

ELEVENTH Edition

# APPLIED THERAPEUTICS

The Clinical Use of Drugs

Caroline S. Zeind

Michael G. Carvalho



Wolters Kluwer

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## The Clinical Use of Drugs

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The editors wish to express their sincere thanks to Dr. Mary Anne Koda-Kimble and Dr. Lloyd Young who created Applied Therapeutics, the gold standard textbook used in the teaching of patient-centered drug therapeutics. Their vision and legendary contributions have inspired generations of health profession students, faculty, and clinicians. We are grateful to the past editors and current editorial team and contributors, as well as faculty colleagues and clinicians across the globe for their tremendous dedication to their patients and their communities. They have shaped and inspired the next generation of health care professionals through innovative teaching, mentoring, and dissemination of their scholarship. Finally, we wish to thank our families for their patience and understanding as we embarked on this journey and completed this eleventh edition of the textbook.



## Preface

It has been over forty years since the first edition of *Applied Therapeutics: The Clinical Use of Drugs* was published, and the landscape of health care has changed dramatically. While we have seen tremendous scientific and technologic advancements transform personalized medicine, we also realize the significant challenges that we face within our increasingly complex health care delivery system. More than ever, we are in need of health professionals who are able to think critically and to utilize problem-solving skills to improve patient outcomes. Approximately four decades later, the founding principle for this textbook—a patient-centric, case-based approach to learning—remains the cornerstone of health professions education. Our authors present approximately 900 patient cases that stimulate the reader to integrate and apply therapeutic principles in the context of specific clinical situations. Health profession students and practitioners gain a glimpse into the minds of clinicians as they work to assess and solve therapeutic problems and develop their own critical-thinking and problem-solving skills.

Readers familiar with past editions of the book will notice that the overall design of the book is consistent with the tenth edition, which incorporates a Core Principles section at the beginning of each chapter, providing the most important “take home” information from the chapter. Each Core Principle is mapped to specific cases within the chapter where the principle is discussed in detail. Key references and websites are listed at the end of each chapter, whereas the full reference lists for each chapter have been moved online.

Building upon the excellent foundation of case-based learning provided in previous editions, the eleventh edition has incorporated changes to meet the evolving educational needs of health profession educators and students across the globe. The editors and contributors have utilized the five Institute of Medicine (IOM) core competencies as a broad framework for proposing case studies and questions within the textbook: patient-centered care; interdisciplinary teams; evidence-based practice; quality improvement; and informatics. In addition, the Accreditation Council for Pharmacy Education (ACPE) Accreditation Standards 2016, the Center for the Advancement of Pharmacy Education (CAPE) Educational Outcomes, and the North American Pharmacist Licensure Examination (NAPLEX) revised competency statements have served as road maps for the editorial team and contributors in designing the eleventh edition.

Featuring contributions from more than 200 experienced clinicians, every chapter

has been revised and updated to reflect our ever-changing knowledge of drugs and the application of this knowledge to the individualized therapy of patients. Content within several sections has been extensively reorganized, with new chapters introduced to expand important topics. Among these are seven new chapters within the General Principles, Immunologic Disorders, Rheumatic and Musculoskeletal Diseases, Neurologic Disorders, Psychiatric Disorders & Substance Abuse, and Hematology and Oncology sections. Of particular note are featured new chapters in the General Principles section on Drug Interactions, Pharmacogenomics and Personalized Medicine, and Interprofessional Education and Practice. In addition, a chapter has been redesigned to focus on Care of the Critically Ill Adult, which now complements the chapter on Care of the Critically Ill Child.

Given the importance of incorporating Interprofessional Education (IPE) within the didactic, practicum, and clinical settings, we have added an array of IPE case studies prepared by contributors that are representative of various sections of the textbook. These IPE cases, along with answer guides, will be available for instructors on the textbook's website (see the "Additional Resources" section).

We welcome your feedback as we undertake planning for the next edition. The authors have drawn on information from the literature, current standards, and their own clinical experiences to share the process involved in making sound and thoughtful therapeutic decisions. However, it remains the responsibility of every practitioner to evaluate the appropriateness of a particular opinion in the context of the actual clinical situation, bearing in mind any recent developments in the field. We strongly urge students and practitioners to consult several appropriate information sources when working with new and unfamiliar drugs.



## Acknowledgments

We are deeply indebted to the many dedicated people who have given of themselves to complete the eleventh edition of *Applied Therapeutics: The Clinical Use of Drugs*. We are grateful to our contributing authors who have worked tirelessly to provide the highest quality of work, while balancing numerous responsibilities as educators, clinicians, and researchers. We are grateful for the exceptional work of our twenty-six section editors, who provided critical feedback necessary both in the organizational structure of the textbook and in the individual editing of chapters; without their dedication and support, this edition would not be possible. In particular, we wish to recognize those returning section editors as they have been a guiding force for the eleventh edition: Drs. Jean M. Nappi, Timothy J. Ives, Marcia L. Buck, Judith L. Beizer, and Myrna Y. Munar. We sincerely thank the past editorial team of *Applied Therapeutics*, with special thanks to Dr. Brian K. Alldredge and Dr. B. Joseph Guglielmo for their guidance and support and contributions to the eleventh edition. We would also like to thank Facts and Comparisons for allowing us to use their data for the construction of some of our tables.

The team from Wolters Kluwer, Matt Hauber, Andrea Vosburgh, and Annette Ferran, deserve special recognition for their efforts. Their exceptional patience, attention to detail, and guidance have been critical to the success of this project. We sincerely thank Tara Slagle (project management) and Samson Premkumar (production) for their assistance in completing this edition. Most importantly, we wish to acknowledge the love, understanding, and unwavering support of our spouses and families. They selflessly gave to us early mornings, late nights, weekends, and vacation time that we spent writing and editing.

Consistent with past editions, we continue to dedicate our work to our students who inspire us and to the many patients we have been privileged to care for and who have taught us invaluable lessons. We also dedicate the eleventh edition to those clinicians and educators who have served as pioneering leaders and role models in the delivery of patient-centered care using team-based approaches.

## Additional Resources

The eleventh edition of *Applied Therapeutics: The Clinical Use of Drugs* includes additional resources for both instructors and students, available on the book's companion website at <http://thepoint.lww.com/AT11e>.

### STUDENT RESOURCES

Students who have purchased *Applied Therapeutics: The Clinical Use of Drugs, Eleventh Edition* have access to the following additional resources for each chapter:

- A full online reference list for that chapter

### INSTRUCTOR RESOURCES

Approved adopting instructors will be given access to the following additional resources:

- Interprofessional Education (IPE) Case Studies and Answer Guides
- Each chapter will map which NAPLEX competency statements are addressed with it, which will be a helpful resource for instructors.

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# SECTION 1 | General Principles

Section Editors: William W. McCloskey and Maria D. Kostka-Rokosz

## 1

## Medication Therapy Management and Assessment of Therapy

Matthew R. Machado, Ameer D. Mistry, and Joseph W. Ferullo

### CORE PRINCIPLES

### CHAPTER CASES

<b>1</b> Medication Therapy Management Services (MTMS) are a service or group of services that optimize therapeutic outcomes for individual patients.	<b>Case 1-5 (Questions 1–4)</b>
<b>2</b> A successful MTMS encounter includes medication reconciliation and a comprehensive medication history.	<b>Case 1-1 (Questions 1–3)</b>
<b>3</b> Sources of patient information for MTMS include the patient, the electronic health record, the paper chart, and the pharmacy information system.	<b>Case 1-5 (Questions 1, 5), Table 1-1</b>
<b>4</b> A careful and complete patient interview should include medical, medication, and social histories, and it must be provided in a culturally sensitive manner.	<b>Case 1-1 (Questions 1–3), Table 1-2, Online Content</b>
<b>5</b> A successful MTMS encounter must be well documented following the Problem Oriented Medical Record (POMR). Documentation involves collecting subjective and objective data to identify the primary problem.	<b>Case 1-5 (Question 1), Table 1-4 Case 1-2 (Question 1), Case 1-3 (Question 1), Case 1-4 (Question 1)</b>
<b>6</b> The clinician must assess the drug therapy or disease-specific problem and create a treatment plan.	<b>Case 1-5 (Questions 1, 2)</b>
<b>7</b> The final step in documenting the MTMS encounter is developing the medication action plan and processing any billing requirements.	<b>Case 1-5 (Questions 1, 2, 4)</b>
<b>8</b> Accurate and complete communication of the MTMS encounter to the patient's health care team is vital.	<b>Case 1-5 (Question 3)</b>

This chapter discusses medication therapy management services (MTMS) with a focus on the assessment of drug therapy. The illustrations in this chapter primarily focus on the pharmacist; however, the principles used to assess patient response to drug therapy are of value to all health care providers.

As defined by the American Pharmacists Association, medication therapy management (MTM) is a term used to describe a broad range of health care services provided by pharmacists, the medication experts on the health care team. A consensus definition created by 11 pharmacy associations, adopted by the pharmacy profession in 2004, defines MTM as a service or group of services that optimize therapeutic outcomes for individual patients.<sup>1</sup> Pharmacists provide MTM to help patients get the best benefits from their medications by actively managing drug therapy and by identifying, preventing, and resolving medication-related problems.

MTM has a direct relationship to pharmaceutical care. Pharmaceutical care has been described as the responsible provision of drug therapy to achieve definite outcomes that are intended to improve a patient's quality of life.<sup>2,3</sup> In fact, MTM has been described as a service provided in the practice of pharmaceutical care.<sup>4</sup> However, unlike pharmaceutical care, MTM is recognized by payers, has current procedural terminology (CPT) codes specifically for pharmacists, and has several clearly defined interventions. Therefore, MTMS will be the term used to describe the activity of MTM in various patient populations.

With the passage of the Patient Protection and Affordable Care Act and the Health Care and Education Reconciliation Act of 2010, pharmacists have tremendous opportunities in the implementation of health care reform.<sup>5,6</sup> One of the hallmarks of this law is delivery system reform. As health care delivery systems change, pharmacists have an opportunity to improve overall quality of

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care, to become involved in coordinated health care approaches such as medical home teams and accountable care organizations, and to collaborate to improve care for high-risk patients and those with chronic conditions in primary-care settings. In the United States, there are an estimated 133 million people that have at least one chronic medical condition.<sup>7</sup> In 2010, 86% of all health care spending was for people with one or more chronic health condition(s).<sup>8</sup> Pharmacists will have additional opportunities as hospitals will have financial incentives to improve quality, reduce costs, and decrease hospital-acquired conditions.<sup>5,6</sup>

Both patient self-care and medication reconciliation are critical aspects of any MTMS encounter regardless of the setting (i.e., inpatient, community, ambulatory, or institutional). Patient self-care requires the patient to take responsibility for the illness; however, the help of a professional to structure healthy self-care is important. For example, patients with diabetes who monitor their blood glucose levels regularly and adjust their diet according to the guidelines published from the American Diabetes Association (ADA) would be practicing self-care. Self-care is often the work that the patient performs between visits with the provider. The patient should be involved in his or her own care to ensure the best outcomes.