7	**Maximum Dosage**	Maximum dosages may appear for a single dose or dosage per day or may be presented as a total cumulative dose. However, maximum dosages for pediatric patients are often extrapolated from adult data because of a lack of documented experience with pediatric patients. Many manufacturers caution against exceeding the maximum recommended adult dosage (usually expressed as *X* g/day) in pediatric patients. In this reference, when the maximum dosage is expressed as "mg/kg/day, NTE *X* g/day," "*X* g/day" is typically the manufacturer's maximum recommended adult dosage and should be used only as a usual upper limit for pediatric dosing. It should not be inferred that use of these maximum dosages in pediatric patients is recommended and without risk of toxicity. Likewise, there may be clinically acceptable times when the usual upper limit may be exceeded. The user should consult the references indicated for use of these maximum dosages in the pediatric population.
8	**Conditions Requiring Dosage Adjustments**	**ECMO:** Significant known interactions between drug and the ECMO circuit may result in drug binding and decrease availability of drug to systemic circulation. Likewise, known ECMO-associated alterations in the pharmacokinetics of a drug within the context of critical illness may occur. Both may necessitate dosage adjustment. **Hepatic Dysfunction:** Information on required dosage adjustment due to altered metabolism of the parent compound, a metabolite, or accumulation of a toxic metabolite is noted. The need for serum drug concentration monitoring is noted as indicated. **Hypothermia:** Therapeutic hypothermia may impact the pharmacokinetic and pharmacodynamic parameters of certain medications by altering hepatic or renal blood flow and influencing specific hepatic metabolic pathways through decreased isozyme or transporter activity.

	Conditions Requiring Dosage Adjustments (*continued*)	**Renal Dysfunction:** Information regarding dosage adjustment due to decreased renal function or altered protein binding is noted (this also applies to some components of a product formulation). Information regarding the impact of intermittent HD or HD and CRRT may be provided if available. The need for serum drug concentration monitoring is noted as indicated. **Obesity:** The presence of obesity may require the practitioner to estimate ideal body mass/weight and calculate an adjusted weight for the dosing of some medications. Appendix B provides a nomogram for estimating total body mass/weight. **Other:** When appropriate, the impact of other disease on the need for dosage adjustment is noted.
9	**Drug Interactions**	Clinically important drug–drug interactions may necessitate avoidance of the medication or a change in dose or interval to ensure efficacy or prevent toxicity. Available information related to significant pharmacokinetic- and pharmacodynamic-based interactions may be noted; however, all known interactions are not listed. Pertinent data regarding protein binding, enzymatic substrate, and possible inhibition and induction may be included. Users are advised to check current available literature for information on specific interactions, including the need for appropriate monitoring.
10	**Preparation and Compatibility**	Parenteral products should be visually inspected for particulate matter and discoloration before use. Use only a solution that is free from haziness or precipitant. Refer to appropriate references for more information on nontraditional storage and extended stability. *It is recommended to review the current information for products used in your institution because a variety of products from different manufacturers may be available.* Specialized references (eg, ASHP Injectable Drug Information. Bethesda, MD: American Society of Health-System Pharmacists; 2023) should be consulted for specific information. **Stability:** Drug stability in some IV solutions is limited by storage conditions, lack of a preservative, changes in temperature, or exposure to light. This will be noted when applicable. **Excursion:** Some drugs may be temporarily stored outside of usual conditions (eg, EMS transport). Degradation of drug may occur as a function of temperature exposure and storage time. Manufacturer labeling and specialized references are used in making recommendations. **Maximum Concentration:** Generally, any concentration up to the maximum may be administered, taking into consideration the patient's fluid status (and potential for loss of vascular access), administration method (IV push versus intermittent infusion), IV site (PVL or CVL), drug administration rate (and drug administration device flow rate range, if applicable), dose (and degree of accuracy required in dose measurement), and drug stability. Some drugs should not be diluted, which may be noted. For drugs available as solutions, the maximum concentration may be the commercially available product. For drugs that must be reconstituted prior to administration, the maximum concentration should serve as a guide for the minimum dilution required. Concentrations listed are referenced to literature on drug use in pediatric patients to the extent possible. However, concentrations administered to adults are cited where documentation on use in pediatric patients is insufficient. **Compatibility:** If a drug can be mixed or diluted with a fluid, the appropriate fluids may be listed. Incompatible solutions are not listed. Generally, compatible and incompatible drugs are NOT listed. For more detailed information, the reader should refer to a compatibility resource, such as *ASHP Injectable Drug Information*. **Photosensitivity:** Significant degradation and loss of activity can occur when some drugs are exposed to light. Recommendations regarding the "best" approach to protect from light may be provided if available. **Delivery System Issues:** At times, a drug may interact with select components of the delivery systems to cause subsequent loss of drug that is available for delivery. **Filter:** Select medications must be filtered. Likewise, filtration is contraindicated with some medications. The manufacturer's labeling and specialized references are used in making recommendations regarding in-line filters.

11	**Infusion-related Cautions**	**Restriction to Use Based on Patient Location:** This section highlights the requirement for specialized education in the administration and monitoring of a medication. It notes facility requirements for monitoring (eg, ECG, EEG) or management of adverse drug effect (eg, anaphylaxis). If the administration of the drug requires availability of another drug (ie, to have on hand), information regarding the additional medications may be provided in this section. The user should follow all institutional requirements and protocols concerning drug use. **Concerns During Administration:** Warnings regarding "anticipated" adverse drug effect and/or specific monitoring are noted where appropriate. These warnings generally relate to events that might occur early during administration or may relate to rate of administration. The section also includes recommendations for preferred route of delivery (PVL versus CVL; IV versus IM). Drugs carrying an increased risk of pain at the injection site, thrombophlebitis, and/or infiltration/extravasation are highlighted. Appendix D provides information regarding extravasation treatment.
12	**Administration**	**Maximum Rate of Administration:** This rate is generally expressed as the quantity of drug per unit of time. **IV Push:** This rate is generally expressed as the period of time over which the dose should be administered (seconds or minutes). For the purpose of this text, IV push is defined as administration of a dose over < 5 minutes. Drugs for which IV push administration is contraindicated may be noted. **Intermittent Infusion:** The recommended infusion rate is expressed as the period of time over which the dose should be administered (minutes to hours). **Continuous Infusion:** The recommended infusion rate is usually expressed as a quantity of drug per unit of time. The infusion is generally continued for 24 hours or until the desired therapeutic endpoint is achieved or limitations in cumulative dosage are reached. **Other Routes of IV Product Use:** Information in this section is specific to the administration of the parenteral product by non-IV routes, which generally include the ET, IM, IN, IO, and/or SubQ routes.
13	**Adverse Drug Effects**	This section highlights what most consider *significant* ADRs that might occur in the pediatric population regardless of frequency or occurrence and are generally presented by organ system affected. Not all known adverse effects are listed. Adverse effects related to the parent drug, active metabolites, or formulation additives are noted as appropriate.
14	**Monitoring**	This section does not include all items that should be monitored but highlights unique needs for monitoring. In addition to vital signs and laboratory monitoring, this section may include specific items important to efficacy and assessment of toxicity. Monitoring of serum drug concentrations and genetic testing may be recommended as appropriate. The possibility of a parent drug or metabolite causing laboratory interference may also be noted.
15	**Additional Comments**	Miscellaneous information may be included when pertinent.

ABBREVIATIONS

Solutions:

BW	bacteriostatic water for injection
D-LR	dextrose—Ringer's injection, lactated, combinations
D-R	dextrose—Ringer's injection combinations
D-S	dextrose—saline combinations
D-SL	dextrose—sodium lactate
D10NS	dextrose 10% in sodium chloride 0.9%
D10W	dextrose 10% in water
D15W	dextrose 15% in water
D20W	dextrose 20% in water
D2.5W	dextrose 2.5% in water
D2.5½NS	dextrose 2.5% in sodium chloride 0.45%
D5LR	dextrose 5% in Ringer's injection, lactated
D5NS	dextrose 5% in sodium chloride 0.9%
D5¼NS	dextrose 5% in sodium chloride 0.225%
D5⅓NS	dextrose 5% in sodium chloride 0.3%
D5½NS	dextrose 5% in sodium chloride 0.45%
D5R	dextrose 5% in Ringer's injection
D5W	dextrose 5% in water
LR	Ringer's injection, lactated
NS	sodium chloride 0.9% (normal saline)
¼NS	sodium chloride 0.225% (¼ normal saline)
⅓NS	sodium chloride 0.3% (⅓ normal saline)
½NS	sodium chloride 0.45% (½ normal saline)
R	Ringer's injection
SW	sterile water for injection

Terms:

AAP	American Academy of Pediatrics
ABW	actual body weight
ACCP	American College of Clinical Pharmacy
ACIP	Advisory Committee on Immunization Practices
ACLS	advanced cardiovascular life support
ACT	activated clotting time
ACTH	adrenocorticotropic hormone
ADH	antidiuretic hormone
AHA	American Heart Association
AHF	antihemophilic factor
AIDS	acquired immunodeficiency syndrome
AKI	acute kidney injury
ALL	acute lymphocytic leukemia
ALT	alanine transaminase
AML	acute myeloid leukemia
ANA	antinuclear antibody
ANC	absolute neutrophil count
aPTT	activated partial thromboplastin time
ARDS	acute respiratory distress syndrome
ASM	antiseizure medication
ASPEN	American Society for Parenteral and Enteral Nutrition
AST	aspartate aminotransaminase
AUC	area under the curve
AV	atrioventricular
BG	blood glucose
BID	two times daily
BIS	bispectral index
BMI	body mass index
BMT	bone marrow transplant
BP	blood pressure
BPD	bronchopulmonary dysplasia
BPM	beats per minute
BSA	body surface area
BUN	blood urea nitrogen
CAPD	continuous ambulatory peritoneal dialysis
CBC	complete blood count
CDAD	*Clostridium difficile*–associated diarrhea
CDC	Centers for Disease Control and Prevention
CDH	congenital diaphragmatic hernia
CDP-1	crystalline degradation product
CF	cystic fibrosis
CHD	congenital heart disease
CHF	congestive heart failure
CI	cardiac index
CINV	chemotherapy-induced nausea and vomiting
CLD	chronic lung disease
CML	chronic myelogenous leukemia
CMV	cytomegalovirus
CNS	central nervous system
CO	cardiac output
CPB	cardiopulmonary bypass
CPK	creatine phosphokinase
CPK-MB	creatine phosphokinase MB isoenzyme
CPR	cardiopulmonary resuscitation
CrCl	creatinine clearance

DOI 10.37573/9781585287192.FM

CRRT	continuous renal replacement therapy
CSF	cerebral spinal fluid
CT	computerized tomography
CVC	central venous catheter
CVL	central venous line
CVVH	continuous venovenous hemofiltration
CYP	cytochrome P450
CYP1A2	cytochrome P450 isoenzyme 1A2
CYP2B6	cytochrome P450 isoenzyme 2B6
CYP2C19	cytochrome P450 isoenzyme 2C19
CYP2C9/10	cytochrome P450 isoenzymes 2C9 and 2C10
CYP2E1	cytochrome P450 isoenzyme 2E1
CYP3A3/4	cytochrome P450 isoenzymes 3A3 and 3A4
DEHP	diethylhexyl phthalate
DIC	disseminated intravascular coagulation
DKA	diabetic ketoacidosis
DRESS	drug reaction with eosinophilia and systemic symptoms
DVT	deep vein thrombosis
ECG	electrocardiogram
ECMO	extracorporeal membrane oxygenation
ED	emergency department
EDTA	ethylenediaminetetraacetic acid
EEG	electroencephalogram
eGFR	estimated glomerular filtration rate
EIA	enzyme immunoassay
ELBW	extremely low birth weight
EMIT	enzyme-multiplied immunoassay technique
ESA	erythropoiesis-stimulating agent
ESPGHAN	European Society for Paediatric Gastroenterology, Hepatology and Nutrition
ET	endotracheal
FAB	digoxin immune Fab (Fractionated Antibodies)
FDA	Food and Drug Administration
g	gram
GALD	gestational alloimmune liver disease
GCSF	granulocyte colony-stimulating factor
GERD	gastroesophageal reflux disease
GFR	glomerular filtration rate
GI	gastrointestinal
GM-CSF	granulocyte-macrophage colony-stimulating factor
GVHD	graft versus host disease
HACEK	*Haemophilus* species, *Aggregatibacter* species, *Cardiobacterium hominis*, *Eikenella corrodens*, and *Kingella* species
hCG	human chorionic gonadotropin
HCl	hydrochloride
Hct	hematocrit
HCV	hepatitis C virus
HD	hemodialysis
Hgb	hemoglobin
HHS	hyperosmolar hyperglycemic state
HHV	human herpes virus
HIB	*Haemophilus influenzae* type B
HIT	heparin-induced thrombocytopenia
HIV	human immunodeficiency virus
HLA	human leukocyte antigen
HPLC	high-performance liquid chromatography
hr	hour
HR	heart rate
hs-PDA	hemodynamically significant patent ductus arteriosus
HSCT	hematopoietic stem cell transplant
HSV	herpes simplex virus
HUS	hemolytic uremic syndrome
iNO	inhaled nitric oxide
IBW	ideal body weight
ICP	intracranial pressure
ICU	intensive care unit
IE	infective endocarditis
IgG	immunoglobulin G
IH	idiopathic hyperphosphatasia
IHD	intermittent hemodialysis
IM	intramuscular
INR	international normalized ratio
IO	intraosseous
IOP	intraocular pressure
IP	intraperitoneal
IQ	intelligence quotient
IS	International Standards
ISMP	Institute for Safe Medication Practices
IT	intrathecal
ITP	idiopathic thrombocytopenic purpura
IU	international unit
IV	intravenous
IVH	intraventricular hemorrhage
IVIG	intravenous immune globulin; intravenous immunoglobulin
IVR	in vivo recovery
JIA	juvenile idiopathic arthritis
KIDs	Key Potentially Inappropriate Drugs

LBM	lean body mass
LBW	lean body weight
LD	loading dose
LFT	liver function test
LGS	Lennox–Gastaut syndrome
MAD	Mucosal Atomization Device
MAO	monoamine oxidase
MAP	mean arterial pressure
MIC	minimum inhibitory concentration
min	minute
mo	month
MRI	magnetic resonance imaging
MRSA	methicillin-resistant *Staphylococcus aureus*
MTX	methotrexate
NAS	neonatal abstinence syndrome
NASPGHAN	North American Society for Pediatric Gastroenterology, Hepatology & Nutrition
NEC	necrotizing enterocolitis
NIH	National Institutes of Health
NMS	neuroleptic malignant syndrome
NMTT	*N*-methylthiotetrazole
nPEP	nonoccupational postexposure prophylaxis
NPO	nothing by mouth
NSAID	nonsteroidal anti-inflammatory drug
NTE	not to exceed
O_2	oxygen
OI	osteogenesis imperfecta
OTC	over-the-counter
PaO_2	arterial partial pressure of oxygen
PALS	pediatric advanced life support
PANDAS	pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections
PBPC	peripheral blood progenitor cell
PCA	patient-controlled analgesia; also postconceptional age
PCI	percutaneous coronary intervention
PD	peritoneal dialysis
PDA	patent ductus arteriosus
PE	phenytoin equivalent
PID	pelvic inflammatory disease
PJP	*Pneumocystis jiroveci* pneumonia
PMA	postmenstrual age
PN	parenteral nutrition
PNA	postnatal age
PO	by mouth
PONV	postoperative nausea and vomiting
PPA	Pediatric Pharmacy Association
PPHN	persistent pulmonary hypertension of the newborn
PPI	proton-pump inhibitor
PRIS	propofol-related infusion syndrome
PRN	pro re nata; as needed
PT	prothrombin time
PTH	parathyroid hormone
PVC	polyvinyl chloride
PVL	peripheral venous line
pVT	pulseless ventricular tachycardia
q	every
RASS	Richmond Agitation-Sedation Scale
RBC	red blood cell
RNA	ribonucleic acid
RR	respiratory rate
SA	sinoatrial
SBECD	sulfobutylether beta-cyclodextrin
SCr	serum creatinine
SE	status epilepticus
sec	second
SIADH	syndrome of inappropriate antidiuretic hormone
SIRS	systemic inflammatory response syndrome
SLE	systemic lupus erythematosus
SMA	spinal muscular atrophy
SNRI	serotonin and norepinephrine reuptake inhibitor
SOS	sinusoidal obstruction syndrome
SSRI	selective serotonin reuptake inhibitor
SubQ	subcutaneous
SVR	systemic vascular resistance
SVT	supraventricular tachycardia
TBW	total body weight
TCA	tricyclic antidepressant
TDD	total digitalizing dose
TID	three times daily
TNA	total nutrient admixture
TNF	tumor necrosis factor
TOF	train-of-four
TPN	total parenteral nutrition
TSH	thyroid-stimulating hormone
TTP	thrombotic thrombocytopenic purpura
UGT	uridine diphosphate–glucuronosyltransferase
UOP	urine output

USP	United States Pharmacopeia
VAD	ventricular assist device
VF	ventricular fibrillation
Vitamin B_{12}	cyanocobalamin
VLBW	very low birth weight
VT	ventricular tachycardia
VTE	venous thromboembolism
vWD	von Willebrand disease
VZV	varicella zoster virus
WBC	white blood cell
wk	week
WGA	weeks gestational age
WHO	World Health Organization
yr	year

REVIEWERS

We would like to recognize the following individuals for proofreading the final content before publication:

Bethany Baker, PharmD, MSHA
Director, Clinical Pharmacy Services
Children's Mercy Kansas City
Kansas City, MO

Jennifer Barnes, PharmD, BCPPS
Clinical Pharmacy Specialist, Neonatal Intensive Care
Levine Children's Hospital
Charlotte, NC

Amanda Capino, PharmD, BCPPS
Clinical Associate Professor
Marshall University School of Pharmacy
Huntington, WV

Michael L. Christensen, PharmD, BCNSP, FPPA, FASPEN
Professor Emeritus
Department of Clinical Pharmacy & Translational Science
The University of Tennessee Health Science Center
Memphis, TN

M. Petrea Cober, PharmD, BCNSP, BCPPS, FASPEN
Professor of Pharmacy Practice
Director of Workforce Development, Office of Student Success
Director of Professional Development, Office of Education
Northeast Ohio Medical University, College of Pharmacy
Rootstown, OH

Ashley Duty, PharmD, MS, BCSCP, FASHP
Director of Inpatient Pharmacy Operations
Nationwide Children's Hospital
Columbus, OH

J. Hunter Fly, PharmD
Assistant Professor
Department of Clinical Pharmacy & Translational Science
The University of Tennessee Health Science Center
Memphis, TN

Elizabeth A. Garcia, PharmD
Independent Consultant
Brooklyn, NY

Lauren Haney, PharmD, BCPS, BCPPS
Clinical Pharmacy Specialist
Medical University of South Carolina
Shawn Jenkins Children's Hospital
Charleston, SC

John Brock Harris, PharmD, BCPS, BCPPS, FCCP, FNCAP
Associate Professor of Pharmacy
Assistant Dean - Assessment and Accreditation
Wingate University School of Pharmacy
Wingate, NC

Sarrah M. Hein, PharmD, MBA, BCPPS
Pharmacy Manager
Akron Children's Hospital
Akron, OH

Allison King, PharmD, FASHP
Investigational Drug Pharmacist, PGY1 Residency Program Director
Children's Mercy Hospital
Kansas City, MO

Van Tran, PharmD, BCPPS, BCPS, MBA
Safety Evaluator, Pediatrics and Rare Diseases, DPV-I
US Food and Drug Administration
Silver Spring, MD
Clinical Pharmacy Specialist, Neonatal Intensive Care (NICU)
Inova LJ Murphy Children's Hospital
Falls Church, VA

Katie Wassil, PharmD, BCPS
Pediatric Clinical Manager
The Studer Family Children's Hospital at Ascension Sacred Heart
Pensacola, FL

DOI 10.37573/9781585287192.FM

Monographs