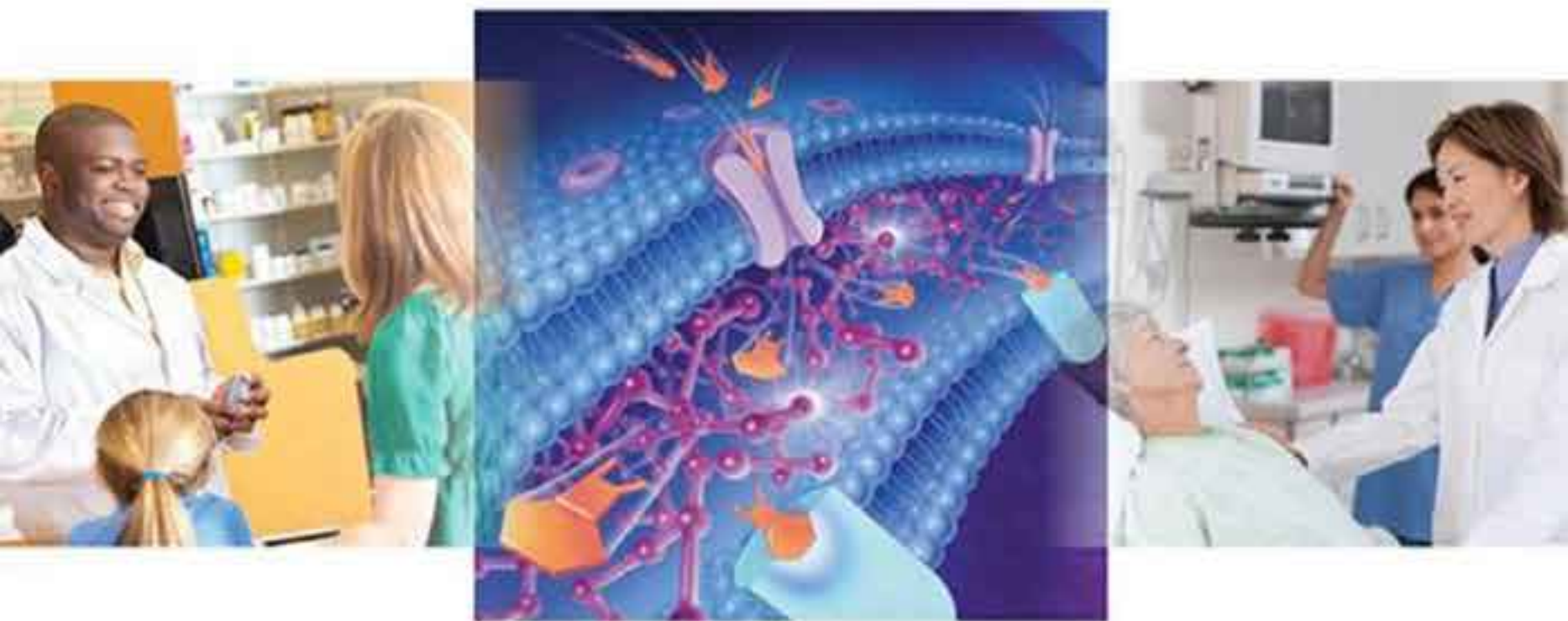


FOURTH EDITION

Pharmacotherapy

PRINCIPLES & PRACTICE



Marie A. Chisholm-Burns

Terry L. Schwinghammer

Barbara G. Wells

Patrick M. Malone

Jill M. Kolesar

Joseph T. DiPiro

Pharmacotherapy Principles & Practice

NOTICE

Medicine is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment and drug therapy are required. The authors and the publisher of this work have checked with sources believed to be reliable in their efforts to provide information that is complete and generally in accord with the standards accepted at the time of publication. However, in view of the possibility of human error or changes in medical sciences, neither the authors nor the publisher nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they disclaim all responsibility for any errors or omissions or for the results obtained from use of the information contained in this work. Readers are encouraged to confirm the information contained herein with other sources. For example and in particular, readers are advised to check the product information sheet included in the package of each drug they plan to administer to be certain that the information contained in this work is accurate and that changes have not been made in the recommended dose or in the contraindications for administration. This recommendation is of particular importance in connection with new or infrequently used drugs.

Pharmacotherapy Principles & Practice

FOURTH EDITION

Editors

**Marie A. Chisholm-Burns,
PharmD, MPH, MBA, FCCP, FASHP**

Dean and Professor
College of Pharmacy
University of Tennessee
Memphis, Knoxville, and Nashville, Tennessee

**Terry L. Schwinghammer,
PharmD, FCCP, FASHP, FAPhA, BCPS**

Professor and Chair
Department of Clinical Pharmacy
School of Pharmacy
West Virginia University
Morgantown, West Virginia

**Barbara G. Wells,
PharmD, FASHP, FCCP**

Dean Emeritus and Professor Emeritus
School of Pharmacy
The University of Mississippi
University, Mississippi

Patrick M. Malone, PharmD, FASHP

Professor and Associate Dean, Internal Affairs
College of Pharmacy
The University of Findlay
Findlay, Ohio

Jill M. Kolesar, PharmD, BCPS, FCCP

Professor
School of Pharmacy
University of Wisconsin
Director, 3P Analytical Instrumentation Laboratory
University of Wisconsin Comprehensive Cancer Center
Madison, Wisconsin

Joseph T. DiPiro, PharmD, FCCP

Dean, Professor, and Archie. O. McCalley Chair
School of Pharmacy
Virginia Commonwealth University
Richmond, Virginia



New York Chicago San Francisco Athens London Madrid Mexico City
Milan New Delhi Singapore Sydney Toronto

Copyright © 2016 by McGraw-Hill Education. All rights reserved. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

ISBN: 978-0-07-183503-9

MHID: 0-07-183503-2

The material in this eBook also appears in the print version of this title: ISBN: 978-0-07-183502-2,
MHID: 0-07-183502-4.

eBook conversion by codeMantra
Version 1.0

All trademarks are trademarks of their respective owners. Rather than put a trademark symbol after every occurrence of a trademarked name, we use names in an editorial fashion only, and to the benefit of the trademark owner, with no intention of infringement of the trademark. Where such designations appear in this book, they have been printed with initial caps.

McGraw-Hill Education eBooks are available at special quantity discounts to use as premiums and sales promotions or for use in corporate training programs. To contact a representative, please visit the Contact Us page at www.mhprofessional.com.

Previous editions copyright © 2013, 2010, 2008 by the McGraw-Hill Companies, Inc.

TERMS OF USE

This is a copyrighted work and McGraw-Hill Education and its licensors reserve all rights in and to the work. Use of this work is subject to these terms. Except as permitted under the Copyright Act of 1976 and the right to store and retrieve one copy of the work, you may not decompile, disassemble, reverse engineer, reproduce, modify, create derivative works based upon, transmit, distribute, disseminate, sell, publish or sublicense the work or any part of it without McGraw-Hill Education's prior consent. You may use the work for your own noncommercial and personal use; any other use of the work is strictly prohibited. Your right to use the work may be terminated if you fail to comply with these terms.

THE WORK IS PROVIDED "AS IS." MCGRAW-HILL EDUCATION AND ITS LICENSORS MAKE NO GUARANTEES OR WARRANTIES AS TO THE ACCURACY, ADEQUACY OR COMPLETENESS OF OR RESULTS TO BE OBTAINED FROM USING THE WORK, INCLUDING ANY INFORMATION THAT CAN BE ACCESSED THROUGH THE WORK VIA HYPERLINK OR OTHERWISE, AND EXPRESSLY DISCLAIM ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. McGraw-Hill Education and its licensors do not warrant or guarantee that the functions contained in the work will meet your requirements or that its operation will be uninterrupted or error free. Neither McGraw-Hill Education nor its licensors shall be liable to you or anyone else for any inaccuracy, error or omission, regardless of cause, in the work or for any damages resulting therefrom. McGraw-Hill Education has no responsibility for the content of any information accessed through the work. Under no circumstances shall McGraw-Hill Education and/or its licensors be liable for any indirect, incidental, special, punitive, consequential or similar damages that result from the use of or inability to use the work, even if any of them has been advised of the possibility of such damages. This limitation of liability shall apply to any claim or cause whatsoever whether such claim or cause arises in contract, tort or otherwise.

CONTENTS

<i>About the Editors</i>	ix	13. Hypovolemic Shock	229
<i>Contributors</i>	xiii	<i>Bradley A. Boucher and G. Christopher Wood</i>	
<i>Reviewers</i>	xxiii	SECTION 2 Respiratory Disorders	241
<i>Preface</i>	xxvii	14. Asthma	241
PART I BASIC CONCEPTS OF PHARMACOTHERAPY PRINCIPLES AND PRACTICES	1	<i>Lori Wilken and Michelle T. Martin</i>	
1. Introduction	3	15. Chronic Obstructive Pulmonary Disease	261
<i>Jack E. Fincham</i>		<i>Tara R. Whetsel and Jon P. Wietholter</i>	
2. Geriatrics	7	16. Cystic Fibrosis	275
<i>Jeannie K. Lee, Damian M. Mendoza, M. Jane Mohler, and Ellyn M. Lee</i>		<i>Kimberly J. Novak</i>	
3. Pediatrics	19	SECTION 3 Gastrointestinal Disorders	285
<i>Hanna Phan, Vinita B. Pai, and Milap C. Nahata</i>		17. Gastroesophageal Reflux Disease	285
4. Palliative Care	31	<i>Dianne May and Marie A. Chisholm-Burns</i>	
<i>Kelly R. Kroustos and Marc A. Sweeney</i>		18. Peptic Ulcer Disease	295
PART II DISORDERS OF ORGAN SYSTEMS	43	<i>Catherine A. Bourg and Dianne May</i>	
SECTION 1 Cardiovascular Disorders	45	19. Inflammatory Bowel Disease	307
5. Hypertension	45	<i>Brian A. Hemstreet</i>	
<i>David Parra, Youssef M. Roman, Emily Anastasia, and Robert J. Straka</i>		20. Nausea and Vomiting	323
6. Heart Failure	65	<i>Sheila Wilhelm and Melissa Lipari</i>	
<i>Orly Vardeny and Tien M. H. Ng</i>		21. Constipation, Diarrhea, and Irritable Bowel Syndrome	333
7. Ischemic Heart Disease	91	<i>Beverly C. Mims and Clarence E. Curry Jr</i>	
<i>Robert J. DiDomenico and Larisa H. Cavallari</i>		22. Portal Hypertension and Cirrhosis	349
8. Acute Coronary Syndromes	111	<i>Laurajo Ryan</i>	
<i>Kelly C. Rogers, Simon de Denus, and Shannon W. Finks</i>		23. Pancreatitis	363
9. Arrhythmias	137	<i>Janine E. Then and Heather M. Rouse</i>	
<i>James E. Tisdale</i>		24. Viral Hepatitis	371
10. Venous Thromboembolism	163	<i>Juliana Chan</i>	
<i>Edith A. Nutescu, Stuart T. Haines, and Ann K. Wittkowsky</i>		SECTION 4 Renal Disorders	387
11. Stroke	193	25. Acute Kidney Injury	387
<i>Susan R. Winkler</i>		<i>Mary K. Stamatakis</i>	
12. Dyslipidemias	207	26. Chronic and End-Stage Renal Disease	399
<i>Matthew K. Ito</i>		<i>Kristine S. Schonder</i>	
		27. Fluids and Electrolytes	427
		<i>Mark A. Malesker and Lee E. Morrow</i>	
		28. Acid–Base Disturbances	441
		<i>Lee E. Morrow and Mark A. Malesker</i>	

SECTION 5 Neurologic Disorders	451	45. Adrenal Gland Disorders	695
29. Alzheimer Disease	451	<i>Devra K. Dang, Judy T. Chen, Frank Pucino Jr, and Karim Anton Calis</i>	
<i>Megan J. Ehret and Kevin W. Chamberlin</i>		46. Pituitary Gland Disorders	711
30. Multiple Sclerosis	463	<i>Judy T. Chen, Devra K. Dang, Frank Pucino Jr, and Karim Anton Calis</i>	
<i>Melody Ryan</i>		SECTION 8 Gynecologic and Obstetric Disorders	729
31. Epilepsy	477	47. Pregnancy and Lactation: Therapeutic Considerations	729
<i>Timothy E. Welty and Edward Faught</i>		<i>Emilia Ferreira, Évelyne Rey, Caroline Morin, and Katherine Theriault</i>	
32. Status Epilepticus	497	48. Contraception	747
<i>Eljim P. Tesoro and Gretchen M. Brophy</i>		<i>Julia M. Koehler and Kathleen B. Haynes</i>	
33. Parkinson Disease	507	49. Menstruation-Related Disorders	761
<i>Thomas R. Smith and Mary L. Wagner</i>		<i>Jacqueline M. Klootwyk and Elena M. Umland</i>	
34. Pain Management	521	50. Hormone Therapy in Menopause	775
<i>Christine Karabin O'Neil</i>		<i>Nicole S. Culhane and Kelly R. Ragucci</i>	
35. Headache	535	SECTION 9 Urologic Disorders	787
<i>Joshua W. Fleming, Leigh Ann Ross, and Brendan S. Ross</i>		51. Erectile Dysfunction	787
SECTION 6 Psychiatric Disorders	545	<i>Cara Liday</i>	
36. Substance-Related Disorders	545	52. Benign Prostatic Hyperplasia	797
<i>Christian J. Teter and Devon A. Sherwood</i>		<i>Mary Lee and Roohollah Sharifi</i>	
37. Schizophrenia	563	53. Urinary Incontinence and Pediatric Enuresis	811
<i>Deanna L. Kelly, Elaine Weiner, and Heidi J. Wehring</i>		<i>Sum Lam</i>	
38. Major Depressive Disorder	583	SECTION 10 Immunologic Disorders	829
<i>Cherry W. Jackson and Marshall E. Cates</i>		54. Allergic and Pseudoallergic Drug Reactions	829
39. Bipolar Disorder	599	<i>J. Russell May and Dennis Ownby</i>	
<i>Brian L. Crabtree and Lydia E. Weisser</i>		55. Solid Organ Transplantation	839
40. Generalized Anxiety Disorder, Panic Disorder, and Social Anxiety Disorder	617	<i>Steven Gabardi, Spencer T. Martin, and Ali J. Olyaei</i>	
<i>Sheila R. Botts, Sallie H. Charles, and Douglas A. Newton</i>		SECTION 11 Bone and Joint Disorders	863
41. Sleep Disorders	631	56. Osteoporosis	863
<i>John M. Dopp and Bradley G. Phillips</i>		<i>Beth Bryles Phillips and Princy A. Pathickal</i>	
42. Attention-Deficit/Hyperactivity Disorder	641	57. Rheumatoid Arthritis	875
<i>Kevin W. Cleveland and John Erramouspe</i>		<i>Susan P. Bruce</i>	
SECTION 7 Endocrinologic Disorders	651	58. Osteoarthritis	889
43. Diabetes Mellitus	651	<i>Nicholas W. Carris, Steven M. Smith, and John G. Gums</i>	
<i>Julie Sease and Kayce Shealy</i>			
44. Thyroid Disorders	679		
<i>Michael D. Katz</i>			

59. Gout and Hyperuricemia <i>Maria Miller Thurston</i>	901	74. Infective Endocarditis <i>Ronda L. Akins and Katie E. Barber</i>	1107
60. Musculoskeletal Disorders <i>Jill S. Borchert</i>	911	75. Tuberculosis <i>Rocsanna Namdar, Michael Lauzardo, and Charles Peloquin</i>	1123
SECTION 12 Disorders of the Eyes, Ears, Nose, and Throat	921	76. Gastrointestinal Infections <i>Bradley W. Shinn and Sharon Ternullo</i>	1135
61. Glaucoma <i>Mikael D. Jones</i>	921	77. Intra-Abdominal Infections <i>Joseph E. Mazur and Joseph T. DiPiro</i>	1147
62. Ophthalmic Disorders <i>Melissa L. Hunter and Michelle L. Hilaire</i>	935	78. Parasitic Diseases <i>J. V. Anandan</i>	1157
63. Allergic Rhinitis <i>David A. Apgar</i>	949	79. Urinary Tract Infections <i>Warren E. Rose</i>	1169
SECTION 13 Dermatologic Disorders	965	80. Sexually Transmitted Infections <i>Marlon S. Honeywell and Evans Branch III</i>	1179
64. Psoriasis <i>Miriam Ansong, Samson Amos, and Victor Padron</i>	965	81. Osteomyelitis <i>Melinda M. Neuhauser and Susan L. Pendland</i>	1199
65. Common Skin Disorders <i>Laura A. Perry and Lori J. Ernsthausen</i>	979	82. Sepsis and Septic Shock <i>Trisha N. Branan, Christopher M. Bland, and S. Scott Sutton</i>	1207
SECTION 14 Hematologic Disorders	993	83. Superficial Fungal Infections <i>Lauren S. Schlesselman</i>	1217
66. Anemia <i>Robert K. Sylvester</i>	993	84. Invasive Fungal Infections <i>Russell E. Lewis and P. David Rogers</i>	1229
67. Coagulation and Platelet Disorders <i>Anastasia Rivkin and Sandeep Vansal</i>	1003	85. Antimicrobial Prophylaxis in Surgery <i>Mary A. Ullman and John C. Rotschafer</i>	1247
68. Sickle Cell Disease <i>Tracy M. Hagemann and Teresa V. Lewis</i>	1019	86. Vaccines and Toxoids <i>Marianne Billeter</i>	1255
SECTION 15 Diseases of Infectious Origin	1033	87. Human Immunodeficiency Virus Infection <i>Emily L. Heil, Christine Trezza, and Amanda H. Corbett</i>	1263
69. Antimicrobial Regimen Selection <i>Catherine M. Oliphant</i>	1033	SECTION 16 Oncologic Disorders	1289
70. Central Nervous System Infections <i>P. Brandon Bookstaver and April Miller Quidley</i>	1047	88. Cancer Chemotherapy and Treatment <i>Amy Robbins Williams</i>	1289
71. Lower Respiratory Tract Infections <i>Diane M. Cappelletty</i>	1065	89. Breast Cancer <i>Gerald Higa</i>	1317
72. Upper Respiratory Tract Infections <i>Heather L. Girand</i>	1077	90. Lung Cancer <i>Val Adams and Justin Balko</i>	1333
73. Skin and Soft Tissue Infections <i>Jaime R. Hornecker</i>	1093		

91. Colorectal Cancer <i>Emily B. Borders and Patrick J. Medina</i>	1347	99. Supportive Care in Oncology <i>Sarah L. Scarpace</i>	1461
92. Prostate Cancer <i>Trevor McKibbin</i>	1363	SECTION 17 Nutrition and Nutritional Disorders	1489
93. Skin Cancer <i>Kenneth Lin and Jill Kolesar</i>	1375	100. Parenteral Nutrition <i>Michael D. Kraft and Melissa R. Pleva</i>	1489
94. Ovarian Cancer <i>Judith A. Smith</i>	1391	101. Enteral Nutrition <i>Sarah J. Miller</i>	1507
95. Acute Leukemia <i>Nancy Heideman and Shirley Abraham</i>	1403	102. Overweight and Obesity <i>Maqual R. Graham and Daniel S. Aistrop</i>	1523
96. Chronic Leukemias and Multiple Myeloma <i>Amy M. Pick</i>	1417	<i>Appendices</i>	1535
97. Malignant Lymphomas <i>Keith A. Hecht and Susanne E. Liewer</i>	1433	<i>Appendix A: Conversion Factors and Anthropometrics</i>	1535
98. Hematopoietic Stem Cell Transplantation <i>Christina Carracedo and Amber P. Lawson</i>	1445	<i>Appendix B: Common Medical Abbreviations</i>	1539
		<i>Appendix C: Glossary</i>	1547
		<i>Appendix D: Prescription Writing Principles</i>	1567
		<i>Index</i>	1571

ABOUT THE EDITORS

Marie A. Chisholm-Burns, BS Pharm, PharmD, MPH, MBA, FCCP, FASHP, is Dean and Professor at the University of Tennessee College of Pharmacy. She received her BS and PharmD degrees from the University of Georgia, and completed a residency at Mercer University Southern School of Pharmacy and at Piedmont Hospital in Atlanta, Georgia. She has served in elected positions in numerous professional organizations. Dr. Chisholm-Burns has greater than 280 publications and approximately \$10 million in external funding as principal investigator. In 2008 and 2011, textbooks co-edited by Dr. Chisholm-Burns, *Pharmacotherapy Principles and Practice* and *Pharmacy Management, Leadership, Marketing, and Finance*, respectively, received the Medical Book Award from the American Medical Writers Association. She has also received numerous awards and honors, including the Robert K. Chalmers Distinguished Pharmacy Educator Award from the American Association of Colleges of Pharmacy (AACP), Clinical Pharmacy Education Award from the American College of Clinical Pharmacy, Daniel B. Smith Practice Excellence Award from the American Pharmacists Association (APhA), Nicholas Andrew Cummings Award from the National Academies of Practice, Award of Excellence from the American Society of Health-System Pharmacists (ASHP), Pharmacy Practice Research Award (2011 and 2014) and Award for Sustained Contributions to the Literature from the ASHP Foundation, Research Achievement Award from the APhA, Clinician of Distinction Award from the American Society of Transplantation, Paul R. Dawson Biotechnology Award from AACP, Chauncey I. Cooper Pharmacist Leadership Award from the National Pharmaceutical Association and Rufus A. Lyman Award for most outstanding publication in the *American Journal of Pharmaceutical Education* (in 1996 and 2007). Dr. Chisholm-Burns lives in Memphis, is married, and has one child, John Fitzgerald Burns Jr. She enjoys writing, cycling, and playing chess.



Terry L. Schwinghammer, BS Pharm, PharmD, BCPS, FCCP, FASHP, FAPhA, is Professor and Chair of the Department of Clinical Pharmacy and holds the Arthur I. Jackowitz Distinguished Chair in Clinical Pharmacy at the West Virginia University School of Pharmacy. He received his BS and PharmD degrees from Purdue University and completed a pharmacy residency at Indiana University Hospitals. He is a Board Certified Pharmacotherapy Specialist and has practiced in adult inpatient and ambulatory care settings. Dr. Schwinghammer is a recipient of the American Pharmacists Association-APPM Distinguished Achievement Award in Clinical/Pharmacotherapeutic Practice and is a Distinguished Practitioner in the National Academies of Practice. His teaching focuses on development of clinical skills, case-based learning, and pharmacotherapy of rheumatic diseases. He is a member of the Academy of Excellence in Teaching and Learning of the WVU Health Sciences Center. In addition to authoring over 75 research papers and journal articles, he is a co-editor of the *Pharmacotherapy Casebook* and *Pharmacotherapy Handbook* and is Editor-in-Chief of McGraw-Hill's *AccessPharmacy* (www.AccessPharmacy.com). Dr. Schwinghammer has served the American Association of Colleges of Pharmacy as Chair of the Pharmacy Practice Section, Chair of the Council of Faculties, and member of the Board of Directors. He is a past president of the Pennsylvania Society of Health-System Pharmacists and received both the Pharmacist of the Year and Sister M. Gonzales Lecture Awards from the organization. He has served as Chair of the Board of Pharmacy Specialties and elected member of the Board of Regents of the American College of Clinical Pharmacy. He is a Fellow of ACCP, ASHP, and APhA and has been elected to membership in the Rho Chi Pharmaceutical Honor Society and the Phi Lambda Sigma Pharmacy Leadership Society. He was named a Distinguished Alumnus of Purdue University in 2004. His hobby is collecting apothecary antiques, and he enjoys spending time with his wife Donna and their two children and three grandchildren.



Barbara G. Wells, BS Pharm, PharmD, FCCP, FASHP, is Dean Emeritus and Professor Emeritus at the University of Mississippi School of Pharmacy and Executive Director Emeritus of the Research Institute of Pharmaceutical Sciences. She earned her BS Pharm and PharmD degrees at the University of Tennessee and completed a residency in psychiatric pharmacy practice at the University of Tennessee and Memphis Mental Health Institute. She is past president of the College of Psychiatric and Neurologic Pharmacists Foundation (CPNPF). She is a past president and chair of the Board of the American Association of Colleges of Pharmacy (AACP) and the American College of Clinical Pharmacy (ACCP). She is a past member of the NIH Advisory Committee on Research on Women's Health and of the FDA Psychopharmacologic Drugs Advisory Committee. Her primary instructional interests are in psychiatric therapeutics, and she has received seven teaching awards. She is the recipient of the Robert K. Chalmers Distinguished Pharmacy Educator Award from AACP, the Paul F. Parker Medal from ACCP, the Gloria Niemeyer Francke Leadership Mentor Award from the American Pharmacists Association, and the Career Achievement Award from the CPNPF. She is a member of the National Academy of Practice of Pharmacy within the National Academies of Practice. Other books that she co-edits are *Pharmacotherapy: A Pathophysiologic Approach* and the *Pharmacotherapy Handbook*.



Patrick M. Malone, BS Pharm, PharmD, FASHP, is Professor and Associate Dean of Internal Affairs at the University of Findlay College of Pharmacy. Dr. Malone received his BS in Pharmacy from Albany College of Pharmacy and PharmD from the University of Michigan. He completed a clinical pharmacy residency at the Buffalo General Hospital, Drug Information Fellowship at the University of Nebraska Medical Center, and U.S. West Fellowship in Academic Development and Technology at Creighton University. His practice and teaching have centered on drug information, and he is the first author for all five editions of *Drug Information—A Guide for Pharmacists*. Dr. Malone was also the drug information pharmacist at the XIII Winter Olympics. He has approximately 100 publications and numerous presentations and has held various offices in national organizations. He was the Director of the Web-Based Pharmacy Pathway at Creighton University Medical Center, from its initial establishment until after graduation of the first class. His hobby is building and flying radio-controlled aircraft.



Jill M. Kolesar, BS Pharm, PharmD, BCPS, FCCP, is a Professor at the University of Wisconsin and the Director of the 3P Laboratory, Co-Leader Cancer Therapy Discovery and Development, Co-Chair, and Molecular Tumor Board at the University of Wisconsin Carbone Comprehensive Cancer Center. She received a BS in pharmacy from the University of Wisconsin and a PharmD from the University of Texas. Dr. Kolesar also completed an oncology residency and fellowship at the University of Texas Health Science Center in San Antonio. Dr. Kolesar is the author of more than 125 peer reviewed publications and has received more than \$1.2 million in external funding as a co and principal investigator. She holds two US and international patents for novel technologies invented in her laboratory and founded Helix Diagnostics based on this technology. She is a member of National Cancer Institute Cancer Prevention and Control Central IRB, and is currently a member of the Pharmacology Taskforce, an advisory group to the Investigational Drug Steering Committee of the NCI. She also co-chairs the Lung Biology Subcommittee for the Thoracic Committee of the Eastern Cooperative Oncology Group. Dr. Kolesar received the Innovations in Teaching Award from AACP, and has served in multiple elected offices of national and international pharmacy organizations. Other books she co-edits are *Top 300 Pharmacy Flash Cards*, *Top 100 Nonprescription Flash Cards*, and *The Pharmacogenomics Handbook*. Dr. Kolesar loves to read, run, ski, and travel with her husband and five children. She has completed 2 marathons and 16 half-marathons.



Joseph T. DiPiro, BS Pharm, PharmD, FCCP, is Dean, Professor, and Archie O. McCalley Chair at the Virginia Commonwealth University School of Pharmacy. From 2005 to 2014, he was Executive Dean of the South Carolina College of Pharmacy. He received his BS in pharmacy (Honors College) from the University of Connecticut and Doctor of Pharmacy from the University of Kentucky. He served a residency at the University of Kentucky Medical Center and a fellowship in Clinical Immunology at Johns Hopkins University. From 1981 to 2005, Dr. DiPiro was a faculty member at the University of Georgia College of Pharmacy and the Medical College of Georgia.

He is Past Chair of the American Association of Colleges of Pharmacy Council of Deans and served as President of the American College of Clinical Pharmacy. He is a Fellow of the College and has served on the Research Institute Board of Trustees. He has been a member of the American Society of Health-System Pharmacists, having served on the Commission on Therapeutics and the Task Force on Science. In 2002, the American Association of Colleges of Pharmacy selected Dr. DiPiro for the Robert K. Chalmers Distinguished Educator Award. He has also received the Russell R. Miller Literature Award and the Education Award from the American College of Clinical Pharmacy, the Award for Sustained Contributions to the Literature from the American Society of Health-System Pharmacists, and was named in 2013 as the national Rho Chi Distinguished Lecturer. Dr. DiPiro was elected a Fellow in the American Association for the Advancement of Science.

Dr. DiPiro served as editor of *The American Journal of Pharmaceutical Education* for 12 years. He is an editor for *Pharmacotherapy: A Pathophysiologic Approach*, now in its ninth edition. He is also the author of *Concepts in Clinical Pharmacokinetics* and editor of the *Encyclopedia of Clinical Pharmacy*. He has published over 200 journal papers, books, book chapters, and editorials in academic and professional journals, mainly related to antibiotics, drug use in surgery, and pharmacy education. His papers have appeared in *Antimicrobial Agents and Chemotherapy*, *Pharmacotherapy*, *Critical Care Medicine*, *JAMA*, *Annals of Surgery*, *Archives of Surgery*, *American Journal of Surgery*, *Journal of Pharmacology and Experimental Therapeutics*, and *Surgical Infections*.



This page intentionally left blank

CONTRIBUTORS

Shirley Abraham, MD

Assistant Professor, Department of Pediatrics,
University of New Mexico, Albuquerque, New Mexico
Chapter 95

Val Adams, PharmD, FCCP, BCOP

Associate Professor, Pharmacy Practice, College of Pharmacy,
University of Kentucky, Lexington, Kentucky
Chapter 90

Daniel S. Aistrope, PharmD, BCACP

Director of Clinical Practice Advancement, American College of
Clinical Pharmacy, Lenexa, Kansas
Chapter 102

Ronda L. Akins, PharmD

Infectious Diseases Clinical Pharmacy Specialist, Methodist
Charlton Medical Center, Dallas, Texas; Adjunct Associate
Professor, Department of Biological Sciences, University of
Texas at Dallas, Richardson, Texas
Chapter 74

Samson Amos, RPh, PhD

Associate Professor of Pharmaceutical Science, Cedarville
University School of Pharmacy, Cedarville, Ohio
Chapter 64

J. V. Anandan, PharmD

Pharmacy Specialist, Department of Pharmacy Services,
Henry Ford Hospital, Detroit Michigan
Chapter 78

Emily Anastasia

Clinical Pharmacy Specialist, Cardiology, Durham Veterans
Affairs Medical Center, Durham, North Carolina
Chapter 5

Miriam Ansong, PharmD, E. MBA

Director, Drug Information, Associate Professor of Pharmacy
Practice, Cedarville University School of Pharmacy,
Cedarville, Ohio
Chapter 64

David A. Apgar, PharmD

Assistant Professor, Department of Pharmacy Practice and
Science, College of Pharmacy, University of Arizona, Tucson,
Arizona
Chapter 63

Justin M. Balko, PharmD, PhD

Assistant Professor, Department of Medicine, Ingram Cancer
Center, Vanderbilt University, Nashville, Tennessee
Chapter 90

Katie E. Barber, PharmD

Assistant Professor of Pharmacy Practice, School of Pharmacy,
University of Mississippi, Mississippi
Chapter 74

Marianne Billeter, PharmD, BCPS

Clinical Pharmacy Coordinator, McLeod Health, Florence,
South Carolina
Chapter 86

Christopher M. Bland, PharmD, BCPS

Clinical Assistant Professor, College of Pharmacy, University of
Georgia, Athens, Georgia
Chapter 82

P. Brandon Bookstaver, PharmD

Associate Professor, Vice Chair, Department of Clinical
Pharmacy and Outcomes Sciences, South Carolina College of
Pharmacy, Columbia, South Carolina
Chapter 70

Jill S. Borchert, PharmD, BCACP, BCPS, FCCP

Vice-Chair and Professor of Pharmacy Practice, Chicago
College of Pharmacy, Midwestern University, Chicago, Illinois
Chapter 60

Emily B. Borders, PharmD, BCOP

Assistant Professor, Clinical and Administrative Sciences,
College of Pharmacy, University of Oklahoma, Oklahoma
City, Oklahoma
Chapter 91

Sheila R. Botts, PharmD, FCCP, BCCP

Chief, Clinical Pharmacy Research and Academic Affairs, Kaiser
Permanente Colorado, Aurora, Colorado
Chapter 40

Bradley A. Boucher, PharmD, FCCP, FCCM

Professor, Department of Clinical Pharmacy, Associate Dean
of Strategic Initiatives and Operations, College of Pharmacy,
University of Tennessee, Memphis, Tennessee
Chapter 13

Catherine A. Bourg, PharmD, BCPS, BCACP

Clinical Assistant Professor, Clinical and Administrative
Pharmacy, College of Pharmacy, University of Georgia,
Athens, Georgia
Chapter 18

Trisha N. Branan, PharmD, BCPS

Clinical Assistant Professor, Clinical and Administrative
Pharmacy, College of Pharmacy, University of Georgia,
Athens, Georgia
Chapter 82

Evans Branch III, PharmD, CPh

Professor, College of Pharmacy and Pharmaceutical Sciences,
Florida A&M University, Miami, Florida
Chapter 80

Gretchen M. Brophy, PharmD, BCPS, FCCP, FCCM, FNCS

Professor of Pharmacotherapy and Outcomes Science and
Neurosurgery, Virginia Commonwealth University, Medical
College of Virginia, Richmond, Virginia
Chapter 32

Susan P. Bruce, PharmD, BCPS

Associate Dean for Pharmacy Education and Interprofessional Studies, Chair and Professor of Pharmacy Practice, College of Pharmacy, Northeast Ohio Medical University, Rootstown, Ohio

Chapter 57

Karim Anton Calis, PharmD, MPH, FASHP, FCCP

Adjunct Senior Clinical Investigator, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, Maryland; Clinical Professor, University of Maryland School of Pharmacy, Baltimore, Maryland; Clinical Professor, Virginia Commonwealth University School of Pharmacy, Richmond, Virginia

Chapters 45 and 46

Diane M. Cappelletty, PharmD

Associate Professor of Clinical Pharmacy, Chair, Department of Pharmacy Practice, Co-Director, The Infectious Disease Research Laboratory, College of Pharmacy and Pharmaceutical Sciences, University of Toledo, Toledo, Ohio

Chapter 71

Christina Carracedo, PharmD, BCOP

BMT/Hematology Clinical Pharmacist, University of Kentucky HealthCare; Assistant Adjunct Professor, Pharmacy Practice and Science, College of Pharmacy, University of Kentucky, Lexington, Kentucky

Chapter 98

Nicholas W. Carris, PharmD, BCPS

Assistant Professor, Department of Pharmacotherapeutics & Clinical Research, College of Pharmacy; Department of Family Medicine, Morsani College of Medicine, University of South Florida, Tampa, Florida

Chapter 58

Marshall E. Cates, PharmD, BCPP, FASHP

Professor of Pharmacy Practice, McWhorter School of Pharmacy, Samford University, Birmingham, Alabama

Chapter 38

Larisa H. Cavallari, PharmD, BCPS, FCCP

Associate Professor and Associate Chair, Department of Pharmacotherapy and Translational Research, Director, Center for Pharmacogenomics, Associate Director, Personalized Medicine Program, University of Florida, Gainesville, Florida

Chapter 7

Kevin W. Chamberlin, PharmD

Associate Clinical Professor, Assistant Head, Department of Pharmacy Practice, School of Pharmacy, University of Connecticut, Farmington, Connecticut

Chapter 29

Juliana Chan, PharmD, FCCP, BCACP

Clinical Associate Professor, Gastroenterology and Hepatology, Clinical Pharmacist, Ambulatory Pharmacy Services, Clinical Associate Professor, Pharmacy Practice, Colleges of Pharmacy and Medicine, University of Illinois, Chicago, Illinois

Chapter 24

Sallie H. Charles, PMHNP-BC, MS, MBA

Advanced Practice Nurse, Psychiatry, Hidden Lake Medical Offices, Kaiser Permanente Colorado, Westminster, Colorado

Chapter 40

Judy T. Chen, PharmD, BCPS, CDE, FNAP

Clinical Associate Professor, Pharmacy Practice, Purdue University College of Pharmacy, Indianapolis, Indiana

Chapters 45 and 46

Marie A. Chisholm-Burns, PharmD, MPH, MBA, FCCP, FASHP

Dean and Professor, College of Pharmacy, University of Tennessee, Memphis, Knoxville, and Nashville, Tennessee

Chapter 17

Kevin W. Cleveland, PharmD

Associate Professor and Assistant Dean for Experiential Education, Department of Pharmacy Practice and Administrative Sciences, College of Pharmacy, Idaho State University, Pocatello, Idaho

Chapter 42

Amanda H. Corbett, PharmD, BCPS, FCCP, AAHIVE

Clinical Associate Professor, Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

Chapter 87

Brian L. Crabtree, PharmD, BCPP

Professor and Chair, Department of Pharmacy Practice, Eugene Applebaum College of Pharmacy and Health Sciences, Wayne State University, Detroit, Michigan

Chapter 39

Nicole S. Culhane, PharmD, FCCP, BCPS

Director, Experiential Education, Associate Professor, Clinical and Administrative Sciences, School of Pharmacy, Notre Dame of Maryland University, Baltimore, Maryland

Chapter 50

Clarence E. Curry Jr., PharmD

Associate Professor Emeritus of Pharmacy Practice, College of Pharmacy, Howard University, Washington, DC

Chapter 21

Devra K. Dang, PharmD, BCPS, CDE

Associate Clinical Professor, Pharmacy Practice, University of Connecticut School of Pharmacy, Storrs, Connecticut

Chapters 45 and 46

Simon de Denus, BPharm, MSc(Pharm), PhD

Beaulieu-Saucier Chair in Pharmacogenomics, Pharmacist, Montreal Heart Institute; Associate Professor, Faculty of Pharmacy, Université de Montréal, Montreal, Canada

Chapter 8

Robert J. DiDomenico, PharmD

Clinical Professor, Department of Pharmacy Practice, College of Pharmacy, University of Illinois at Chicago, Chicago, Illinois

Chapter 7

Joseph T. DiPiro, PharmD, FCCP

Professor and Dean, Archie O. McCalley Chair, School of Pharmacy, Virginia Commonwealth University, Richmond, Virginia
Chapter 77

John M. Dopp, PharmD

Associate Professor, School of Pharmacy, University of Wisconsin-Madison, Madison, Wisconsin
Chapter 41

Megan J. Ehret, PharmD, MS, BCPP

Behavioral Health Clinical Pharmacist, Department of Defense, Fort Belvoir Community Hospital, Fort Belvoir, Virginia
Chapter 29

Lori J. Ernsthausen, PharmD, BCPS

Associate Professor and Chair, Department of Pharmacy Practice, University of Findlay College of Pharmacy, Findlay, Ohio
Chapter 65

John Erramouspe, PharmD, MS

Professor, Pharmacy Practice and Administrative Sciences, College of Pharmacy, Idaho State University, Pocatello, Idaho
Chapter 42

Edward Faught, MD

Professor, Department of Neurology, School of Medicine, Emory University, Atlanta, Georgia
Chapter 31

Emma Ferreira, BPharm, MSc, PharmD, FCHSP

Pharmacist, Clinical Professor, Associate Dean, Academics, CHU Ste-Justine, Université de Montréal, Montreal, Quebec, Canada
Chapter 47

Jack E. Fincham, PhD, RPh

Professor, Pharmaceutical and Administrative Sciences, School of Pharmacy, Presbyterian College, Clinton, South Carolina
Chapter 1

Shannon W. Finks, PharmD, FCCP, BCPS

Associate Professor, Department of Clinical Pharmacy, College of Pharmacy, University of Tennessee, and Clinical Pharmacy Specialist, Cardiology, VA Medical Center, Memphis, Tennessee
Chapter 8

Joshua W. Fleming, PharmD, BCACP

Clinical Assistant Professor, Department of Pharmacy Practice, University of Mississippi School of Pharmacy, Jackson, Mississippi
Chapter 35

Steven Gabardi, PharmD, FAST, FCCP, BCPS

Abdominal Organ Transplant Clinical Specialist, Brigham and Women's Hospital; Assistant Professor of Medicine, Harvard Medical School, Boston, Massachusetts
Chapter 55

Heather L. Girand, PharmD

Professor, Pharmacy Practice, College of Pharmacy, Ferris State University, Big Rapids, Michigan
Chapter 72

Maqual R. Graham, PharmD

Professor and Associate Dean for Academic Affairs, University of Missouri School of Pharmacy, Kansas City, Missouri
Chapter 102

John G. Gums, PharmD, FCCP

Professor of Pharmacy and Medicine, Associate Dean for Clinical Affairs, Department of Pharmacotherapy and Translational Research, College of Pharmacy, University of Florida, Gainesville, Florida
Chapter 58

Tracy M. Hagemann, PharmD, FCCP, FPPAG

Associate Dean and Professor, College of Pharmacy, University of Tennessee, Nashville, Tennessee
Chapter 68

Stuart T. Haines, PharmD, BCPS, BC-ADM

Professor and Vice Chair for Clinical Services, Department of Pharmacy Practice and Science, University of Maryland School of Pharmacy, Baltimore, Maryland
Chapter 10

Kim Hawkins, PhD, APRN-NP

Assistant Professor, Creighton University College of Nursing, Omaha, Nebraska
Appendix D

Kathleen B. Haynes, PharmD, BCPS, CDE

Clinical Coordinator, Bridges to Health, Community Health Network, Indianapolis, Indiana
Chapter 48

Keith A. Hecht, PharmD, BCOP

Associate Professor, Department of Pharmacy Practice, School of Pharmacy, Southern Illinois University, Edwardsville, Illinois
Chapter 97

Nancy Heideman, PharmD, BCPS

Clinical Specialist-Pediatrics, University of New Mexico Hospital, Albuquerque, New Mexico
Chapter 95

Emily L. Heil, PharmD

Clinical Assistant Professor, School of Pharmacy, University of Maryland Medical Center, Baltimore, Maryland
Chapter 87

Brian A. Hemstreet, PharmD, FCCP, BCPS

Associate Professor and Assistant Dean for Student Affairs, Regis University School of Pharmacy, Denver, Colorado
Chapter 19

Gerald Higa, PharmD

Professor, Schools of Pharmacy and Medicine, West Virginia University, Morgantown, West Virginia
Chapter 89

Michelle L. Hilaire, PharmD, CDE, BCPS

Clinical Associate Professor of Pharmacy Practice, University of Wyoming School of Pharmacy, Laramie, Wyoming
Chapter 62

Marlon S. Honeywell, PharmD

Professor, College of Pharmacy and Pharmaceutical Sciences,
Florida A&M University, Tallahassee, Florida
Chapter 80

Jaime R. Hornecker, PharmD, BCPS

Clinical Associate Professor of Pharmacy Practice, School of
Pharmacy, University of Wyoming, Laramie, Wyoming
Chapter 73

Melissa L. Hunter, PharmD

Drug Information Director, School of Pharmacy, University of
Wyoming, Laramie, Wyoming
Chapter 62

Jill Isaacs, MS, APRN-NP

Charleston Southern University, Charleston, South Carolina
Appendix D

Matthew K. Ito, PharmD, FCCP, FNLA, CLS

Professor, Department of Pharmacy Practice, Oregon State
University/Oregon Health and Science University College of
Pharmacy, Portland, Oregon
Chapter 12

Cherry W. Jackson, PharmD, BCPP, FASHP, FCCP

Professor, Department of Pharmacy Practice, Auburn
University; Clinical Professor, Department of Psychiatric and
Behavioral Neurobiology, School of Medicine, University of
Alabama, Birmingham, Alabama
Chapter 38

Mikael D. Jones, PharmD, BCPS

Clinical Associate Professor, Pharmacy Practice and Science,
College of Pharmacy, University of Kentucky, Lexington,
Kentucky
Chapter 61

Michael D. Katz, PharmD

Professor and Director, International Education, Department
of Pharmacy Practice and Science, College of Pharmacy,
University of Arizona, Tucson, Arizona
Chapter 44

Deanna L. Kelly, PharmD, BCPP

Professor of Psychiatry, Director and Chief, Treatment Research
Program, Maryland Psychiatric Research Center, University
of Maryland School of Medicine, Baltimore, Maryland
Chapter 37

Jacqueline M. Klootwyk, PharmD, BCPS

Assistant Professor of Pharmacy Practice, Division of Clinical,
Social, and Administrative Sciences, Mylan School of
Pharmacy, Duquesne University, Pittsburgh, Pennsylvania
Chapter 49

Emily Knezevich, PharmD, BCPS, CDE

Associate Professor of Pharmacy Practice, School of Pharmacy
and Health Professions, Creighton University, Omaha,
Nebraska
Appendix D

Jon Knezevich, PharmD, BCPS

Pharmaceutical Care Pharmacist, Think Whole Person
Healthcare, Omaha, Nebraska
Appendix D

Julia M. Koehler, PharmD, FCCP

Associate Dean for Clinical Education and External Affiliations,
Professor of Pharmacy Practice, Butler University College of
Pharmacy and Health Sciences, Indianapolis, Indiana
Chapter 48

Jill M. Kolesar, PharmD, BCPS, FCCP

Professor, School of Pharmacy, University of Wisconsin;
Director, 3P Analytical Instrumentation Laboratory,
University of Wisconsin Comprehensive Cancer Center
Madison, Wisconsin
Chapter 93

Michael D. Kraft, PharmD, BCNSP

Clinical Associate Professor, University of Michigan College
of Pharmacy; Assistant Director—Education and Research,
University of Michigan Health System, Ann Arbor, Michigan
Chapter 100

Kelly R. Kroustos, PharmD

Associate Professor of Pharmacy Practice, Raabe College of
Pharmacy, Ohio Northern University, Ada, Ohio
Chapter 4

Sum Lam, PharmD

Associate Clinical Professor, Department of Clinical Pharmacy
Practice, College of Pharmacy and Allied Health Professions,
St. John's University, Queens, New York; Clinical Specialist
in Geriatric Pharmacy, Divisions of Geriatric Medicine and
Pharmacy, Winthrop University Hospital, Mineola, New York
Chapter 53

Michael Lauzardo, MD

Chief, Division of Infectious Diseases and Global Medicine,
College of Medicine, University of Florida, Gainesville,
Florida
Chapter 75

Amber P. Lawson, PharmD, BCOP

Clinical Pharmacy Specialist, Hematology/Oncology, University
of Kentucky Healthcare, Lexington, Kentucky
Chapter 98

Ellyn M. Lee, MD, FACP

Director, Palliative Care Services Swedish Medical Center,
Seattle, Washington
Chapter 2

Jeannie K. Lee, PharmD, BCPS

Assistant Head, Department of Pharmacy Practice and Science,
Associate Professor, Colleges of Pharmacy and Medicine,
University of Arizona, Tucson, Arizona
Chapter 2

Mary Lee, PharmD, BCPS, FCCP

Professor of Pharmacy Practice, Chicago College of Pharmacy,
Vice President and Chief Academic Officer, Midwestern
University, Chicago, Illinois
Chapter 52

Russell E. Lewis, PharmD, FCCP, BCPS

Associate Professor, Department of Medical and Surgical Sciences, University of Bologna, Bologna, Italy
Chapter 84

Teresa V. Lewis, PharmD, BCPS

Assistant Professor, Department of Pharmacy, Clinical and Administrative Sciences, College of Pharmacy, University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma
Chapter 68

Cara Liday, PharmD, BCPS, CDE

Associate Professor, Department of Pharmacy Practice, College of Pharmacy, Idaho State University; Clinical Pharmacist, InterMountain Medical Clinic, Pocatello, Idaho
Chapter 51

Susanne E. Liewer, PharmD, BCOP

Pharmacy Coordinator, Blood and Marrow Transplant; Clinical Assistant Professor, College of Pharmacy, University of Nebraska Medical Center, Omaha, Nebraska
Chapter 97

Kenneth H. Lin, MAT

Student Pharmacist, School of Pharmacy, University of Wisconsin, Madison, Wisconsin
Chapter 93

Melissa Lipari, PharmD, BCACP

Clinical Assistant Professor, Wayne State University Eugene Applebaum College of Pharmacy and Health Sciences; Clinical Pharmacy Specialist, Ambulatory Care, St. John Hospital and Medical Center, Detroit, Michigan
Chapter 20

Mark A. Malesker, PharmD, FCCP, FCCP, FASHP, BCPS

Professor of Pharmacy Practice and Medicine, Creighton University, Omaha, Nebraska
Chapters 27 and 28

Michelle T. Martin, PharmD, BCPS, BCACP

Clinical Pharmacist, University of Illinois Hospital and Health Sciences System; Clinical Assistant Professor, University of Illinois at Chicago College of Pharmacy, Chicago, Illinois
Chapter 14

Spencer T. Martin, PharmD, BCPS

Solid Organ Transplant Specialist, Department of Pharmacy Services, Hartford Hospital, Hartford, Connecticut
Chapter 55

Dianne May, PharmD, BCPS

Campus Director for Pharmacy Practice Experiences, Division of Experience Programs; Clinical Professor, Department of Clinical and Administrative Pharmacy, University of Georgia College of Pharmacy, Augusta, Georgia
Chapters 17 and 18

J. Russell May, PharmD, FASHP

Clinical Professor, Department of Clinical and Administrative Pharmacy, University of Georgia College of Pharmacy, Augusta, Georgia
Chapter 54

Joseph E. Mazur, PharmD, BCPS, BCNSP

Critical Care Clinical Specialist, Medical Intensive Care Unit; Clinical Associate Professor, South Carolina College of Pharmacy, Charleston, South Carolina
Chapter 77

Trevor McKibbin, PharmD, MS, BCOP

Clinical Pharmacy Specialist, Medical Oncology, Winship Cancer Institute, Emory University, Atlanta, Georgia
Chapter 92

Patrick J. Medina, PharmD, BCOP

Professor, College of Pharmacy, University of Oklahoma, Oklahoma City, Oklahoma
Chapter 91

Damian M. Mendoza, PharmD, CGP

Clinical Instructor in Pharmacy Practice and Science, University of Arizona College of Pharmacy; Clinical Pharmacy Specialist, Geriatrics, Southern Arizona VA Health Care System, Tucson, Arizona
Chapter 2

Sarah J. Miller, PharmD, BCNSP

Professor, Department of Pharmacy Practice, University of Montana Skaggs School of Pharmacy; Pharmacy Clinical Coordinator, Saint Patrick Hospital, Missoula, Montana
Chapter 101

Beverly C. Mims, PharmD

Associate Professor of Pharmacy Practice, Howard University, College of Pharmacy, Clinical Pharmacist, Howard University Hospital, Washington, DC
Chapter 21

M. Jane Mohler, RN, MPH, PhD

Associate Professor, Section of Geriatrics, General and Palliative Medicine, University of Arizona, Tucson, Arizona
Chapter 2

Caroline Morin, BPharm, MSc

Pharmacist in Obstetrics and Gynecology, Associated Clinician, CHU Ste-Justine, Université de Montreal Pharmacist, Montreal, Quebec, Canada
Chapter 47

Lee E. Morrow, MD, MSc

Professor, Division of Pulmonary, Critical Care, and Sleep Medicine, Creighton University School of Medicine, Omaha, Nebraska
Chapters 27 and 28

Milap C. Nahata, PharmD, MS

Professor Emeritus of Pharmacy, Pediatrics and Internal Medicine; Director, of the Institute of Therapeutic Innovations and Outcomes, College of Pharmacy, Ohio State University; Columbus, Ohio
Chapter 3

Rocsanna Namdar, PharmD

Lecturer, School of Pharmacy, University of Colorado, Denver, Colorado
Chapter 75

Melinda M. Neuhauser, PharmD, MPH

National PBM Clinical Pharmacy Program Manager, Infectious Diseases, Department of Veterans Affairs Pharmacy Benefits Management Services, Hines, Illinois
Chapter 81

Douglas A. Newton, MD, MPH

Child and Adolescent Psychiatrist, Colordao Permanente Medical Group, Denver, Colorado
Chapter 40

Tien M.H. Ng, PharmD, FCCP, BCPS AQ-C

Associate Professor, Clinical Pharmacy, School of Pharmacy, University of Southern California, Los Angeles, California
Chapter 6

Kimberly J. Novak, PharmD, BCPS

Clinical Pharmacy Specialist, Pediatric Pulmonary Medicine, Nationwide Children's Hospital; Clinical Assistant Professor, Ohio State University College of Pharmacy, Columbus, Ohio
Chapter 16

Edith A. Nutescu, PharmD, MS, FCCP

Associate Professor, Department of Pharmacy Systems, Outcomes and Policy, and Director, Center for Pharmacoepidemiology and Pharmacoeconomic Research, College of Pharmacy, University of Illinois, Chicago, Illinois
Chapter 10

Catherine M. Oliphant, PharmD

Associate Professor and Assistant Chair, Department of Pharmacy Practice and Administrative Sciences, College of Pharmacy, Idaho State University, Meridian, Idaho
Chapter 69

Ali J. Olyaei, PharmD

Professor, Department of Medicine and Pharmacy Practice, Oregon State University and Oregon Health and Sciences University, Portland, Oregon
Chapter 55

Christine Karabin O'Neil, BS, PharmD, BCPS, CGP, FCCP

Professor of Pharmacy Practice, Division of Clinical, Social, and Administrative Sciences, Duquesne University, School of Pharmacy, Pittsburgh, Pennsylvania
Chapter 34

Dennis Ownby, MD

Professor of Pediatrics and Chief, Section of Allergy and Immunology, Georgia Regents Medical Center, Georgia Regents University, Augusta, Georgia
Chapter 54

Victor Padron, PhD

Associate Professor, Department of Pharmacy Sciences, Creighton University School of Pharmacy and Health Professions, Omaha, Nebraska
Chapter 64

Vinita B. Pai, PharmD, MS

Associate Professor of Clinical Pharmacy, Ohio State University, College of Pharmacy; Clinical Pharmacy Specialist, Pediatric Blood and Marrow Transplant Program, Nationwide Children's Hospital, Columbus, Ohio
Chapter 3

David Parra, PharmD, FCCP, BCPS

Clinical Pharmacy Program Manager in Cardiology, Veterans Integrated Service Network 8, Pharmacy Benefits Management, Bay Pines, Florida; Clinical Associate Professor, Department of Experimental and Clinical Pharmacology, College of Pharmacy, University of Minnesota, Minneapolis, Minnesota
Chapter 5

Princy A. Pathickal, PharmD, BCPS

Clinical Pharmacy Specialist, Good Samaritan Regional Medical Center, Suffern, New York
Chapter 56

Charles Peloquin, PharmD, FCCP

Professor, Department of Pharmacotherapy and Translational Research, School of Pharmacy, University of Florida, Gainesville, Florida
Chapter 75

Susan L. Pendland, MS, PharmD

Adjunct Associate Professor, University of Illinois at Chicago, Chicago, Illinois
Chapter 81

Laura A. Perry, PharmD, BCPS

Associate Professor, Department of Pharmacy Practice, University of Findlay College of Pharmacy, Findlay, Ohio
Chapter 65

Hanna Phan, PharmD, BCPS

Assistant Professor, Department of Pharmacy Practice and Science, Assistant Professor, Department of Pediatrics, Colleges of Pharmacy and Medicine, University of Arizona; Clinical Pharmacy Specialist, Pediatric Pulmonary Medicine, Arizona Respiratory Center, University of Arizona Medical Center, Tucson, Arizona
Chapter 3

Beth Bryles Phillips, PharmD, FCCP, BCPS

Rite Aid Professor, University of Georgia College of Pharmacy; Director VAMC/UGA Ambulatory Care Residency Program, Athens, Georgia
Chapter 56

Bradley G. Phillips, PharmD, FCCP, BCPS

Millikan-Revee Professor and Head, Department of Clinical and Administrative Pharmacy, University of Georgia College of Pharmacy, Athens, Georgia
Chapter 41

Amy M. Pick, PharmD, BCOP

Associate Professor of Pharmacy Practice, Creighton University School of Pharmacy and Health Professions, Omaha, Nebraska
Chapter 96

Melissa R. Pleva, PharmD, BCPS, BCNSP

Clinical Pharmacist and Adjunct Clinical Assistant Professor, University of Michigan Health System and College of Pharmacy, Ann Arbor, Michigan
Chapter 100

Frank Pucino, Jr., PharmD, MPH

New Market, Maryland
Chapters 45 and 46

April Miller Quidley, PharmD, BCPS

Critical Care Pharmacist and Critical Care Residency Program
 Director, Vidant Medical Center, Greenville, North Carolina
Chapter 70

Kelly R. Ragucci, PharmD, FCCP, BCPS, CDE

Professor and Chair, Clinical Pharmacy and Outcome Sciences,
 South Carolina College of Pharmacy, Medical University of
 South Carolina Campus, Charleston, South Carolina
Chapter 50

Évelyne Rey, MD

Internist, Department of Obstetrics and Gynecology, CHU
 Sainte-Justine, Montreal, Quebec, Canada
Chapter 47

Anastasia Rivkin, PharmD, BCPS

Assistant Dean for Faculty and Professor of Pharmacy Practice,
 School of Pharmacy, Fairleigh Dickinson University, Florham
 Park, New Jersey
Chapter 67

Kelly C. Rogers, PharmD, FCCP

Professor, Department of Clinical Pharmacy, College of
 Pharmacy, University of Tennessee, Memphis, Tennessee
Chapter 8

P. David Rogers, PharmD, PhD, FCCP

First Tennessee Endowed Chair of Excellence in Clinical
 Pharmacy, Vice Chair for Research, Director, Clinical
 and Experimental Therapeutics, and Professor of Clinical
 Pharmacy and Pediatrics, College of Pharmacy, University of
 Tennessee Memphis, Tennessee
Chapter 84

Youssef M. Roman, PharmD

Pharmacist and Clinical Toxicologist, Safetycall International;
 Research Assistant, University of Minnesota, Minneapolis,
 Minnesota
Chapter 5

Warren E. Rose, PharmD

Associate Professor, Pharmacy Practice Division, School of
 Pharmacy, University of Wisconsin, Madison, Wisconsin
Chapter 79

Brendan S. Ross, MD

Staff Physician, G.V. (Sonny) Montgomery Veterans Affairs
 Medical Center; Clinical Associate Professor, Department
 of Pharmacy Practice, University of Mississippi School of
 Pharmacy, Jackson, Mississippi
Chapter 35

Leigh Ann Ross, PharmD, BCPS, FCCP, FASHP

Associate Dean for Clinical Affairs, Professor and Chair,
 Department of Pharmacy Practice, University of Mississippi
 School of Pharmacy, Jackson, Mississippi
Chapter 35

John C. Rotschafer, PharmD, FCCP

Professor, College of Pharmacy, University of Minnesota,
 Minneapolis, Minnesota
Chapter 85

Laurajo Ryan, PharmD, MSc, BCPS, CDE

Clinical Associate Professor, University of Texas at Austin
 College of Pharmacy, University of Texas Health Science
 Center, Department of Medicine, Pharmacotherapy
 Education Research Center, Austin, Texas
Chapter 22

Melody Ryan, PharmD, MPH

Professor, Department of Pharmacy Practice and Science,
 College of Pharmacy, and Associate Professor, Department
 of Neurology, College of Medicine, University of Kentucky,
 Lexington, Kentucky
Chapter 30

Sarah L. Scarpace, PharmD, MPH, BCOP

Associate Professor, Pharmacy Practice, Albany College of
 Pharmacy and Health Sciences, St. Peter's Health Partners
 Cancer Care Center, Albany, New York
Chapter 99

Lauren S. Schlesselman, MEd, PharmD

Associate Clinical Professor of Pharmacy Practice, Assistant
 Dean of Academic and Strategic Initiatives, and Director of
 Assessment and Accreditation, University of Connecticut
 School of Pharmacy, Storrs, Connecticut
Chapter 83

Kristine S. Schonder, PharmD

Assistant Professor, Department of Pharmacy and Therapeutics,
 University of Pittsburgh School of Pharmacy, Pittsburgh,
 Pennsylvania
Chapter 26

Julie Sease, PharmD, FCCP, BCPS, CDE, BCACP

Professor of Pharmacy Practice and Associate Dean for
 Academic Affairs, School of Pharmacy, Presbyterian College,
 Clinton, South Carolina
Chapter 43

Roohollah Sharifi, MD

Section Head of Urology, Jesse Brown Veterans Administration
 Hospital, and Department of Medicine, University of Illinois
 at Chicago College of Medicine, Chicago, Illinois
Chapter 52

Kayce Shealy, PharmD, BCPS

Assistant Professor of Pharmacy Practice, Director, Center
 for Entrepreneurial Development, School of Pharmacy,
 Presbyterian College, Clinton, South Carolina
Chapter 43

Devon A. Sherwood, PharmD, BCPP

Assistant Professor, Psychopharmacology, Department of
 Pharmacy Practice, College of Pharmacy, University of New
 England, Portland, Maine
Chapter 36

Bradley W. Shinn, PharmD

Professor of Pharmacy Practice, University of Findlay College of Pharmacy, Findlay, Ohio
Chapter 76

Judith A. Smith, PharmD, BCOP, CPHQ, FCCP, FISOPP

Associate Professor, Department of Obstetrics, Gynecology and Reproductive Sciences, University of Texas Medical School at Houston, Houston, Texas
Chapter 94

Steven M. Smith, PharmD, MPH, BCPS

Assistant Professor, Departments of Pharmacotherapy and Translational Research and Community Health & Family Medicine, Colleges of Pharmacy and Medicine, University of Florida, Gainesville, Florida
Chapter 58

Thomas R. Smith, PharmD

Assistant Professor of Pharmacy Practice, College of Pharmacy, Natural, and Health Sciences, Manchester University, Fort Wayne, Indiana
Chapter 33

Mary K. Stamatakis, PharmD

Associate Dean for Academic Affairs and Educational Innovation and Professor, West Virginia University School of Pharmacy, Morgantown, West Virginia
Chapter 25

Robert J. Straka, PharmD, FCCP

Professor and Head, Experimental and Clinical Pharmacology Department, University of Minnesota College of Pharmacy, Minneapolis, Minnesota
Chapter 5

S. Scott Sutton, PharmD, BCPS

Professor, South Carolina College of Pharmacy, University of South Carolina, Columbia, South Carolina
Chapter 82

Marc A. Sweeney, PharmD, MDiv

Professor and Dean, School of Pharmacy, Cedarville University, Cedarville, Ohio
Chapter 4

Robert K. Sylvester, PharmD

Professor Emeritus, Department of Pharmacy Practice, College of Health Professions North Dakota State University; Fargo, North Dakota
Chapter 66

Sharon Ternullo, PharmD

Assistant Professor of Pharmacy Practice, University of Findlay College of Pharmacy, Findlay, Ohio
Chapter 76

Eljim P. Tesoro, PharmD, BCPS

Clinical Associate Professor, College of Pharmacy, Clinical Pharmacist, Neurosciences, Director, PGY2 Critical Care Residency, University of Illinois Hospital and Health Sciences System, Chicago, Illinois
Chapter 32

Christian J. Teter, PharmD, BCPP

Associate Professor, Psychopharmacology, Department of Pharmacy Practice, College of Pharmacy, University of New England, Portland, Maine
Chapter 36

Heather M. Teufel, PharmD, BCPS

Clinical Pharmacy Specialist, Emergency Medicine, University of Pennsylvania Health System, Chester County Hospital, West Chester, Pennsylvania

Janine E. Then, PharmD, BCPS

Lead Pharmacist—Clinical Services, University of Pittsburgh Medical Center, Presbyterian-Shadyside Hospital, Pittsburgh, Pennsylvania
Chapter 23

Katherine Theriault, MD

Fellow in Maternal Fetal Medicine, Department of Obstetrics-Gynecology, CHU Ste-Justine, Université de Montréal, Montreal, Canada
Chapter 47

Maria Miller Thurston, PharmD, BCPS

Clinical Assistant Professor, Department of Pharmacy Practice, Mercer University College of Pharmacy, Atlanta, Georgia
Chapter 59

James E. Tisdale, PharmD, BCPS, FCP, FAPhA, FAHA

Professor, College of Pharmacy, Purdue University; Adjunct Professor, School of Medicine, Indiana University, Indianapolis, Indiana
Chapter 9

Christine Trezza, PharmD

Division of Pharmacotherapy and Experimental Therapeutics, Eshelman School of Pharmacy, University of North Carolina, Chapel Hill, North Carolina
Chapter 87

Mary A. Ullman, PharmD

Pharmacist, Regions Hospital, St. Paul, Minnesota
Chapter 85

Elena M. Umland, PharmD

Associate Dean for Academic Affairs, Associate Professor of Pharmacy, Thomas Jefferson School of Pharmacy, Thomas Jefferson University, Philadelphia, Pennsylvania
Chapter 49

Sandeep Vansal, PharmD

Associate Professor and Director, Pharmaceutical Sciences, School of Pharmacy, Fairleigh Dickinson University, Florham Park, New Jersey
Chapter 67

Orly Vardeny, PharmD, MS, FCCP, BCACP

Associate Professor, School of Pharmacy, University of Wisconsin, Madison, Wisconsin
Chapter 6

Mary L. Wagner, PharmD, MS

Associate Professor, Department of Pharmacy Practice and Administration, Ernest Mario School of Pharmacy, Rutgers University, Piscataway, New Jersey
Chapter 33

Heidi J. Wehring, PharmD, BCPP

Assistant Professor, Department of Psychiatry, Maryland Psychiatric Research Center, University of Maryland School of Medicine, Washington, DC
Chapter 37

Elaine Weiner, MD

Assistant Professor, Department of Psychiatry, University of Maryland Medical School, Catonsville, Maryland
Chapter 37

Lydia E. Weisser, DO

Director, Inpatient Mental Health Services, William Jennings Bryan Dorn Veterans Affairs Medical Center, Columbia, South Carolina
Chapter 39

Timothy E. Welty, PharmD, MA, FCCP, BCPS

Professor and Chair, Department of Clinical Sciences, College of Pharmacy and Health Sciences, Drake University, Des Moines, Iowa
Chapter 31

Tara R. Whetsel, PharmD, BCACP, BC-ADM

Clinical Associate Professor, West Virginia University School of Pharmacy, Morgantown, West Virginia
Chapter 15

Jon P. Wietholter, PharmD, BCPS

Clinical Associate Professor, West Virginia University School of Pharmacy; Internal Medicine Clinical Pharmacist, WVU Medicine Ruby Memorial Hospital, Morgantown, West Virginia
Chapter 15

Sheila Wilhelm, PharmD, FCCP, BCPS

Clinical Associate Professor, Department of Pharmacy Practice, Eugene Applebaum College of Pharmacy and Health Sciences, Wayne State University; Clinical Pharmacy Specialist, Internal Medicine, Harper University Hospital, Detroit, Michigan
Chapter 20

Lori Wilken, PharmD, BCACP, AE-C

Clinical Pharmacist, University of Illinois Hospital and Health Sciences System, Clinical Assistant Professor, Pharmacy Practice, University of Illinois at Chicago College of Pharmacy, Chicago, Illinois
Chapter 14

Amy Robbins Williams, PharmD, BCOP

Adjunct Professor of Pharmacy Practice, Union University School of Pharmacy, Jackson, Tennessee
Chapter 88

Susan R. Winkler, PharmD, FCCP, BCPS

Professor and Chair, Department of Pharmacy Practice, Midwestern University Chicago College of Pharmacy, Downers Grove, Illinois
Chapter 11

Ann K. Wittkowsky, PharmD, CACP, FASHP, FCCP

Director, Anticoagulation Services, Department of Pharmacy, UWMedicine; Clinical Professor, School of Pharmacy, University of Washington, Seattle, Washington
Chapter 10

G. Christopher Wood, PharmD, FCCP

Associate Professor, Department of Clinical Pharmacy, College of Pharmacy, University of Tennessee, Memphis, Tennessee
Chapter 13

This page intentionally left blank

REVIEWERS

Julie Akens, PharmD, BCPS

Clinical Pharmacy Specialist, Spinal Cord Injury, Louis Stokes Cleveland VA Medical Center, Cleveland, Ohio

Rita R. Alloway, PharmD, FCCP

Research Professor of Medicine; Director, Transplant Clinical Research; Director, Transplant Pharmacy Residency and Fellowship, University of Cincinnati, Cincinnati, Ohio

Jennifer H. Austin, PharmD, BCPS

Clinical Pharmacy Specialist—Internal Medicine, University of Chicago School of Medicine, Chicago, Illinois

Carmela Avena-Woods, BS Pharm, PharmD, CGP

Associate Clinical Professor, Department of Clinical Health Professions, College of Pharmacy and Health Sciences, St. John's University, Queens, New York

Deborah Berlekamp, PharmD, BCPS

Assistant Professor of Pharmacy Practice, University of Findlay, Findlay, Ohio

Martha Blackford, PharmD, BCPS

Pediatric Clinical Pharmacologist and Toxicologist, Akron Children's Hospital, Akron, Ohio

Mary Brennan, DNP, ACNP-BC, ANP, CNS, RN

Clinical Associate Professor, College of Nursing, New York University, New York, New York

Denise Buonocore, MSN, ACNPC, CCNS, CCRN, CHFN

Acute Care Nurse Practitioner for HF Services, St. Vincent's Multispecialty Group, Bridgeport, Connecticut

Katie E. Cardone, PharmD, BCACP, FNKF

Associate Professor, Department of Pharmacy Practice, Albany College of Pharmacy and Health Sciences, Albany, New York

Kimberly Joy L. Carney, DNP, APRN, FNP-BC, CDE

Doctor of Nursing Practice Graduate Faculty, Eleanor Mann School of Nursing, University of Arkansas, Fayetteville, Arkansas

Amber N. Chiplinski, PharmD, BCPS

Clinical Pharmacy Coordinator, Meritus Medical Center, Hagerstown, Maryland

Jennifer Confer, PharmD, BCPS

Clinical Associate Professor, West Virginia University School of Pharmacy; Critical Care Clinical Pharmacy Specialist, Cabell Huntington Hospital, Huntington, West Virginia

Kelli Coover, PharmD, CGP, FASCP

Associate Professor and Vice-Chair of Pharmacy Practice, Creighton University School of Pharmacy and Health Professions, Omaha, Nebraska

Sandra Cuellar, PharmD, BCOP

Clinical Assistant Professor, Department of Pharmacy Practice, University of Illinois at Chicago College of Pharmacy, Chicago, Illinois

Bonnie A. Dadig, EdD, PA-C

Professor and Chair, Physician Assistant Department, College of Allied Health Sciences, Augusta University, Physician Assistant, Department of Family Medicine, Medical College of Georgia, Augusta, Georgia

Lawrence W. Davidow, PhD, RPh

Director, Pharmacy Skills Laboratory, University of Kansas School of Pharmacy, Lawrence, Kansas

Thomas Dowling, PharmD, PhD

Assistant Dean and Department Head-Pharmacy Practice, College of Pharmacy, Ferris State University

David P. Elliott, PharmD, CGP, FASCP, FCCP, AGSF

Professor and Associate Chair of Clinical Pharmacy, School of Pharmacy, West Virginia University, Charleston, West Virginia

Jingyang Fan, PharmD, BCPS

Clinical Associate Professor, Southern Illinois University Edwardsville, School of Pharmacy; Cardiovascular Clinical Pharmacist, Mercy Hospital, St. Louis, Missouri

Karen M. Fancher, PharmD, BCOP

Assistant Professor of Pharmacy Practice, Duquesne University Mylan School of Pharmacy, Clinical Pharmacy Specialist, University of Pittsburgh Medical Center at Passavant Hospital, Pittsburgh, Pennsylvania

Shannon W. Finks, PharmD, FCCP, BCPS

Associate Professor, Department of Clinical Pharmacy, College of Pharmacy, University of Tennessee, and Clinical Pharmacy Specialist, Cardiology, VA Medical Center, Memphis, Tennessee

Thomas S. Franko II, PharmD, BCACP

Assistant Professor of Pharmacy Practice, Wilkes University Nesbitt School of Pharmacy; Ambulatory Care/Pain Management Clinical Pharmacist, The Wright Center for Graduate Medical Education, Clarks Summit, Pennsylvania

Maisha Freeman, PharmD, MS, BCPS, FASCP

Professor of Pharmacy Practice, Samford University McWhorter School of Pharmacy, Birmingham, Alabama

Lisa R. Garavaglia, PharmD, BCPS

Pediatric Clinical Pharmacist, WVU Medicine; Adjunct Assistant Professor, West Virginia University School of Pharmacy, Morgantown, West Virginia

Justine S. Gortney, PharmD, BCPS

Assistant Professor of Pharmacy Practice, Wayne State University, Eugene Applebaum College of Pharmacy and Health Sciences, Detroit, Michigan

Leslie Hamilton, PharmD, BCPS

Associate Professor, Department of Clinical Pharmacy, College of Pharmacy, University of Tennessee, Knoxville, Tennessee

Jin Han, PharmD, PhD, BCPS

Clinical Pharmacist and Clinical Assistant Professor,
Department of Pharmacy Practice, University of Illinois at
Chicago College of Pharmacy, Chicago, Illinois

Cara A. Harshberger, PharmD, BCOP

Clinical Assistant Professor of Pharmacy Practice, School of
Pharmacy, University of Wyoming, Laramie, Wyoming

Deborah A. Hass, PharmD, BCOP, BCPS

Oncology Pharmacist, Mt. Auburn Hospital Cambridge,
Massachusetts

Lisa M. Holle, PharmD, BCOP

Assistant Clinical Professor, Department of Pharmacy Practice,
University of Connecticut School of Pharmacy, Storrs,
Connecticut; Assistant Professor, Department of Medicine,
University of Connecticut School of Medicine, Farmington,
Connecticut

Irma O. Jordan, DNP, APRN, FNP/PMHNP-BC

Assistant Professor, Retired, University of Tennessee, College of
Nursing, Hayden, Kentucky

Michelle D. Lesé, PharmD, BCPS

Assistant Professor of Pharmacy Practice, Lloyd L. Gregory
School of Pharmacy, Palm Beach Atlantic University, West
Palm Beach, Florida

Jennifer M. Malinowski, PharmD

Associate Professor, Pharmacy Practice, Nesbitt School of
Pharmacy, Wilkes University, Wilkes-Barre, Pennsylvania;
Director, Clinical Pharmacy Services Integration, The Wright
Center for Primary Care, Jermyn, Pennsylvania

Michael A. Mancano, PharmD

Chair, Department of Pharmacy Practice; Clinical Professor of
Pharmacy Practice, Temple University School of Pharmacy,
Philadelphia, Pennsylvania

Rupal Mansukhani, PharmD

Clinical Assistant Professor, Rutgers University, Piscataway,
New Jersey; Clinical Pharmacist, Morristown Medical Center,
Morristown, New Jersey

Mary Mihalyo, PharmD, BCPS, CGP, CDE

Assistant Professor Pharmacy Practice, Division of Clinical,
Social and Administrative Science, Duquesne University
School of Pharmacy, Pittsburgh, Pennsylvania

Rima A. Mohammad, PharmD, BCPS

Clinical Assistant Professor, Department of Clinical, Social, and
Administrative Services, College of Pharmacy and Health
System, University of Michigan, Ann Arbor, Michigan

Anne Moore, DNP, APN, FAANP

Nurse Practitioner, Women's Health and Adult Certification,
Division of Family Health and Wellness, Tennessee
Department of Health, Nashville, Tennessee

Candis M. Morello, PharmD, CDE

Professor of Clinical Pharmacy, Skaggs School of Pharmacy,
University of California, San Diego, La Jolla, California

Jadwiga Najib, BS, PharmD

Professor of Pharmacy Practice, Long Island University, Arnold
and Marie Schwartz College of Pharmacy and Health
Sciences, Brooklyn, New York, Clinical Pharmacist, Mount
Sinai Roosevelt Hospital Center, New York

Stephen Orr, MD

Ophthalmologist, Spectrum Eye Care, Inc., Findlay, Ohio

Victor Padron, RPh, PhD

Associate Professor of Pharmacy Practice, Creighton University,
Omaha, Nebraska

Robert B. Parker, PharmD

Professor, Department of Clinical Pharmacy, University of
Tennessee College of Pharmacy, Memphis, Tennessee

Maribel A. Pereiras, PharmD, BCPS, BCOP

Clinical Assistant Professor, Pharmacy Practice and
Administration, Ernest Mario School of Pharmacy, Rutgers
University, Piscataway, New Jersey; Clinical Pharmacist, John
Theurer Cancer Center, Hackensack University Medical
Center, Hackensack, New Jersey

Stephanie A. Plummer, DNP, APRN, PMHNP-BC, FNP

Assistant Professor, College of Nursing, University of Tennessee
Health Science Center, Memphis, Tennessee; Veterans
Healthcare System of the Ozarks, Fayetteville, Arkansas

Jeremy J. Prunty, PharmD, BCPS

Clinical Assistant Professor, West Virginia University School of
Pharmacy; Internal Medicine Clinical Pharmacy Specialist,
Cabell Huntington Hospital, Huntington, West Virginia

Shaunta' M. Ray, PharmD

Associate Professor, Department of Clinical Pharmacy, College
of Pharmacy, University of Tennessee, Knoxville, Tennessee

Michael Reed, PharmD, FCCP, FCP

Director, Rainbow Clinical Research Center, Rainbow Babies
and Children's Hospital, Cleveland, Ohio

Kelly C. Rogers, PharmD, FCCP

Professor, Department of Clinical Pharmacy, College of
Pharmacy, University of Tennessee, Memphis, Tennessee

Carol Rollins, MS, RD, PharmD, BCNSP, FASPEN, FASHP

Clinical Professor, University of Arizona, College of Pharmacy,
Tucson, Arizona

Tricia M. Russell, PharmD, BCPS, CDE

Medicare Formulary Clinical Pharmacist, OptumRx, Mountain
Top, Pennsylvania; Adjunct Instructor, Department of
Pharmacy, Nesbitt School of Pharmacy, Wilkes University,
Wilkes-Barre, Pennsylvania

Aline Saad, PharmD

Clinical Assistant Professor, Department of Pharmacy Practice,
School of Pharmacy, Lebanese American University, Byblos,
Lebanon

Maha Saad, PharmD, CGP, BCPS

Associate Clinical Professor, St. John's University College of
Pharmacy and Health Sciences, Queens, New York

JoAnne M. Saxe, DNP, ANP-BC, MS, FAAN

Health Sciences Clinical Professor, Department of Community Health Systems, School of Nursing, University of California San Francisco, San Francisco, California

Denise Schentrup, DNP, ARNP-BC

Associate Dean for Clinical Affairs, College of Nursing, University of Florida, Gainesville, Florida

Catherine N. Shull, PA-C, MPAS

Assistant Professor, Department of Physician Assistant Studies, Department of Family and Community Medicine, Wake Forest School of Medicine, Winston-Salem, North Carolina

J. Andrew Skirvin, PharmD, BCOP

Associate Clinical Professor, Department of Pharmacy and Health System Sciences, School of Pharmacy, Northeastern University, Boston, Massachusetts

April Smith, PharmD, BCPS

Assistant Professor of Pharmacy Practice, Creighton University, Omaha, Nebraska

Michael A. Smith, PharmD, BCPS

Assistant Professor of Clinical Pharmacy, Philadelphia College of Pharmacy, University of the Sciences, Philadelphia, Pennsylvania

Jacqueline Jordan Spiegel, MS, PA-C

Associate Professor, College of Health Sciences, Director, Clinical Skills and Simulation, Midwestern University, Glendale, Arizona

Sneha Baxi Srivastava, PharmD, BCACP

Clinical Associate Professor, Pharmacy Practice, Chicago State University College of Pharmacy, Chicago, Illinois

Javad Tafreshi, PharmD, BCPS-AQ Cardiology, FAHA

Professor and Chair, Department of Pharmacy Practice, Director, PGY2 Cardiology Pharmacy Practice Residency Program, Loma Linda University School of Pharmacy, Loma Linda, California

Justin B. Usery, PharmD, BCPS

Internal Medicine/Infectious Disease Pharmacy Specialist, Methodist University Hospital; Associate Professor, College of Pharmacy, University of Tennessee, Memphis, Tennessee

Kurt Wargo, PharmD, BCPS(AQ-ID)

Associate Clinical Professor, Auburn University Harrison School of Pharmacy, Huntsville, Alabama

Kimberly M. Welch, PharmD, BCPS

Inpatient Clinical Pharmacist, James H. Quillen Veterans Affairs Medical Center, Mountain Home, Tennessee

Christine M. Werner, PhD, PA-C, RD

Professor, Department of Physician Assistant Education, Doisy College of Health Sciences, Saint Louis University, St. Louis, Missouri

Thomas White, JD, PA-C

Associate Professor, Physician Assistant Program, Westbrook College of Health Professions, University of New England, Portland, Maine

Jon P. Wietholter, PharmD, BCPS

Clinical Associate Professor, West Virginia University School of Pharmacy; Internal Medicine Clinical Pharmacist, WVU Medicine Ruby Memorial Hospital, Morgantown, West Virginia

Monty Yoder, PharmD, BCPS

Clinical Specialist, Department of Pharmacy, Wake Forest Baptist Health; Assistant Clinical Professor, Wake Forest School of Medicine, Winston-Salem, North Carolina

This page intentionally left blank

PREFACE

Use of effective and safe pharmacotherapy is a cornerstone of appropriate patient care for both acute and chronic medical conditions. Although the biomedical research enterprise continues to provide medications that have enormous potential to improve individual patient and population health outcomes, these agents are too often applied inappropriately and ineffectively. Consequently, many patients do not achieve the best possible outcomes or incur harm from their drug therapy.

Appropriate implementation and management of high-quality, cost-effective pharmacotherapy by health care providers requires an integration of scientific knowledge and clinical practice skills combined with a fiduciary responsibility to put the patient's needs first. The development of mature, independent pharmacotherapists occurs through structured learning processes that include formal coursework, independent study, mentorship, and direct involvement in the care of actual patients in interprofessional settings.

The fourth edition of *Pharmacotherapy Principles & Practice* is designed to provide student learners and health care practitioners with essential knowledge of the pathophysiology and pharmacotherapeutics of disease states likely to be encountered in routine practice. Chapters are written by content experts and peer reviewed by clinical pharmacists, nurse practitioners, physician assistants, and physicians who are authorities in their fields.

Pharmacotherapy Principles & Practice, fourth edition, opens with an introductory chapter followed by chapters on pediatrics, geriatrics, and palliative care. The remainder of the book consists of 98 disease-based chapters that review disease etiology, epidemiology, pathophysiology, and clinical presentation, followed by clear therapeutic recommendations for drug selection, dosing, and patient monitoring. The following features were designed in collaboration with educational design specialists to enhance learning and retention:

- *Structured learning objectives* at the beginning of each chapter, with information in the text that corresponds to each learning objective identified by a vertical rule in the margin, allowing the reader to quickly find content related to each objective.
- *Key concepts related to patient assessment and treatment* highlighted with an easily identifiable icon throughout the chapter.
- *Patient encounters* that facilitate development of critical thinking skills and lend clinical relevance to the scientific foundation provided.
- A new section on the *patient care process* that provides specific recommendations about the process of care for an individual patient, from the initial patient assessment through therapy evaluation, care plan development, and follow-up monitoring.

- *Up-to-date literature citations* for each chapter to support treatment recommendations.
- *Tables, figures, and algorithms* that enhance understanding of pathophysiology, clinical presentation, medication selection, pharmacokinetics, and patient monitoring.
- *Medical abbreviations and their meanings* at the end of each chapter to facilitate learning the accepted shorthand used in real-world health care settings.
- *Self-assessment questions and answers for each chapter* in the Online Learning Center to facilitate self-evaluation of learning.
- *Laboratory values* expressed as both conventional units and Système International (SI) units.
- *Appendices* that contain: (1) conversion factors and anthropometrics; (2) common medical abbreviations; (3) glossary of medical terms (the first use of each term in a chapter appears in bold, colored font); and (4) prescription writing principles.
- *A table of common laboratory tests and reference ranges* appears on the inside covers of the book.

A companion textbook, *Pharmacotherapy Principles and Practice Study Guide: A Case-Based Care Plan Approach*, is available to further enhance learning by guiding students through the process of applying knowledge of pharmacotherapy to specific patient cases. This study guide contains approximately 100 patient cases that correspond to chapters published in the textbook.

The Online Learning Center at www.ChisholmPharmacotherapy.com provides self-assessment questions, grading and immediate feedback on the questions, and reporting capabilities. The complete textbook and study guide are now available to subscribers of the publisher's AccessPharmacy site (www.accesspharmacy.com), an online educational resource for faculty and students of the health professions.

We acknowledge the commitment and dedication of more than 185 contributing authors and more than 65 peer reviewers of the chapters in this new edition. We are also grateful to many educators and institutions that have adopted this text in their courses. Finally, we extend our sincere thanks to the McGraw-Hill Professional editorial team, especially Michael Weitz, Peter Boyle, and Laura Libretti, for their dedication in bringing this new edition to you.

The Editors
February 2016

This page intentionally left blank

Part I

Basic Concepts of Pharmacotherapy Principles and Practices

This page intentionally left blank

1

Introduction

Jack E. Fincham

INTRODUCTION

Health professionals are given significant responsibilities in our health care system. These roles may be taken for granted by patients until a pharmacist, nurse practitioner, physician assistant, physician, or others perform assigned tasks that make major impacts upon patients and patients' families lives in countless ways. The exemplary manner in which health professionals provide necessary care to patients is a hallmark of health professional practice and delivery of US health care. Patients are thus well served, and fellow health professionals share knowledge and expertise specific to their profession. However, there are significant problems remaining in the US health care system from a structural standpoint. The United States spends 17% to 18% of the gross domestic product (GDP) on health care, yet the United States ranks 37th in the world considering outcomes of care. Comparing the United States to similar industrialized countries, we rank 11th out of 11 comparator countries.¹

The uninsured remain a major concern. There were close to 45.2 million uninsured individuals in the United States in 2012, representing 16.9% of the population.² This significant number exists despite the institution of health care reform in the United States beginning in 2010. Even with health care reform, the number of uninsured younger than 65 years has decreased only 1.3%. Simply stated, this uninsured segment of the US population is simply staggering in scope and implications for the future collective health of the US population.

Countless other Americans in our midst are underinsured. They may have partial coverage after a fashion, but for these Americans the high price of deductibles, co-pays, and monthly payments for insurance create an economic dilemma for individuals each time they seek care or pay premiums. Recent expenditure data indicate that in 2013, \$3.8 trillion was spent on health care in the United States during 2013³ and \$329.2 billion was spent for prescriptions.⁴

There are tremendous opportunities for health professionals due to the implementation the Patient Protection and Affordable Care Act (PPACA). For the first time in the structure of the US health care system, there is a tangible, significant effort to enhance the quality and outcomes of health care delivered. Now payment mechanisms are in place to demand the evidence of quality of health care delivered, regardless of point of delivery of services. If the quality is not there, reimbursement will be decreased, increased, or stay static in monetary values provided to providers.⁵ The intent of these measures is to reduce and/or eliminate unnecessary expenditures and duplicative health care service in the United States.

The use of medications in the health care system provides enormous help to many; lives are saved or enhanced, and life

spans are lengthened. Many other uses of medications lead to significant side effects, worsening states of health, and premature deaths. So, how to separate these disparate pictures of drug use outcomes? You, within your practices and within your networks in the health care workplace, can help to promote the former and diminish the latter. The authors of the chapters in this book have written informative, current, and superb chapters that can empower you to positively influence medication use.

DRUG USE IN THE HEALTH CARE SYSTEM

Spending on drugs, as a percentage of what was spent on health care in total, increased 3.2% in 2013 compared to the previous year.⁶ Drivers for this significant increase include increasing numbers of therapy innovative products and price increases for agents not facing patent expirations.

Prescription medications are used daily; 48.5% of the population uses one prescription drug daily, 21.7% use three or more drugs daily, and 10.6% use five or more prescription drugs daily.² Problems occurring with the use of drugs can include:

- Medication errors
- Suboptimal drug, dose, regimen, dosage form, and duration of use
- Unnecessary drug therapy
- Therapeutic duplication
- Drug–drug, drug–disease, drug–food, or drug–nutrient interactions
- Drug allergies
- Adverse drug effects, some of which are preventable

Clinicians are often called upon to resolve problems that occur due to undertreatment, overtreatment, or inappropriate treatment. Individuals can purchase medications through numerous outlets. Over-the-counter (OTC) medications can be purchased virtually anywhere. OTCs are widely used by all age groups. Prescription medications can be purchased through traditional channels (community chain and independent pharmacies), from mail-order pharmacies, through the Internet, from physicians, from health care institutions, and elsewhere. Herbal remedies are marketed and sold in numerous outlets. The monitoring of positive and negative outcomes of the use of these drugs, both prescription and OTC, can be disjointed and incomplete. Clinicians and health professionals need to take ownership of these problems and improve patient outcomes resulting from drug use.

Although clinicians are the gatekeepers for patients to obtain prescription drugs, patients obtain prescription medications from numerous sources. Patients may also borrow from friends, relatives, or even casual acquaintances. In addition, patients

obtain OTC medications from physicians through prescriptions, on advice from pharmacists and other health professionals, through self-selection, or through the recommendations of friends or acquaintances. Through all of this, it must be recognized that there are both formal (structural) and informal (word-of-mouth) components at play. Health professionals may or may not be consulted regarding the use of medications, and in some cases are unaware of the drugs patients are taking.

External variables may greatly influence patients and their drug-taking behaviors. Coverage for prescribed drugs allows those with coverage to obtain medications with varying cost-sharing requirements. However, many do not have insurance coverage for drugs or other health-related needs.

Self-Medication

Self-medication can be broadly defined as a decision made by a patient to consume a drug with or without the approval or direction of a health professional. The self-medication activities of patients have increased dramatically in the late 20th and early 21st centuries. Many factors affecting patients have continued to fuel this increase in self-medication. There have been many prescription items switched to OTC classification in the last 50 years, which is dramatically and significantly fueling the rapid expansion of OTC drug usage. In addition, patients are increasingly comfortable with self-diagnosing and self-selection of OTC remedies.

Through the rational use of drugs, patients may avoid more costly therapies or expenditures for other professional services. Self-limiting conditions, and even some chronic health conditions (eg, allergies and dermatologic conditions), if appropriately treated through patient self-medication, allow the patient to have a degree of autonomy in health care decisions.

Compliance Issues

Noncompliance with prescription regimens is one of the most understated problems in the health care system. Approximately 10% of initial prescriptions written by physicians are never filled.⁶ Reasons can include trying too soon to obtain a new prescription, prior approval requirements, the prescribed drug may not be covered under the patient's insurance, etc. The effects of noncompliance have enormous ramifications for patients, caregivers, and health professionals. Noncompliance is a multifaceted problem with a need for interprofessional, multidisciplinary solutions. Interventions that are organizational (how clinics are structured), educational (patient counseling, supportive approach), and behavioral (impacting health beliefs and expectations) are necessary. Compliant behavior can be enhanced through your actions with the patients for whom you provide care. Sometimes what is necessary is referral to specific clinicians for individualized treatment and monitoring to enhance compliance. The case histories provided in this textbook will allow you to follow what others have done in similar situations to optimally help patients succeed in improving compliance rates and subsequent positive health outcomes.

Drug Use by the Elderly

The major source of payment for prescription drugs for those aged 65 years and older in the United States is the Medicare Part D Drug Benefit. Seniors have benefitted tremendously from this component. Estimates place the expenditure for Medicare Part D to be \$58 billion in 2014; this is 11% of Medicare expenditures.⁷ Since the inception of Medicare Part D, recipients have had to pay costs after initial minimum threshold amounts are reached, then enter the so-called "donut hole" requiring payment out of

pocket until a certain amount would be paid, and then coverage for payment would ensue. This so called donut hole closes in 2020, which will provide more benefits for more enrollees. At that point, estimates place Medicare Part D payments to account for 16% of Medicare expenditures.⁷ Enhanced use of pharmacoeconomic tenets to select appropriate therapy, while considering cost and therapeutic benefits for seniors and others, will become even more crucial for clinicians in the future.

Unnecessary drug therapy and overmedication are problems with drug use in the elderly. Cost estimates are projected to be \$1.3 billion per year for elderly patient polypharmacy alone.⁴ A joint effort by health professionals working together is the best approach to aiding seniors in achieving optimal drug therapy. Evaluation of all medications taken by seniors at each patient visit can help prevent polypharmacy from occurring.⁸

IMPACTING THE PROBLEMS OF DRUG USE

Medication Errors

There is a tremendous opportunity in medication use and monitoring for working to reduce medication errors. Untold morbidity and mortality occur due to the many errors occurring in medication use. Studies have shown that reconciling the medications that patients take, with coordination by various caregivers providing care, can help reduce medication errors in patient populations.¹¹ Current changes in how drugs are prescribed, such as electronic prescribing, bar code identification of patients, and electronic medication records, can and have helped to reduce medication errors.^{9,10}

The incorporation of three key interventions (computerized physician order entry [CPOE], additional staffing, and bar coding) have been shown in an institutional setting to help reduce medication errors.¹⁰ Being able to track drug ordering, dispensing, and administration electronically has been shown to be cost-effective in the long run.¹¹ Nurses and office staff have been proven as a valuable resource for reporting prescribing errors, especially with ongoing reminders to scrutinize orders.¹²

HEALTH CARE REFORM

The potential for health care reform to enhance patient outcomes and the quality of care provided to Americans is very significant. The inclusion of health professionals in segments of the innovative medical homes and accountable care organizations will help all health care providers reach more patients needing care.¹³

DiPiro and Davis¹⁴ noted that now and in the future, there will be an important and expectant need for pharmacists to focus on health outcomes and documentation of quality to fully participate in the new health care models that are a focus of health care reform. These authors point to accountable care organizations and patient centered medical homes as innovative models for health professionals to more fully participate.

There are also covered preventive aspects enabled by the PPACA that include immunizations, screenings, and other offering. The provision of these preventive activities by health professionals will serve patients over the long term and work to prevent costly care later on.

SUMMARY

Health professionals are at a crucial juncture facing an uncertain, yet promising future. Technological advances, including electronic prescribing, may stem the tide of medication errors and inappropriate prescribing. These technological enhancements

for physician order entry (via personal data assistants or through web access to pharmacies) have been implemented to reduce drug errors. The skills and knowledge that enable effective practice have never been more daunting among the numerous health professions. Technology can further empower health professionals to play an effective role in helping patients and fellow health professionals to practice safe and effective medicine. Health care reform has the potential to dramatically impact your practices in the health care system for the length of your careers. There is also current, and no doubt future, enhanced use of health care apps available to consumers. Consumer computer apps have pervaded many aspects of society, including health care.¹⁵ Consumer apps, although many in number, have not gained widespread use at present; it may be that there are simply too many in number and their utility has not yet been widely adopted.

The use of this text, which incorporates materials written by the finest minds in pharmacy practice and education, can enable the reader to play a crucial role in improving the drug use process for patients, providers, payers, and society. The thorough analysis of common disease states, discussion of therapies to treat these conditions, and specific advice for patients will help you in your practices. The purpose of this book is to help you make a real improvement in the therapies you provide to your patients. Current and future clinicians can rely on the information laid out here to enhance your knowledge and allow you to assist your patients with the sound advice that they expect you to provide. Use the text, case histories, and numerous examples here to expand your therapeutic skills, and to help positively impact your patients in the years to come.

You can help to reverse medication-related problems, improve outcomes of care both clinically and economically, and enable drug use to meet stated goals and objectives. This text provides a thorough analysis and summary of treatment options for commonly occurring diseases and the medications or alternative therapies used to successfully treat these conditions.

Abbreviations Introduced in This Chapter

CPOE	computerized physician order entry
GDP	gross domestic product
OTC	over-the-counter
PPACA	Patient Protection and Affordable Care Act

REFERENCES

1. Davis K, Stremikis K, Schoen C, Squires D. Mirror, mirror on the wall, 2014 update: how the U.S. health care system compares internationally. New York: The Commonwealth Fund, June 2014.

- National Center for Health Statistics. Health, United States, 2013: with special feature on prescription drugs. Hyattsville, MD: National Center for Health Statistics; 2014.
- Munro D. Annual U.S. health care spending hits \$3.8 trillion. *Forbes PHARMA and Health Care* [Internet]. Jersey City (NJ): Forbes; 2014 Feb 2 [cited 2015 Jul 7]. Available from: <http://www.forbes.com/sites/danmunro/2014/02/02/annual-u-s-healthcare-spending-hits-3-8-trillion/>.
- Aitken H, Valkova S. Exhibit 1: avoidable U.S. healthcare costs add up to \$213 billion. Avoidable costs in U.S. Healthcare: the \$200 billion opportunity from using medicines more responsibly. Report by the IMS Institute for Healthcare Informatics. Parsippany (NJ): IMS Institute for Healthcare Informatics; June 2013: p. 3.
- Emanuel EJ. Reinventing American health care: how the Affordable Care Act will improve our terribly complex, blatantly unjust, outrageously expensive, grossly inefficient, error prone system. New York, NY: PublicAffairs, 2014.
- Aitken M, Kleinrock M, Lyle J, Caskey L. Introduction. Medicine use and shifting costs of healthcare. Report by the IMS Institute for Healthcare Informatics. Parsippany (NJ): IMS Institute for Healthcare Informatics; April 2014: p. 2.
- The Medicare Part D Prescription Drug Benefit [Internet]. Menlo Park (CA): The Henry J. Kaiser Family Foundation; 2013 Nov [cited 2015 Jul 7]. Available from: <http://kaiserfamilyfoundation.files.wordpress.com/2013/11/7044-14-medicare-part-d-fact-sheet.pdf>.
- Hajjar ER, Cafiero AC, Hanlon JT. Polypharmacy in elderly patients. *Am J Geriatr Pharmacother*. 2007;5:345–351.
- Fincham JE. e-prescribing: The Electronic Transformation of Medicine. Sudbury, MA: Jones and Bartlett Publishers, 2009.
- Franklin BD, O'Grady K, Donyai P, Jacklin A, Barber N. The impact of a closed-loop electronic prescribing and administration system on prescribing errors, administration errors and staff time: a before-and-after study. *Qual Saf Health Care*. 2007;16:279–284.
- Karnon J, McIntosh A, Dean J, et al. Modelling the expected net benefits of interventions to reduce the burden of medication errors. *J Health Serv Res Policy*. 2008;13:85–91.
- Kennedy AG, Littenberg B, Senders JW. Using nurses and office staff to report prescribing errors in primary care. *Int J Qual Health Care*. 2008;20:238–245.
- Smith M, Bates DW, Bodenheimer T, Cleary PD. Why pharmacists belong in the medical home. *Health Aff*. 2010;29(5):906–913.
- DiPiro JT, Davis RE. New questions for pharmacists in the health care system. *Am J Pharm Educ*. 2014;78(2):26.
- Aitken M, Gauntlett C. Profiling widely available consumer health-care apps. Patient Apps for Improved Healthcare: From Novelty to Main-stream. Report by the IMS Institute for Healthcare Informatics. Parsippany, NJ: IMS Institute for Healthcare Informatics; October 2013, Chap. 1: p. 6.

This page intentionally left blank

2

Geriatrics

Jeannie K. Lee, Damian M. Mendoza,
M. Jane Mohler, and Ellyn M. Lee

LEARNING OBJECTIVES

Upon completion of the chapter, the reader will be able to:

1. Explain changing aging population demographics.
2. Discuss age-related pharmacokinetic and pharmacodynamic changes.
3. Identify drug-related problems and associated morbidities commonly experienced by older adults.
4. Describe major components of geriatric assessment.
5. Recognize interprofessional patient care functions in various geriatric practice settings.

INTRODUCTION

The growth of the aging population and increasing lifespan require that health care professionals gain knowledge necessary to meeting the needs of this patient group. Despite the availability and benefit of numerous pharmacotherapies to treat their diseases, older patients commonly experience drug-related problems resulting in additional morbidities. Therefore, it is essential for clinicians serving older adults across all health care settings to understand the epidemiology of aging, age-related physiological changes, drug-related problems prevalent in the elderly, comprehensive geriatric assessment, and interprofessional approaches to geriatric care.

EPIDEMIOLOGY AND ETIOLOGY

As humans age, they are at increasing risk of disease, disability, and death for three reasons: (a) genetic predisposition; (b) reduced immunological surveillance; and (c) the accumulated effects of physical, social, environmental, and behavioral exposures over the life course. All elders experience increasing vulnerability (**homeostenosis**) as they age, resulting in considerable heterogeneity in health states and care requirements. While resilient elders can maintain high levels of physical and cognitive functioning, others suffer functional decline, **frailty**, disability, or premature death. There is an urgent need for all clinicians to better understand the epidemiology of aging to comprehensively provide high-value services to optimize functioning and health-related quality of life of older adults.¹

Sociodemographics

► Population

KEY CONCEPT *Our population is rapidly growing older.* In 2010, 40.3 million US residents were 65 years and older (13% of the total population), nearly 5.5 million people were 85 years or older (the “oldest-old”), and over 53,000 were centenarians.² The baby boomers (those born between 1946 and 1964) began turning

65 years in 2011; their numbers will double to 83.7 million in the year 2050, representing over 20% of the total US population.³ In 2010, there were a total of 22.9 million women and 17.4 million men (an average ratio of 100 women to 77.3 men) 65 years and older; this ratio widens as elders age. The oldest-old are projected to increase from 5.3 million in 2006 to nearly 21 million in 2050.³ In addition, minority elders are projected to increase to 12.9 million in 2020.³ Surviving baby boomers will be disproportionately female, more ethnically/racially diverse, better educated, and have more financial resources than were elders in previous generations.

► Economics

More elders are enjoying higher economic prosperity than ever before, although major inequalities persist, with older blacks and those without high school diplomas reporting fewer financial resources.⁴ Considerable disparities exist, and may prevent less advantaged elders from being able to purchase all prescribed medications.

► Education and Health Literacy

By 2007, more than 75% of US elders had graduated from high school, and nearly 20% had a bachelor’s degree or higher. Still, substantial educational differences exist among racial and ethnic minorities. While more than 80% of non-Hispanic white elders had high school degrees in 2007, 72% of Asians, 58% of blacks, and 42% of Hispanic elders were graduates. Nearly 40% of people 75 years or older have low **health literacy**, more than any other age group.⁴ Despite these limitations, the Pew Trust reports that more than 8 million Americans (22%) 65 years or older increasingly use the Internet,⁵ and large health care systems are increasingly offering online health information to older health consumers. These advances are important because communication between health care providers and elders is vital in providing quality care, supporting self-care, and in negotiating transitions of care.

Health Status

► Life Expectancy

Although Americans are living longer than ever before, an estimated average of 78.14 years overall in 2008, US life expectancy lags behind that of many other industrialized nations.⁶ There is nearly a 6-year gap between 2008 estimated life expectancy in men (75.29 years) and women (81.13 years).⁶ Disparities in mortality persist, with estimated 2008 life expectancy in the white population nearly 5 years higher than that of the black population.⁶ Nearly 35% of US deaths in 2000 were attributed to three risk behaviors: smoking, poor diet, and physical inactivity. Currently, only 9% of Americans older than 65 years smoke; however, nearly 54% of men and 21% of women are former smokers.⁷ Overweight elders 65 to 74 years of age increased from 57% to 73% in 2004 largely due to inactivity and a diet high in refined foods, saturated fats, and sugared beverages.⁴ Despite the proven health benefits of regular physical activity, more than half of the older population is sedentary; 47% of those 65 to 74 years and 61% older than 75 years report no physical activity.⁸

The 2007 National Health Interview Survey indicated that 39% of non-Hispanic white elders reported “very good” or “excellent” health, compared with 29% of Hispanics and 24% of blacks.⁹ Approximately 80% of older adults have at least one chronic condition, and 50% have at least two. The prevalence of certain chronic conditions differs by sex, with women reporting higher levels of arthritis (54% vs 43%), and men reporting higher levels of heart disease (37% vs 26%) and cancer (24% vs 19%).⁵ Among the 15 leading causes of death, age-adjusted death rates decreased significantly from 2004 to 2005 for the top three leading causes: heart disease (33%), cancer (22%), and stroke (8%); while rates of chronic lower respiratory diseases, unintentional injuries, Alzheimer disease, influenza and pneumonia, hypertension, and Parkinson disease increased.⁶ Figure 2-1 specifies the most common chronic conditions of older adults by sex. Frailty is a common biological syndrome in the elderly. Once frail, elders may rapidly progress toward failure to thrive and death. Only 3% to 7% of elders between the ages of 65 and 75 years are frail, increasing to more than 32% in those older than 90 years.¹⁰

Patient Encounter, Part 1

CC is an 80-year-old woman who lived in Mexico until just after her 67th birthday when she moved to the United States to take care of her grandchildren. Her daughter was promoted at work and required more travel, so asked CC for help with the children. CC finished eighth grade in Mexico, speaks almost no English, therefore has low health literacy. She was referred to the Interprofessional Geriatrics Clinic for a comprehensive care of multiple chronic conditions, including hypertension, diabetes, stroke, seizure disorder, arthritis, depression, insomnia, and glaucoma. CC uses 14 medications for the described conditions and supplements from Mexico for “general health.” She is overweight and reports eating high amount of refined foods because she cooks for her grandchildren only. She watches TV most of the day while the kids are at school.

What information is consistent with epidemiology of aging?

Which of CC's medical conditions are commonly found in older adults?

What additional information do you need before conducting a comprehensive medication review?

► Health Care Utilization and Cost

KEY CONCEPT Older Americans use more health care services than younger Americans do. Although hospital stays for those 65 years and older decreased by half from 1970 to 2010 (12.6 vs 5.5 days), they accounted for more than 65% of hospitalizations overall, with longer lengths of stay corresponding to increasing age.¹¹ In 2010 there were 1.3 million (3.6%) US nursing home residents aged 65 and older, and as the aged live longer, more will require assistance, which will be increasingly performed in the home. Health care costs among older Americans are three to five times greater than the cost for someone younger than 65 years.

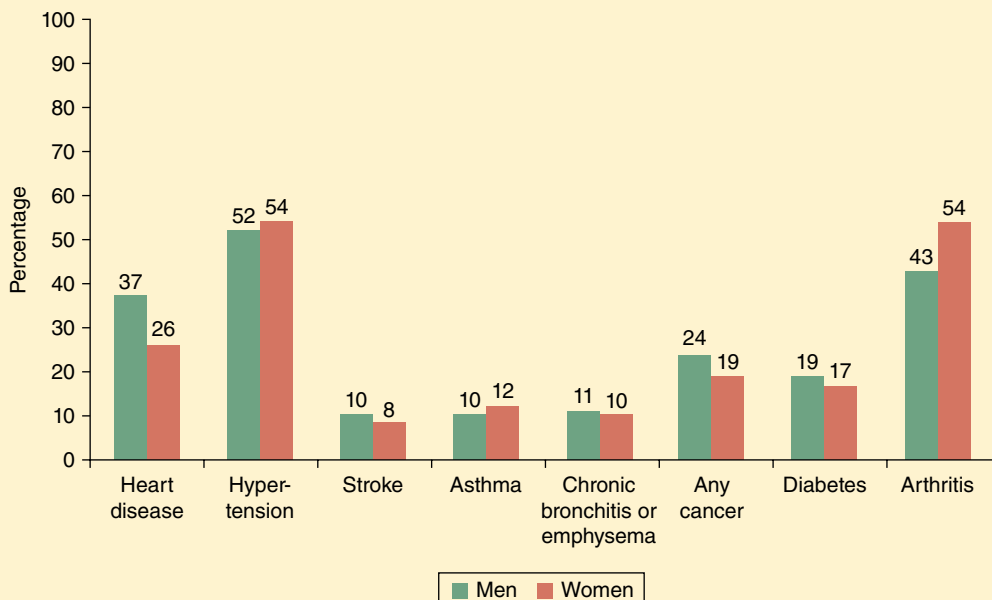


FIGURE 2-1. Percentage of people 65 years and older who reported having selected chronic conditions, by sex, 2005 to 2006. Note: Data are based on a 2-year average from 2005 to 2006. Reference population: These data refer to the noninstitutionalized population. (From Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey.)

Medicare plays a major role in health care costs, accounting for 20% of total US health spending in 2012, 27% of spending on hospital care, and 23% of spending on physician services.¹²

By applying the epidemiology of aging, clinicians can better intervene with pharmacotherapy to postpone disease, disability, and mortality, and promote health, functioning, and health-related quality of life.

AGE-RELATED CHANGES

In basic terms, pharmacokinetics is what the body does to the drug, and pharmacodynamics is what the drug does to the body.

KEY CONCEPT All four components of pharmacokinetics—absorption, distribution, metabolism, and excretion—are affected by aging; the most clinically important and consistent is the reduction of renal elimination of drugs.¹³ As people age, they can become more frail and are more likely to experience altered and variable drug pharmacokinetics and pharmacodynamics. Even though this alteration is influenced more by a patient's clinical state than their chronological age, the older patient is more likely to be malnourished and suffering from diseases that affect pharmacokinetics and pharmacodynamics.¹⁴ Clinicians have the responsibility to use pharmacokinetic and pharmacodynamic principles to improve the care of older patients and avoid adverse effects of pharmacotherapy.

Pharmacokinetic Changes

► Absorption

Multiple changes occur throughout the gastrointestinal (GI) tract with aging, but little evidence indicates that drug absorption is significantly altered. The changes include decreases in overall surface of the intestinal epithelium, gastric acid secretion, and splanchnic blood flow.¹³ Peristalsis is weaker and gastric emptying delayed. These changes slow absorption in the stomach, especially for enteric-coated and delayed-release preparations. Delays in absorption may lead to a longer time required to achieve peak drug effects, but it does not significantly alter the amount of drug absorbed, and drug movement from the GI tract into circulation is not meaningfully changed.^{13,14} However, relative **achlorhydria** can decrease the absorption of nutrients such as vitamin B₁₂, calcium, and iron.¹⁴

Aging facilitates atrophy of the epidermis and dermis along with a reduction in barrier function of the skin. Tissue blood perfusion is reduced, leading to decreased or variable rates of transdermal, subcutaneous, and intramuscular drug absorption. Therefore, intramuscular injections should generally be avoided in the elderly due to unpredictable drug absorption.¹³ Additionally, because saliva production decreases with age, medications that need to be absorbed rapidly by the buccal mucosa are absorbed at a slower rate.¹⁴ Yet, for most drugs, absorption is not significantly affected in older patients and the changes described are clinically inconsequential.¹⁵

► Distribution

Main physiological changes that affect distribution of drugs in older adults are changes in body fat and water, and in protein binding. Lean body mass can decrease by 12% to 19% through loss of skeletal muscle in the elderly. Thus, blood levels of drugs primarily distributed in muscle increase (eg, digoxin), presenting a risk for overdose.¹⁴ While lean muscle mass decreases, adipose tissue can increase with aging by 18% to 36% in men and 33% to 45% in women. Therefore, fat-soluble drugs (eg, diazepam,

amiodarone, and verapamil) have increased volume of distribution (V_d), leading to higher tissue concentrations and prolonged duration of action. Greater V_d leads to increased half-life and time required to reach steady-state serum concentration.^{13,14}

Total body water decreases by 10% to 15% by age 80. This lowers V_d of hydrophilic drugs (eg, aspirin, lithium, and ethanol) leading to higher plasma drug concentrations than in younger adults when equal doses are used.^{13,14} Toxic drug effects may be enhanced when dehydration occurs and when the extracellular space is reduced by diuretic use.

Likewise, plasma albumin concentration decreases by 10% to 20%, although disease and malnutrition contribute more to this decrease than age alone.¹³ In patients with an acute illness, rapid decreases in serum albumin can increase drug effects. Examples of highly protein-bound drugs include warfarin, phenytoin, and diazepam.¹⁴ For most chronic medications, these changes are not clinically important because although the changes affect peak level of a single dose, mean serum concentrations at steady state are not altered unless clearance is affected.¹⁴ For highly protein-bound drugs with narrow therapeutic indices (eg, phenytoin), however, it is important to appropriately interpret serum drug levels in light of the older patient's albumin status. In a malnourished patient with hypoalbuminemia, a higher percentage of the total drug level consists of free drug than in a patient with normal serum albumin. Thus, if a hypoalbuminemic patient has a low total phenytoin level and the phenytoin dose is increased, the free phenytoin concentration may rise to a toxic level.¹⁵

► Metabolism

Drug metabolism is affected by age, acute and chronic diseases, and drug-drug interactions. The liver is the primary site of drug metabolism, which undergoes changes with age; though the decline is not consistent, older patients have decreased metabolism of many drugs.^{13,15} Liver mass is reduced by 20% to 30% with advancing age, and hepatic blood flow is decreased by as much as 40%. These changes can drastically reduce the amount of drug delivered to the liver per unit of time, reduce its metabolism, and increase the half-life.¹⁴ Metabolic clearance of some drugs is decreased by 20% to 40% (eg, amiodarone, amitriptyline, warfarin, and verapamil), but it is unchanged for drugs with a low hepatic extraction.¹⁴ Drugs that have high **extraction ratios** have significant first-pass metabolism, resulting in higher bioavailability for older adults. For example, the effect of morphine is increased due to a decrease in clearance by around 33%. Similar increases in bioavailability can be seen with propranolol, levodopa, and statins. Thus, older patients may experience a similar clinical response to that of younger patients using lower doses of these medications.¹⁴

The effect of aging on liver enzymes (cytochrome P-450 system [CYP450]) may lead to a decreased elimination rate of drugs that undergo oxidative phase I metabolism, but this is controversial.¹³ Originally, it was thought that the CYP450 system was impaired in the elderly, leading to decreased drug clearance and increased serum half-life, but studies have not consistently confirmed this. Thus, variations in the CYP450 activity may not be due to aging but to lifestyle (eg, smoking), illness, or drug interactions.^{14,15} A patient's nutritional status plays a role in drug metabolism as well. Frail elderly have a more diminished drug metabolism than those with healthy body weight.¹³ Aging does not affect drugs that undergo phase II hepatic metabolism, known as conjugation or glucuronidation, but conjugation is reduced with frailty. Temazepam and lorazepam are examples of drugs that undergo phase II metabolism.¹⁴