Health Informatics

Eta S. Berner *Editor*

Informatics Education in Healthcare

Lessons Learned

Second Edition

Springer

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To our students, from whom we have learned much

Preface

Twenty-five years ago almost the only individuals involved in healthcare who had even heard the term "informatics" were those who identified themselves as medical or nursing informaticians. Today, we have a variety of subfields of informatics including not just medical and nursing informatics, but informatics applied to other health professions (such as dental or pharmacy informatics), as well as health informatics, biomedical informatics, bioinformatics, and public health informatics, among others. In addition, there has been growth of a spectrum of informatics education programs, from new undergraduate majors to medical subspecialty fellowship programs. There are even informatics summer programs for high school students.

This book addresses the broad range of informatics education programs available today. My own background in health professions education over 45 years ago at the beginning of my career and in online informatics education in my work today has provided me with a tacit understanding of the breadth of content, pedagogical techniques, strategies, and approaches to informatics education in a wide variety of areas. As a leader of UAB's Center for Health Informatics for Patient Safety/Quality and the UAB Curriculum Development Center that was part of ONC's health IT workforce development program, I have seen the rapidly growing interest in the development of new informatics education programs and the growth of informatics as a profession.

The aim of this book is to make the tacit knowledge explicit and to share some of the lessons learned by a group of very experienced informatics educators. The contributors to this volume are internationally recognized informatics educators, and this short preface cannot do justice to their expertise. However, to give the reader a snapshot of their knowledge and experience, the following is a description of the contributors' expertise as related to the particular chapters that they wrote.

Dr. Jacqueline Moss, who coauthored the overview chapter with me, is an experienced nursing informatics educator, who has been integrally involved in informatics education at the national level and throughout her institution in other areas in addition to nursing informatics.

The authors of the chapters describing different training programs in the USA have direct experience with the programs they describe. *Dr. Valerie Florance* is Associate Director of Extramural Programs at the National Library of Medicine (NLM) at the US National Institutes of Health (NIH). Dr. Florance has been responsible for oversight of the many NLM-funded informatics training programs. She describes the NLM programs in Chap. 2 and the NIH Data Science training activities in Chap. 10. In addition to Dr. Moss, *Drs. Marisa Wilson and Beth Elias* are coauthors of the chapter on nursing informatics (Chap. 3). Dr. Wilson and Dr. Elias have taught nursing informatics in a variety of institutions and are involved with national efforts in nursing informatics education. *Amanda Dorsey*, *Meg Bruck*, *and Sue Feldman* bring the perspective of health informatics students, instructors, and program directors to Chap. 4. Ms. Dorsey and Ms. Bruck were both students in the University of Alabama at Birmingham (UAB) MSHI program and have gone on to become broad-based informatics educators. Ms. Dorsey led the transition of the MSHI program to an online format, and she and Ms. Bruck developed a variety of courses in health informatics as part of the ONC workforce development program. Dr. Feldman is currently program director of the UAB MSHI program. She also brings experience as a member of the Health Informatics Accreditation Council (HIAC) of the Commission on Accreditation for Health Informatics and Health Information Management Education (CAHIIM). In addition to her contributions to Chap. 4, she is the lead author of Chap. 17 on accreditation of HI programs and is a contributor to Chap. 6 on undergraduate informatics education. *Dr. Saif Khairat* is the lead author on Chap. 6. He is chair of AMIA's Education Committee and has conducted an extensive review of the growing number of undergraduate informatics programs.

The growth of programs to educate specialists in bioinformatics has also been developing rapidly. While some of these programs have been more focused on computational biology, many of them have focused on translational bioinformatics and are often incorporated within broader informatics training programs. The authors of Chap. 5 focus on translational bioinformatics and bring multi-institutional expertise in education in translational bioinformatics. *Dr. Susan Fenton* oversees the informatics education programs at the School of Biomedical Informatics (SBMI) at UT Houston. *Dr. Assaf Gottlieb*, also at SBMI, is actively involved in its Center for Precision Medicine. *Dr. Meredith Zozus* has led bioinformatics education at Duke, the University of Arkansas, and the University of Texas at San Antonio.

The contributors of the chapters on informatics education programs for other health professionals bring a similar breadth of experience as those for the dedicated informatics programs. *Dominic Covvey* is internationally recognized for leading the development of competency descriptions for multiple roles including informatics researchers, applied informaticians, and clinician users of informatics applications. *Margaret Schulte* was the leader of the HIMSTA project described in Chap. 8 and also has years of experience as a leader of HIMSS' education activities and in her work with the Commission on Accreditation of Healthcare Management Education (CAHME). *Drs. Peter Embi and Philip Payne* are widely recognized as major leaders in the USA in the area of clinical research informatics (CRI). Dr. Embi led the

first AMIA CRI conference and also developed an AMIA 10 × 10 course in this area. Both authors have published seminal articles in this domain.

The chapters on informatics education outside the USA have been expanded significantly in this edition. In the first edition, we had a single chapter on three different regions: Latin America, Sub-Saharan Africa, and the Asia Pacific region. In this edition, we have separate chapters for each region with the informatics education activities in additional countries within regions described. All of the chapter authors on worldwide informatics education are experienced educators within their own country and around the world.

Dr. John Holmes and *Jeffrey Williamson* were instrumental in working with AMIA's Global Health Informatics Partnership that was involved with disseminating informatics educational materials to countries around the world. *Dr. Paula Proctor* and her colleagues (*Drs. Ursula Hubner, Elizabeth Cummings, Jen Bichel-Findlay, Michelle Honey, and Karen Day*) who authored Chap. 12 represent nursing informatics from multiple continents. The authors of Chap. 13, on informatics education in Latin America (*Drs. Paula Otero, Mariela Leikam, Zulma Gonzalez, Heimar de Fatima Marin, Ignacio Pérez Aravena, and Saadia Zawadzki*), are leaders within their countries and have also engaged with each other in collaborative informatics activities across countries in Latin America. *Ngai Tseung Cheung, Juanita Fernando, Oomen John, Alvin Marcelo, Iris Thiele Isip-Tan, Cheng Ooi Low, Daniel Li, and Vajira HW Dissanayake* developed highly regarded informatics education programs in a variety of countries in the Asia Pacific region. Finally, *Drs. Caroline Perrin, Cheick-Oumar Bagayoko, and Antoine Geissbuhler* have years of collaboration with colleagues in Sub-Saharan Africa.

This edition also has two new sections that contain updates of some of the chapters in the previous edition as well as additional chapters. The section on assessment of individuals and programs contains the chapter on the clinical informatics subspecialty certification (Chap. 16), which was updated and expanded. *Drs. Reed Gardner* and *Charles Safran* were leaders of the task forces that led to the approval of the clinical informatics subspecialty, and lead chapter author *Dr. Christoph Lehmann* has led the Clinical Informatics Examination Committee now that it has been established. *Dr. Howard Silverman* runs a Clinical Informatics Fellowship Program and has been a leader nationally of the Clinical Informatics training directors. *Dr. Cynthia Gadd* was the leader of the team that did the initial work to establish an advanced health informatics certification examination for those who are not eligible for the medical subspecialty exam. A new chapter (Chap. 17) in this section includes discussion of CAHIIM's informatics education program accreditation. It was written by *Dr. Sue Feldman* (described above), *Dr. Suzanne Austin Boren*, *Linde Tesch*, and *Dr. Annette Valenta,* all of whom have been directly involved with CAHIIM's accreditation activities. Dr. Boren leads the Health Informatics Program at the University of Missouri and has also led CAHIIM's Health Informatics Accreditation Council. Ms. Tesch is Senior Education Officer at CAHIIM, and Dr. Valenta was chair of the AMIA Accreditation Committee that developed the foundational domains used by CAHIIM in their accreditation process. Dr. Valenta is also an author of Chap. 19 bringing her extensive experience in teaching online informatics

programs. She was program director of the online health informatics masters' program and developed the AMIA 10 × 10 program at the University of Illinois at Chicago (UIC).

The last section on online informatics education contains updates and expansions of three chapters in the previous edition. The authors of Chap. 19 have taken the insights gained by years of experience in online education and articulated them in a series of strategies that will be useful for others, especially those who have struggled with the issues that are raised. In addition to Dr. Valenta's and my own expertise in online informatics education, the other authors bring additional expertise and experience. *Ms. Lorrinda Khan* has years of online learning experience, both as an instructor and as an instructional design expert. *Dr. Michael Dieter* was program director for the online master of health informatics program at UIC.

The other chapters in this section (Chaps. 18 and 20) are written by *Dr. William Hersh*. Dr. Hersh is internationally recognized as an informatics educator. He is the leader of OHSU's informatics education activities which include not only the NLM-funded informatics training program, but he also led the university-based training program funded by ONC as part of the ONC workforce development program. He was a leader in other ONC-funded workforce programs including the Curriculum Development Centers program and the National Training and Dissemination Center. In addition to his work with the ONC workforce programs, Dr. Hersh was the impetus behind the AMIA 10 × 10 program and was director of the first 10 × 10 program. He was also a contributor to the NIH BD2K program of online educational materials.

In addition to the outstanding contributions of the chapter authors, I want to express my appreciation for the support of Grant Weston, Anand Shanmugam, and the Springer editorial team.

Birmingham, AL Eta S. Berner

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Acronyms and Abbreviations

AACN	American Association of Colleges of Nursing
AAMSI	American Association for Medical Systems and Informatics
ABMS	American Board of Medical Specialties
ABP	American Board of Pathology
ABPM	American Board of Preventive Medicine
ACGME	Accreditation Council for Graduate Medical Education
ACMI	American College of Medical Informatics
AHI	Applied Health Informatics
AHIMA	American Health Information Management Association
AMIA	American Medical Informatics Association
ANA	American Nurses Association
ANCC	American Nurses Credentialing Center
APAMI	Asia-Pacific Association for Medical Informatics
ARRA	American Recovery and Reinvestment Act
ASL	Asynchronous learning
AUPHA	Association of University Programs in Health Administration
BIOTEC	National Center for Genetic Engineering and Biotechnology (Thailand)
BISTI	Biomedical Information Science and Technology Initiative
BSN	Bachelor of Science in Nursing
CAHIIME	Commission on Accreditation for Health Informatics and Information Management Education
CAHIMS	Certified Associate in Health Information and Management Systems
CAHME	Commission on Accreditation of Healthcare Management Education
CBMI	Regenstrief Institute Center for Biomedical Informatics
CCNE	Commission on Collegiate Nursing Education
CDC	Curriculum Development Center
CE	Continuing education
CEO	Chief executive officer

CERTES	Center for Research Expertise in Telemedicine and eHealth (Centre d'Expertise et de Recherche en Télémédecine et E-santé)
CHCF	California Health Care Foundation
CHI	Center for Health Informatics (Singapore)
CHIRAD	Centre for Health Informatics Research and Development (South Africa)
CIN	Computers, Informatics, Nursing (Journal)
CIO	Chief information officer
CMIO	Chief medical information officer
CMS	Centers for Medicare & Medicaid Services
CMS	Clinical Management System (Hong Kong)
COSTAR	Computer Stored Ambulatory Record
CPHIMS	Certified Professional in Health Information and Management Systems
CPOE	Computerized physician (or provider) order entry
CRI	Clinical Research Informatics
CTRI	Clinical and Translational Research Informatics
CTSA	Clinical and Translational Science Awards
DHHS	Department of Health and Human Services (USA)
DNP	Doctor of Nursing Practice
EBM	Evidence-based medicine
EBP	Evidence-based practice
EDUCTRA	Education and Training in Health Informatics
EFMI	European Federation for Medical Informatics
EHR	Electronic health record
EMR	Electronic medical record
EMRAM	Electronic Medical Record Adoption Model (HIMSS)
ENRICH	Enhancing Research Informatics Capacity for Health Information in Colombia
EU	European Union
EXPASY	Expert Protein Analysis System
FEMI	Federación Médica del Interior (Uruguay)
FOA	Funding Opportunity Announcement
G2HI	Gateway to Health Informatics (Singapore)
GBS	Graduate Biomedical Sciences
GHIP	Global Health Informatics Partnership
GMDS	German Medical Informatics Association
GNU	Refers to a free software license
GPRS	General Packet Radio Service
GWAS	Genome-wide association studies
HELINA	Health Informatics in Africa
HELP	Health Evaluation through Logical Processing
HIBA	Hospital Italiano of Buenos Aires
HIBBS	Health Informatics Building Blocks

HIM	Health information management
HIMSS	Healthcare Information and Management Systems Society
HIMSTA	Health Information Management Systems Technology and Analysis
HIPAA	Health Insurance Portability and Accountability Act
HIT	Health Information Technology
HITECH	Health Information Technology for Economic and Clinical Health
HITPRO™	Health Information Technology Competency Exams
HSP	Hybrid Skills Development Program (Singapore)
ICT	Information and communications technologies
IDA	Infocomm Development Authority (Singapore)
IMIA	International Medical Informatics Association
INFOMED	Telematic Network for Health (Cuba)
INS	Informatics nursing specialist
IOM	Institute of Medicine
IR	Information retrieval
IS	Information systems
ISD	Information Services Department
ISfTeH	International Society for Telemedicine and eHealth
IT	Information technology
ITU	International Telecommunication Union
JAMA	Journal of the American Medical Association
JAMIA	Journal of the American Medical Informatics Association
KHI	Kigali Health Institute
LDS	Latter-Day Saints
LMS	Learning Management System
MIT	Massachusetts Institute of Technology
MLAA	Medical Library Assistance Act
MOC	Maintenance of Certification
MOOC	Massive Open Online Course
MRI	Magnetic resonance imaging
MRS	Medical Record System (OpenMRS)
MSHIM	Master of Science in Health Information Management
MSN	Master of Science in Nursing
MU	Meaningful use
MUMPS	Massachusetts General Hospital Utility Multi-Programming System
NCBI	National Center for Biotechnology Information
NCHS	National Center for Health Statistics
NCSBN	National Council of State Boards of Nursing
NEHR	National Electronic Health Record (Singapore)
NHIP	National Healthcare Information Project (Taiwan)
NIH	National Institutes of Health
NIHI	National Institutes of Health Informatics (Canada)

NLM	National Library of Medicine
NRSA	National Research Service Award
NTDC	National Training and Dissemination Center
NUR	National University of Rwanda
NUS	National University of Singapore
OER	Open Educational Resources (OER Africa)
OHSU	Oregon Health & Science University
ONC	Office of the National Coordinator (for Health Information Technology)
PAHO	Pan American Health Organization
PDB	Protein Data Bank
PHR	Personal health record
proTICS	Professionalization Program in Information Technology & Communication in Health
PURE-HIT	Professional University Resources and Education for Health Information Technology
QUIPU	Andean Global Health Informatics Research and Training Center
RAFT	Reseau en Afrique Francophone pour la Télémédecine (Research in Africa for Telemedicine)
RCR	Responsible Conduct of Research
RDHI	Research and Development Health Informatics
REACH-Informatics	Regional East African Center for Health Informatics
REC	Regional Extension Center
REHCE	Regional e-Health Center of Excellence (Kigali)
REIMICOM	Malian Medical Information and Communication Network
RHIT	Registered Health Information Technician
RN-BC	Registered Nurse – Board Certified
SCAMC	Symposium on Computer Applications in Medical Care
SWOT	Strengths, Weaknesses, Opportunities, Threats (Analysis)
TBI	Translational bioinformatics
TIGER	Technology Informatics Guiding Education Reform
TMI	Thai Medical Informatics Association
TMT	Taiwan Electronic Medical Record Template
UAB	University of Alabama at Birmingham
UBT	University-based Training
UCSF	University of California—San Francisco
UIC	University of Illinois at Chicago
UP-HI	University Partnership for Health Informatics (University of Minnesota)
VistA	Veterans Health Information Systems and Technology Architecture
WEB	Workshop on Education in Bioinformatics
WHO	World Health Organization

Part I
Introduction to Lessons Learned

Chapter 1
Introduction and Overview

Eta S. Berner and Jacqueline A. Moss

In the last 25 years, there has been a proliferation in the number and types of informatics education programs. Interest in health and biomedical informatics education has increased dramatically in response to the increase in use of healthcare information technology (HIT) in both clinical and research settings. Accompanying the growth in these programs is the concurrent interest in the development of informatics certification processes and program accreditation standards. Some of the impetus for informatics education in the U.S. comes from the growing use of HIT in clinical settings as a result of the HITECH Act [1], a part of the American Recovery and Reinvestment Act, which tied adoption of Health IT to incentives from the Centers for Medicare and Medicaid Services (CMS). In research settings, drivers for the increased use of health IT include the growing interest in personalized and precision medicine, the growth of the bioinformatics field, and the emphasis on biomedical informatics to support research as a part of the Clinical and Translational Science Awards (CTSA). Internationally, as technology infrastructures have grown, there is increasing use of HIT and the concomitant need for education not only for informatics professionals, but for the clinicians and others who use these systems.

While there have been many definitions of informatics in the literature over the years [2–7], it is more productive to examine the scope of the field, rather than a specific definition, when we talk about education in informatics in healthcare. The

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following description of the scope of the field was developed by the first author (ESB) over 20 years ago, with recent adaptation. This definition was developed as a result of conversations with students, to help clarify their understanding of the purpose and scope of their informatics education.

> Informatics involves developing and utilizing a broad range of **information technology** to facilitate the collection, management, exchange, analysis, use (and re-use) and storage of **patient** (**including clinical and genomic**), **fiscal, and administrative information** to support and improve (1) the **quality** of patient care and health outcomes, (2) **secure access** to information, (3) professional and organizational **efficiency**, and (4) the **decision making** capabilities of health professionals, administrators and others within the healthcare organization.

The highlighted areas above indicate that information technology supports the field, but the focus of informatics is on the **information**, rather than the technology per se. This book describes the major initiatives in informatics education internationally. It includes educational initiatives to produce informatics researchers, applied informatics practitioners, and informatics education programs for other healthcare practitioners as well. The focus is on the lessons learned from the variety of health and biomedical informatics programs, some of which are fairly young, while others have been established for decades. Although we will describe a variety of types of programs for different audiences, some common themes run through these programs.

Interdisciplinary Basis

The practice of informatics, and therefore the education necessary for this practice, draws on knowledge from a wide variety of disciplines. Informatics practice, and the research of phenomena central to this practice, involves knowledge that informs the optimal design of information systems for the optimization of data collection, delivery, and analysis, as well as usefulness and usability for end-users. All of the relevant knowledge and skills related to aspects of organizational science, information science, human factors, computer science, and cognitive science must also be nested within the associated healthcare context. This context may be primarily driven by end users, such as in consumer health informatics, nursing informatics or pharmacy informatics, or public health informatics.

Informatics education programs, regardless of their healthcare focus, include content from other related supporting disciplines and apply this content to either the design of research for the generation of knowledge in informatics or the application of this knowledge to the practice environment. Each professional domain applies this interdisciplinary content in relation to their healthcare focus; however all informatics specialties are based on the same or very similar theoretical underpinnings. Several of the chapters in this book explicitly describe curricular content in some detail and the interdisciplinary nature of the content is obvious. In addition, as the chapters in the section on Assessment of Individuals and Programs in

Informatics illustrate, the standards for certification of individuals and accreditation of programs implicitly or explicitly include these supportive interdisciplinary underpinnings.

Informatics Competencies

Another consistent theme echoed by multiple contributors to this edition, is the assertion that all healthcare professionals require basic competencies in the use of information technology to work in today's technology rich environment. A competency is "an expected level of performance that integrates knowledge, skills, abilities, and judgment" [8]. First, all healthcare professionals need to acquire basic computer and information science competencies to be able to interact, not only with electronic medical records, but also with a variety of patient information and communication technologies that are increasingly a part of every aspect of healthcare. Second, every healthcare professional needs to be information literate. Finding, evaluating, and synthesizing the best evidence helps ensure that patients receive the highest level of care available from their providers. Those managing the organization and delivery of this care require current and accurate information to effectively and efficiently manage care access and organizational resources. Finally, all healthcare professionals require basic competencies related to the management and analysis of data. Development of data management competencies enables individuals and organizations to understand the need for ensuring the privacy and confidentiality of data, standardized data collection, and patient and organizational outcomes analysis. Chapters 3, 7, 8, 16 and 17 in particular list competencies that reflect these emphases and provide references that include the recommended competencies in more detail.

Standards for Certification and Accreditation

As the field of informatics education has matured there has been increased interest in certification of individuals' competencies and accreditation of informatics education and training programs that produced these individuals. Different organizations are often involved in certification of individuals than are involved in the accreditation of the programs preparing these students. The International Medical Informatics Association has focused on informatics education program accreditation on a worldwide basis [9]. In this book we include other examples of accreditation efforts. For instance, as described in Chap. 8, the Commission on Accreditation of Healthcare Management Education (CAHME) is responsible for accrediting programs in healthcare management. Within their accreditation guidelines are the information management competencies that are expected to be taught by educational programs. None of these accreditation programs oversees a certification program for

individuals. On the other hand, there are certification programs for individuals that are not specifically tied to program accreditation. The HITPRO examination that was initially designed for students graduating from the ONC-funded workforce program (see Chap. 20) did not require specific educational preparation for the credential. The CPHIMS credential, administered by the Health Information and Management Systems Society (HIMSS), that is designed to certify healthcare IT managers like those described in Chap. 4, also does not prescribe specific educational preparation. The American Nurses Credentialing Center (ANCC) in association with the American Nurses Association offers a credential for nurse informatics specialists (Chap. 3), but a different organization, the American Association of Colleges of Nursing (AACN), is involved in accrediting nursing education programs. However, graduating from an accredited informatics program is currently not required for eligibility for the certification examination.

On the other hand, the clinical informatics subspecialty examination for physicians described in Chap. 16 is closely tied to preparation in an accredited training program, especially after the initial years of the examination. Although the Informatics Fellowship program accreditation is done by the Accreditation Council for Graduate Medical Education (ACGME), there is close collaboration between the organizations that certify individuals and accredit programs.

The Commission on Accreditation for Health Informatics and Information Management Education (CAHIIM) [10], which began as a Health Information Management (HIM) accrediting body, has now added health informatics to its name and mission and some informatics programs are starting to seek accreditation from them, as described in Chap. 17. There is a new Health Informatics Certification Commission that is in the process of determining eligibility criteria for granting certification (see Chap. 16).

As informatics education programs proliferate and more individuals are trained, we can expect to see that both individual certification and informatics education accreditation will become more important. For this reason, we have devoted a specific section of this book to the issues of accreditation and certification.

Adaptation to Current and Future Needs

One of the challenges of developing informatics education programs in today's world is that the world keeps changing and the change is in the direction of requiring more and more varied informatics competencies, even if one is not an "informatician" and especially if one is. 'Big data' and 'data science' have become buzzwords [11], but being able to use those data that, with the help of electronic health records, we are now able to collect, will require some traditional and some new informatics competencies. Chapters 10 and 20 discuss new educational programs in data science. Similarly, the focus on Meaningful Use in the U.S. [12] has led to more interest in informatics-trained professionals. New developments in genomic research have spurred the development of programs in bioinformatics education (Chap. 5), as well as programs for translational scientists [13] that integrate both clinical and

bioinformatics (Chaps. 5 and 9). Existing programs for health professionals have also seen the need to incorporate informatics into the basic educational preparation of clinicians (Chaps. 3, 7 and 12) and other health professionals (Chap. 8). Chapter 4 focuses directly on the need to adapt curricula to a changing external environment, but virtually all of the chapters recognize that informatics competencies will change and evolve as the environment in which they apply changes.

Online Education

One of the major changes that has been occurring in education generally is a trend toward more and more education being delivered online via distance learning technology. Several informatics programs described in this book are either primarily or entirely delivered online. Examples of online curriculum content, strategies for creating online content, and feasible methods of content delivery are included in these chapters, but there is now an entire section (Chaps. 18, 19 and 20) that focuses specifically on online educational programs. Chapter 19, in particular, is focused specifically on the different assumptions and expectations of students and teachers in online education as compared to face-to-face programs. While the focus of this book is on informatics education, and not distance learning per se, there is a great deal of information for those who want to start a distance-accessible informatics education program.

Arrangement and Focus of Book

This book is arranged in five major sections with additional introductory and concluding chapters. This overview is the introductory chapter. The last chapter, Chap. 21, synthesizes and integrates the key points from the other chapters for a comprehensive view of the lessons learned from the variety of informatics education programs described.

The other major sections include chapters on:

1. Training Informatics Specialists in the U.S. (Chaps. 2, 3, 4, 5 and 6)
2. Informatics Education for Other Health Professionals (Chaps. 7, 8, 9 and 10)
3. Informatics Education Worldwide (Chaps. 11, 12, 13, 14 and 15)
4. Assessment of Individuals and Programs in Informatics (Chaps. 16 and 17)
5. Use of Distance Learning for Informatics Education (Chaps. 18, 19 and 20)

The section on training informatics specialists in the U.S. includes chapters on the National Library of Medicine (NLM) training programs (Chap. 2), as well as programs to train IT managers and other IT and informatics workforce professionals (Chap. 4). Chapter 3 on Nursing Informatics focuses on both educating nurse informaticians as well as integrating informatics into general nursing curricula. In addition to programs that train applied informatics in clinical settings, this section

also includes chapters on training specialists in bioinformatics (Chap. 5) as well as undergraduate informatics majors (Chap. 6).

The other chapters that involve integrating informatics education into other educational programs are covered in the next section, Informatics Education for Other Health Professionals. These professionals include physicians (Chap. 7), health administrators (Chap. 8), and clinical and translational researchers (Chap. 9). Chapter 10, the last chapter in this section, focuses on informatics and data science training for students in basic science training programs.

The third major section of this book includes chapters on informatics education in non-U.S. settings. This section is significantly expanded from the previous edition. Chapter 11 includes a description of the efforts and challenges of translating some of the U.S. programs into educational programs in other countries. Conversely, Chaps. 13, 14 and 15 provide the perspectives of the recipients of some of those programs, as well as a description of informatics education programs developed in the local settings. The focus of these chapters is on the many countries with limited resources for healthcare in general, and for informatics education in particular. While Chaps. 13, 14 and 15 focus primarily on medical and health informatics, Chap. 12 describes nursing education in a variety of countries outside the U.S.

Although competencies are described throughout many of the chapters, the section on assessment of programs and individuals describes the activities of certification programs for medical subspecialists and others (Chap. 16) and accreditation of informatics programs (Chap. 17).

Within the section on distance learning, Chap. 18 describes the AMIA 10 × 10 programs which have been used for continuing education not just in the U.S., but in other countries as well. Chapters 19 and 20 address some of the challenges of online education. Chapter 19 focuses on the various assumptions that both students and teachers bring to online education and describes strategies for managing these assumptions. Chapter 20 discusses the benefits and challenges involved in using freely available online educational materials. Each chapter of the book ends with lessons learned and/or key take-away points.

While the lessons learned provide ‘words of wisdom’ from internationally recognized informaticians and educators, the references in this book provide a comprehensive compilation of the scholarly literature on the history and current status of informatics education in the U.S. and globally. Both the lessons and the references will be useful for informatics educators who are embarking on developing the new informatics education programs that are sorely needed as we navigate the expanding digital healthcare age.

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Part II
Training Informatics Specialists in the US