PHARMACY INFORMATICS

Philip O. Anderson
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Philip E. Bourne

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A CHAPMAN & HALL BOOK

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Foreword

Sequencing of the human genome did not simply carry us into a postgenomic era; rather, it was a critical milestone in the start of genomic perspectives that will affect how we approach disease, diagnosis, and therapy. Similarly, the emergence of genomic information was a watershed development that led to the field of bioinformatics and will influence pharmacy practices and pharmaceutical research and development for the foreseeable future.

We have reached new levels in the information age in which contemporary informatics will enable us to collect and handle the explosion of data that can be mined from therapeutic outcomes. Personalized medicine and pharmaceutical care, with linkages to genomic information, will not begin to serve society optimally until they translate to the practitioners positioned to apply them to large segments of the world population. Sophisticated quantitative approaches to data handling and assessment are essential to future advances. Of equal importance, however, is the education of the practitioner who will be engaged in individualizing therapy and communicating outcomes to the patient.

Practicing pharmacists and physicians will be expected to use databases to ensure medication efficacy, patient safety, and confidentiality. Telepharmacy and telemedicine with patient information networks will become more common, and pharmaceutical research and development will assume more global positions. Such endeavors require new means of information transfer for which our academic institutions should be taking a leadership position.

Continual growth and increasing complexity of therapeutic information require our colleges and schools of pharmacy to prepare the practitioner not only for practice after licensure but also for a practice that can respond to the scientific advances over the four decades of an active career. In starting a new pharmacy school on a research-intensive campus with a burgeoning internal healthcare system, members of the faculty at the University of California, San Diego (UCSD), have attempted to address this issue. We feel that informatics not only will play a greatly expanded role in pharmacy education, but also will undergo substantive technological advances.

To develop a core course in informatics and apply its principles throughout the curriculum, we have asked faculty with expertise in drug information, library sciences, bioinformatics, and the computational technologies of high-performance computing to lead this endeavor. In turn, they have engaged a variety of faculty in different practice settings to consider applications as contributing authors. Curricular and textbook design encompasses what a traditional faculty might assemble, but is also informed by individuals outside pharmacy circles.

Doctors Phil Anderson, Sue McGuinness, and Phil Bourne have contributed to and edited this reference informatics textbook for the student pharmacists in their course. This course follows a prior introductory course that exposes the student to computer skills and biostatistics. The pharmacy informatics course is positioned to offer the basic principles for courses in study design, therapeutics, drug information, and pharmacogenomics delivered later in the curriculum. The diversity in backgrounds of the three editors has enabled them to fashion a textbook that extends beyond the UCSD curriculum and should serve as a treatise for the evolving curricula in pharmacy to refine over the years.

Palmer Taylor, Ph.D.
Dean, Skaggs School of Pharmacy and Pharmaceutical Sciences
Sandra and Monroe Trout Chair in Pharmacology
Associate Vice-Chancellor for Health Sciences
University of California, San Diego

Preface

Pharmacy practice, like all areas of healthcare delivery, is in a state of rapid change—some would say crisis. These changes are being driven by an aging population, new legislative initiatives, healthcare costs, the promise of genomic medicine, expanding roles for pharmacists in healthcare, and upheavals in the pharmaceutical industry that include company mergers, increased emphasis on biologicals, limited pipelines of new drugs, and drug recalls. Information technology is seen as both a driver of these changes and a response to the perceived crisis. It is timely, therefore, to introduce a book specifically on the subject of pharmacy informatics.

Taken separately, "pharmacy" and "informatics" are broad subjects. For the past 7 years, we have grappled with offering the appropriately focused doctor of pharmacy course that provides the training needed to cope with changes in pharmacy practice—whether future careers will be in community pharmacy, hospital pharmacy, the pharmaceutical industry, or other healthcare sectors. This book is a result of that process. Although it is intended as a textbook for our course, we hope that it appeals not only to the pharmacists of tomorrow, but also to pharmacists already in practice and interested consumers of pharmacy services.

We are part of the new and dynamic Skaggs School of Pharmacy and Pharmaceutical Sciences (SSPPS) at the University of California, San Diego. The doctor of pharmacy and doctor of pharmacy/doctor of philosophy programs reflect our unique association with the School of Medicine: Students undergo part of their training with medical students and the broader health sciences campus, as well as having access to UCSD's strengths in the biomedical and computer sciences. We are also fortunate that healthcare informatics is quite advanced in San Diego and that we are able to tap experts from other local institutions for our course and this textbook. We hope that our excitement in being part of a new enterprise, unafraid of pushing the boundaries while still providing all the fundamental elements of more traditional training, comes across in this book.

Given the breadth of topics that fall under pharmacy informatics, no one or two individuals could hope to provide the expertise needed in all areas. We have called upon all our course lecturers to participate in this work and, just as we seek continuity and relevance in the course material, we have tried to organize the book in the same way. Pharmacy informatics is learned by doing. Our course reflects this principle. Each class of two 3-hour sessions per week for 10 weeks consists of a prerequisite presentation of background material by the lecturer, followed by hands-on exercises.

It is fitting that we start with a foreword by the dean of our new school, Dr. Palmer Taylor, because his vision, more than anything else, saw the inclusion of this course as part of the core curriculum for all doctor of pharmacy students. The book is divided into five parts, each of which builds upon what has been discussed before. We hope that this organization will facilitate the use of this book as a textbook and also as a reference source where appropriate discussion can be found.

- Section I introduces the scope of the material to be covered and the motivators for the book. Drs. Susan McGuinness, pharmacy librarian, Philip Anderson, coordinator of UCSD's drug information course, and Philip Bourne, bioinformatics expert define what we mean by pharmacy informatics. This overview is followed by a discussion of information and biomedical technologies that are the drivers of change by Howard Asher, president and CEO of Global Life Sciences, Inc., and Philip Bourne, professor of pharmacology at UCSD.
- Section II provides the prerequisites for the effective use of the informatics resources discussed subsequently. Dr. Bourne discusses the basics of maintaining the reliability and security of computers in a connected world. Among both practicing pharmacists and our students, basic knowledge of computing varies widely and we have organized the material so that sections can be easily skipped. A theme that appears repeatedly is the need for standardization in the healthcare industry, including the information contained therein. Doctors McGuinness and Bourne discuss the standards and controlled vocabularies that pharmacists will confront throughout their careers. Dr. McGuinness discusses effective strategies for navigating, searching, evaluating, and managing the wide variety of information resources available today.
- Section III covers the types of information systems that exist in hospitals and pharmacies. The electronic health record (EHR) underlies all these systems and is discussed by Dr. Joshua Lee, associate clinical professor of medicine, who practices both clinically and in informatics at UCSD. Doctors Daniel Boggie, Jennifer Howard, and Armen Simonian, informatics pharmacists from neighboring affiliated healthcare institutions, review the basic elements of pharmacy information and automation systems. Bar coding, a relatively new technology for reducing medication errors, is described by Dr. Ashley Dalton, who was instrumental in implementing this technology at UCSD Medical Center. Dr. Simonian returns to describe how pharmacists and students interested in a pharmacy informatics career can prepare for and function in this role.

  A critical aspect of any of these systems is the need to avoid errors. Dr. Joseph Scherger, a professor of family and preventive medicine, and Dr. Grace Kuo, an associate professor of clinical pharmacy in our school, elaborate on medical errors and review how information technology can reduce errors in healthcare delivery. Drug information systems and Web-based resources are vital tools for pharmacists and their effective use is discussed by Doctors Anderson and McGuinness. Finally, Dr.

Joseph Ennesser, a graduate of the founding class of the Skaggs School of Pharmacy and Pharmaceutical Sciences and now a practicing pharmacist, describes the use of personal digital assistants (PDAs) and their roles in today's pharmacy practice.

- Section IV details the next step, where systems are used beyond the basic recall of information to help in decision support of patients. Dr. Laura Nicholson, a hospitalist from a neighboring institution, Scripps Health, has particular expertise in evidence-based medicine and discusses tools for use in evidence-based practice. Dr. Anderson returns with a review of computerized clinical pharmacokinetics methods as a decision support tool. Dr. Pieter Helmons, a pharmacoeconomics specialist at UCSD Medical Center with extensive experience in clinical decision support, elaborates on this promising technology. Dr. Robert Schoenhaus, a pharmacist specializing in pharmacoeconomics, discusses ways in which data contained in information systems can be mined to improve therapy, decrease adverse outcomes, and cut costs.
- Section V takes us to the future of pharmacy informatics and what will drive the field. Dr. Bourne discusses the various developments driven by the Internet, such as the emergence of virtual communities, video on demand, and changing publishing models. Dr. Richard Peters provides the perspective of a pioneer in advanced healthcare informatics on how current informatics solutions have developed and how they need to evolve to maximize their potential.

Taken together, the five sections of this book reflect a changing pharmacy profession in which information plays a central role if that practice is to be conducted in the most productive and efficient way for both producer and consumer of healthcare services. We have tried to capture what such a change means to the pharmacy student and the practicing pharmacist, as well as to prepare the reader for what lies ahead in a world characterized by only one certainty: It will be very different.

Philip O. Anderson
Susan M. McGuinness
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Editors

Philip O. Anderson is Health Sciences Clinical Professor of Pharmacy at the University of California, San Diego, Skaggs School of Pharmacy and Pharmaceutical Sciences, where he is in charge of the drug information course. Dr. Anderson is also a member of the coordinating faculty team for the pharmacy informatics and therapeutics courses and lecturer in the pharmacy practice course. He is also a partner in Healthware, Inc., where he helped develop T.D.M.S. 2000, and is the author of the National Library of Medicine's LactMed database.

Susan M. McGuinness is the pharmacy librarian at the Biomedical Library at the University of California, San Diego, and Assistant Clinical Professor at the Skaggs School of Pharmacy and Pharmaceutical Sciences. Dr. McGuinness is chair (2009–2010) of the Libraries and Educational Resources Section of the American Association of Colleges of Pharmacy. She is a member of the coordinating faculty team for the pharmacy informatics course and lectures in the drug information, pharmacy practice, pharmaceutical chemistry, and pharmaceutics courses.

Philip E. Bourne is Professor of Pharmacology at the University of California, San Diego, Skaggs School of Pharmacy and Pharmaceutical Sciences, where he is the lead faculty member for the pharmacy informatics course. Dr. Bourne is also currently the editor-in-chief of *PLoS Computational Biology* and associate director of the RCSB Protein Data Bank, a vital public resource used in drug discovery.

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