APPLIED CLINICAL INFORMATICS FOR NURSES

Edited by
Susan Alexander, DNP, RN, ANP-BC, ADM-BC
Clinical Associate Professor
University of Alabama, Huntsville
Huntsville, Alabama

Karen H. Frith, PhD, RN, NEA-BC
Professor
University of Alabama, Huntsville
Huntsville, Alabama

Haley Hoy, PhD, ACNP
Assistant Professor
University of Alabama, Huntsville
Nurse Practitioner
Vanderbilt Medical Center
Nashville, Tennessee
Contents

Preface ix
Acknowledgments xi
Contributors xiii
Reviewers xvii
About the Editors xxii

Section I Concepts and Issues in Clinical Informatics 1

Chapter 1 Overview of Informatics in Health Care 3
  Chapter Overview 3
  Informatics in Nursing Practice 4
  History of Clinical Informatics Development 5
  Clinical Informatics and Nursing Informatics Defined 7
  Clinical Informatics Concepts 9
  Health Care in the United States and the Need for Health Information Management 9
  Summary 13
  References 14

Chapter 2 Information Needs for the Healthcare Professional of the 21st Century 17
  Chapter Overview 17
  Program Curricular Changes 18
  Informatics Competencies and the TIGER Initiative 20
  Knowledge Management and Transformation 22
  Nurses, Informatics, and Nursing Workflow 23
  Quality Improvement Techniques and Nursing Informatics 27
  Ongoing Education and Nursing Informatics 28
  Summary 31
  References 31
## CONTENTS

### Chapter 3 Informatics and Evidence-Based Practice 33
- Chapter Overview 34
- Essentials of Evidence-Based Practice 34
- EBP Process 34
- Finding More About EBP Online 37
- Using Library Sources After Graduation 38
- Using Reference Manager Software to Store and Use Sources 43
- Staying Current in Nursing Practice and Specialty Areas 44
- Evidence-Based Practice Integrated in Clinical Decision-Support Systems 46
- Summary 48
- References 48

### Section II Use of Clinical Informatics in Care Support Roles 51

#### Chapter 4 Human Factors in Computing 53
- Chapter Overview 53
- Introduction 54
- Human Factors/Ergonomics (HFE) 54
- Standards, Laws, Recommendations, and Style Guides 56
- Information Processing 68
- Summary 71
- References 72

#### Chapter 5 Usability in Health Information Technology 77
- Chapter Overview 77
- Introduction 78
- Importance of Usability Testing 79
- User-Centered Design 80
- Dimensions of Usability 81
- Planning Usability Testing 84
- Examples of Usability Testing in Health Care 88
- Summary 88
- References 90

#### Chapter 6 Privacy, Security, and Confidentiality 93
- Chapter Overview 93
- Introduction 94
- History of Legal Protection for Privacy 95
# Health Insurance Portability and Accountability Act of 1996 (HIPAA)
- 96

# Use of PHI in Marketing, Fundraising, and Research
- 106

# Enforcement of Privacy and Security of PHI
- 107

# Filing Complaints
- 107

# Health Information Technology for Economic and Clinical Health (HITECH) Act
- 108

# Unresolved Issues of Health Information
- 110

# Summary
- 112

# References
- 114

## Chapter 7 Database Systems for Healthcare Applications
- 117

### Chapter Overview
- 117

### Using Databases in Healthcare Settings
- 118

### Working with Databases
- 120

### Data Warehousing
- 124

### Applications in Healthcare Settings
- 127

### Summary
- 130

### References
- 131

## Chapter 8 Adapting Business Intelligence for Health Care
- 133

### Chapter Overview
- 133

### Basic Principles of Data Analytics
- 134

### Analytics in Use
- 136

### Overview of Algorithms Generated by Data-Mining Methods
- 138

### Examples of Predictive Algorithms
- 139

### Descriptive Algorithms
- 143

### Tracking Trends in Data
- 145

### Summary
- 149

### References
- 150

## Chapter 9 Workflow Support
- 153

### Chapter Overview
- 153

### Introduction
- 154

### The Promise of Health IT
- 154

### Planning for Health IT
- 156

### Workflow Analysis
- 158

### Gap Analysis and Workflow Redesign
- 168

### Technology to Automate Workflow
- 169
CONTENTS

Healthcare Provider Roles in Workflow Analysis 170
Summary 171
References 173

Chapter 10 Promoting Patient Safety with the Use of Information Technology 177
Chapter Overview 177
Health IT Used in Patient Care 178
Beginning at the Point of Care 179
Beyond the Point of Care 183
Electronic Documentation 185
Informed Medication Administration 186
Where, Oh Where, Has My Patient Gone? 189
Medical Device Safety 191
Summary 193
References 195

Section III Use of Clinical Informatics Tools in Care Delivery Systems 197

Chapter 11 The Electronic Health Record 199
Chapter Overview 199
Definitions and Descriptions 200
Benefits of Using EHRs 202
Challenges of EHR Use 208
Role of the Nurse and the EHR 215
Summary 218
References 219

Chapter 12 Clinical Decision-Support Systems 223
Chapter Overview 223
Introduction 223
Clinical Decision-Support Systems 224
Data Capture 225
Data Quality and Validity 226
CDSS Applications 227
User Issues with CDSSs 228
Professional Practice 229
Summary 230
References 230
Chapter 13  Telehealth  233
   Chapter Overview  233
   Introduction  233
   Core Concepts and Definitions  234
   A Brief History of Telehealth  237
   Current Applications of Telehealth  239
   Privacy, Ethics, and Limitations in Telehealth  246
   Summary  251
   References  251

Chapter 14  Mobile Health Applications  253
   Chapter Overview  253
   Introduction  254
   mHealth Benefits  254
   Driving Forces for mHealth  255
   mHealth Systems for HCPs and Researchers  256
   mHealth System in Action: A Case Study of Cardiac Rehabilitation  263
   mHealth Applications (Apps) for HCPs  264
   mHealth Applications (Apps) for Consumers  265
   mHealth Challenges  267
   Summary  270
   References  271

Chapter 15  Informatics and Public Health  275
   Chapter Overview  275
   Concepts in Public Health  276
   Methods of Describing the Health of Communities and Populations  279
   Applying Informatics Tools to Improve Public Health  287
   Future Directions  292
   Summary  295
   References  295

Chapter 16  Genetics/Genomics  299
   Chapter Overview  299
   Introduction  300
   Historical Perspectives on Genetic Testing and Diagnostic Technologies  301
   Current Clinical Applications of Genetic Information  302
CONTENTS

Large-Scale Sequencing in a Clinical Setting 304
Evaluating and Selecting Genomic Tests 304
Using Patient Information to Assess Risk 306
Generating and Interpreting Large-Scale Sequencing Data 308
Reporting and Storing Genetic Results 311
Looking Toward the Future 315
An Educational Challenge 316
Summary 317
References 322
Resource 325

Chapter 17  Digital Patient Engagement and Empowerment 327
Chapter Overview 327
Introduction 328
Engagement and Empowerment 328
Healthcare Information Revolution 330
The Future of E-Health Applications 340
Summary 344
References 346

Glossary 351
Index 363
Preface

FOR WHOM IS THIS TEXT WRITTEN?
This is a contributed text designed for nurses who are interested in expanding their knowledge about technology and informatics as applied in the setting of health care. The chapters are written by a diverse group of contributors who have experience in both designing and using health informatics applications. The content is broad in scope, covering topics beginning with an overview of basic concepts in informatics and proceeding to a discussion of application of the concepts in selected healthcare delivery settings. Though advanced concepts are included in the text, they are discussed in a manner that is highly readable for nursing students. The text includes multiple examples and case studies that will aid students in immediately linking the content to the clinical environment.

WHY IS THIS TEXT IMPORTANT FOR THE STUDENT NURSE?
This text stems from the recognition of the need for improvements in nurses’ skill sets in the use of health information technology. Nursing is a high-tech field, requiring a wide variety of competencies ranging from basic computer abilities to advanced skills with medical devices and lifesaving equipment. Nurses are the largest group of healthcare providers in the United States, with statistics from the U.S. Department of Labor, Bureau of Labor Statistics, indicating that there are more than 2.6 million nurses employed in the United States (in 2012). The ability of nurses to use health information technologies safely and efficiently to improve patient care cannot be ignored. It is essential that all nurses have minimum levels of competency to use health information technology in all aspects of patient care in both outpatient and inpatient settings. Perhaps the most appropriate place to begin the integration of technology and informatics in patient care is for the pre-licensure nurse. If this group of nurses enters the
workforce with the skill sets, clinical experience, and the expectation to integrate health information technologies into practice, many of the issues that confound healthcare organizations now may cease to exist. This is not an unusual phenomenon. Consider the example of universal precautions for blood and body fluids. The use of universal precautions began in response to the HIV and hepatitis B outbreaks in the 1980s. The integration of universal precautions in patient care caused great upheaval. Millions of dollars were spent in reeducating healthcare providers, redesigning hospital rooms and units, and in revising nursing curricula to teach the foundational practice of universal precautions. The nursing graduates of today have been taught the need for handwashing from the first day of class, and it is simply no longer an issue. Likewise, as informatics knowledge and skills become more embedded in nursing education and in practice settings, the more informatics will be accepted as an indispensable component of nursing practice and patient care.

WHAT MAKES THIS TEXT UNIQUE?

This text is written primarily for the pre-licensure nurse who has experience in the use of diverse hardware and software applications and who is now ready to apply those skills in the healthcare setting. A distinctive feature of this text is its flexibility. While it could be used in a focused informatics course, it could also be integrated into a nursing program that elects to teach designated informatics concepts at different points throughout the program. In addition, this text is distinctive because its content largely adheres to the competencies described in the American Association of Colleges of Nursing’s *Essentials of Baccalaureate Education for Professional Nursing Practice* (2008).

The text is divided into three sections. Section I introduces concepts and issues relevant to the field of clinical informatics. A review of the culture of health care and the use of health information technology in the United States, with a summary of information science principles, sets the stage for a discussion of the nurse’s role in healthcare informatics in the 21st century. In Chapter 3, Section I, the reader is presented with strategies to obtain, evaluate, and apply evidence for nursing practice with the use of informatics tools.

Sections II and III contain chapters with more isolated content, not necessarily building on one another. The content and resources in the chapters of Sections II and III could be used in multiple areas of the nursing curricula. The material contained in Sections II and III is a rather basic discussion of advanced concepts. It is purposely designed to stimulate the interest of the reader and to initiate discussion and interaction between students and teachers on the enormous possibilities for use of healthcare technologies, now and in the future.
Acknowledgments

There are many to whom we are grateful for their assistance in making the idea for this text become a reality. Our students, whose rich blend of backgrounds and talents make life endlessly interesting, helped us to understand the need for creating a textbook that could build on existing computer skills and enhance informatics competencies to improve patient care. Studying to become a nurse in the 21st century involves more than learning the basic skills of caring for patients at the bedside. Technology is interwoven into many of the nurses’ tasks, and we applaud those nurses who realize the importance of competence with technology and informatics early in their careers. This is not an easy task, but effective use of health information technologies will lead to important advancements in patient care.

We would like to thank the staff at Jones & Bartlett Learning for their encouragement and guidance. The JBL production team is a pleasant and talented group. Special thanks also go to Amanda Martin, our optimistic and supportive Senior Editor, who shared our vision of crafting a book that would integrate informatics content into nursing curricula in a manner both clinically relevant and exciting for nursing students. Amanda has been unfailingly gracious over the past months, while managing to keep this project on course! Sara Bempkins, our Associate Managing Editor, has been patient and flexible in offering editorial assistance, yet somehow kept us all on track in meeting (most) of our deadlines.

We are grateful to the talented and diverse group of authors who contributed their expertise to the writing of this text. Though their positions range from computer scientists to physicians and, of course, nurses, each of our contributors understands the role that informatics will continue to play in achieving high-quality patient care. They also understand the need to challenge our nursing students to apply more advanced informatics concepts in varied healthcare settings.
Finally, we must acknowledge the unceasing support from our families. While they did not always understand our motives for taking on the project of creating a book, they remained positive and calming in ways that only families can do. Alan, Kendal, Ashley, and Trey—we love you all.

Susan Alexander
Karen H. Frith
Haley Hoy
Contributors

Ellise D. Adams, PhD, RN, CNM
Associate Professor
University of Alabama, Huntsville
Huntsville, Alabama

Susan Alexander, DNP, RN, ANP-BC, ADM-BC
Clinical Associate Professor
University of Alabama, Huntsville
Huntsville, Alabama

Faye E. Anderson, DNS, RN, NEA-BC
Associate Professor
University of Alabama, Huntsville
Huntsville, Alabama

Gennifer Baker, MSN, RN, CCNS
Director of Nursing Practice
Huntsville Hospital
Huntsville, Alabama

Janie T. Best, DNP, RN, ACNS-BC, CNL
Assistant Professor
Blair College of Health
Queens University of Charlotte
Charlotte, North Carolina
CONTRIBUTORS

Jane M. Carrington, PhD, RN
Assistant Professor
Community & Systems Health Science Division
College of Nursing
University of Arizona
Tucson, Arizona

Elizabeth Clark, BA, BSN, RN
Huntsville Hospital
Huntsville, Alabama

Evan Corley, BS
University of Alabama, Huntsville
Huntsville, Alabama

Kelly M. East, MS, CGC
Genetic Counselor
HudsonAlpha Institute for Biotechnology
Huntsville, Alabama

Crayton Fargason Jr., MD, MBA
Professor
University of Alabama, Birmingham
Medical Director
Children’s of Alabama
Birmingham, Alabama

Karen H. Frith, PhD, RN, NEA-BC
Professor
University of Alabama, Huntsville
Huntsville, Alabama

Haley Hoy, PhD, ACNP
Assistant Professor
University of Alabama, Huntsville
Nurse Practitioner
Vanderbilt Medical Center
Nashville, Tennessee
Emil Jovanov, PhD  
Associate Professor  
Department of Electrical and Computer Engineering  
University of Alabama, Huntsville  
Huntsville, Alabama

Steffi Kreuzfeld, MD  
Research Associate  
Deputy Director  
Institute for Preventive Medicine  
University of Rostock  
Rostock, Germany

Neil E. Lamb, PhD  
Director of Educational Outreach  
HudsonAlpha Institute of Biotechnology  
Huntsville, Alabama

Manil Maskey, MS  
Research Scientist II  
Information Technology and Systems Center  
University of Alabama, Huntsville  
Huntsville, Alabama

Aleksandar Milenkovic, PhD  
Associate Professor  
Department of Electrical and Computer Engineering  
University of Alabama, Huntsville  
Huntsville, Alabama

Mladen Milosevic, PhD  
Research Assistant  
Department of Electrical and Computer Engineering  
University of Alabama, Huntsville  
Huntsville, Alabama

Stephanie Norman-Lenz, BSN, RN  
Nurse Informaticist  
Children's of Alabama  
Birmingham, Alabama
CONTRIBUTORS

Rahul Ramachandran, PhD
Informatics and Data Management
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama

Kimberly D. Shea, PhD, RN
Assistant Professor
Community & Systems Health Science Division
College of Nursing
University of Arizona
Tucson, Arizona

Regina Stoll, MD
Director
Institute of Preventive Medicine
University of Rostock
Rostock, Germany

Mariah Strickland, BSN, RN
Nurse Informaticist
Children’s of Alabama
Birmingham, Alabama

Brenda Talley, PhD, RN, NEA-BC
Associate Professor
College of Nursing
University of Alabama, Huntsville
Huntsville, Alabama

Diana Hankey-Underwood, MS, WHNP-BC
Nurse Practitioner
Center for Aging
Huntsville, Alabama

Xiaohua Sarah Wu, MSN, RN, FNP-BC
University of Rochester Medical Center
Strong Memorial Hospital
Rochester, New York
Reviewers

**Kim Siarkowski Amer, PhD, RN**  
Associate Professor  
School of Nursing  
DePaul University  
Chicago, Illinois

**Judith Bailey, RN, MS**  
Cedar Crest College  
Allentown, Pennsylvania  
Lehigh Valley Health Network  
Allentown, Pennsylvania

**Margaret Benham-Hutchins, PhD, RN**  
Texas Woman’s University  
College of Nursing  
Denton, Texas

**Ann M. Bowling, PhD, RN, CPNP-PC, CNE**  
Wright State University  
Miami Valley College of Nursing and Health  
Dayton, Ohio

**Deborah Cheater, MS, RN, CNE**  
Nursing Instructor  
Carl Albert State College  
Poteau, Oklahoma
Mary Anne Blum Condon, PhD
Chair and Professor
Averett University
Danville, Virginia

David J. Crowther, PhD, RN, CNS
Associate Professor
Angelo State University
San Angelo, Texas

Kathleen Dunenm, PhD, APRN, CNM
Associate Professor
University of Northern Colorado
Greeley, Colorado

Tresa Kaur Dusaj, PhD(c), RN-BC, CNE, CHSE
Monmouth University
Long Branch, New Jersey

Beth Elias, PhD, MS
Assistant Professor
University of Alabama, Birmingham
School of Nursing
Birmingham, Alabama

Sally K. Fauchald, PhD, RN
The College of St. Scholastica
Department of Graduate Nursing
Duluth, Minnesota

Rebecca Hill, DNP, MSN, FNP-C
Assistant Professor
Massachusetts College of Pharmacy and Health Sciences
Boston, Massachusetts

Janice M. Jones, PhD, RN, CNS
Clinical Professor
University at Buffalo School of Nursing
Buffalo, New York
Lynn M. Klima, MSN, RN
Faculty
School of Nursing
Siena Heights University
Adrian, Michigan

Barbara A. Miller, PhD, RN, ACNS-BC
Assistant Professor
Darton State College
Albany, Georgia

Catherine S. Moe, MS, RN, CNE
Assistant Professor
Lakeview College of Nursing
Danville, Illinois

Angela Mountain, RN, MS, CMSRN
Assistant Professor
Texas A&M Health Sciences Center

Colleen Neal, MS, RN
Assistant Professor
Texas A&M Health Science College of Nursing

Anita K. Reed, MSN, RN
Department Chair Adult and Community Health Practice
Saint Joseph's College
St. Elizabeth School of Nursing
Lafayette, Indiana

Tina Reinckens, RN, MA
Coppin State University
Baltimore, Maryland

Marisa L Wilson, DNSc, MHSc, RN-BC
University of Maryland School of Nursing
Baltimore, Maryland
REVIEWERS

Annette M. Weiss, PhD, RN, CNE
Assistant Professor and RN to BSN Program Director
Misericordia University
Dallas, Pennsylvania
About the Editors

Susan Alexander, DNP, RN, ANP-BC, ADM-BC, is a Clinical Associate Professor of Nursing at the University of Alabama in Huntsville. She has more than 20 years of experience in nursing, with experience in a variety of both inpatient and outpatient settings, having earned her Doctor of Nursing Practice degree in 2009. In addition to her faculty responsibilities, she is certified by the American Nurses Credentialing Center as an Adult Health Nurse Practitioner and in Advanced Diabetes Management. She is a member of a research team that is studying the use of mobile applications to facilitate networking, transfer of information, and ease of patient care among healthcare providers in the field of organ donation and transplantation. Dr. Alexander serves as a reviewer for the Health Resources and Services Administration, Online Journal of Issues in Nursing, McMaster Online Rating of Evidence, and Multimedia Educational Resources for Learning and Online Teaching (MERLOT) Health Sciences. She has authored articles on topics including implementation of software applications for health professionals and the use of online teaching strategies and mobile applications for healthcare providers in transplant. In addition, she is a contributor to Distance Education in Nursing, Third Edition (2013, Springer). Dr. Alexander was the recipient of a 2013 American Association of Nurse Practitioners State Award for Excellence.

Karen H. Frith, PhD, RN, NEA-BC, is a Professor of Nursing at the University of Alabama in Huntsville. She has been a nurse educator since 1992 and has an active program of research in health services focusing on nurse staffing and patient outcomes. She cofounded a startup company that has developed decision support software for nurse leaders to improve patient and organizational outcomes. She is a member of the American Organization of Nurse Executives (AONE) and served for 2 years on the national Patient Safety Committee for AONE. She is a member of Healthcare Information and Management Systems Society (HIMSS), Sigma Theta Tau International
ABOUT THE EDITORS

Honor Society of Nursing, and the Southern Nursing Research Society. She serves as reviewer (of grants and articles) for Sigma Theta Tau; Health Resources and Services Administration, Journal of Nursing Administration, Online Journal of Issues in Nursing, Computers, Informatics, Nursing, Journal of Health & Medical Informatics, and Nurse Educator, among others. She has authored more than 30 articles in peer-reviewed journals, authored the book, Distance Education in Nursing, Third Edition, contributed chapters to three other books, and presents nationally. Her previous clinical positions experience is in cardiovascular surgical intensive care, coronary intensive care, and orthopedics. She is board certified by the American Nurses Credentialing Center as Nurse Executive, Advanced (NEA-BC).

Haley Hoy, PhD, ACNP, is an acute care nurse practitioner and Interim Associate Dean at the University of Alabama in Huntsville. She has been a nurse practitioner for more than 15 years and is a leader in technology and transplant nursing. Her current research interests include the role of technology and web- and mobile-based applications for the transplant community, in addition to nurse and community attitudes toward organ donation. She has research grants from the North American Transplant Coordinators Organization (NATCO) and from the University of Alabama in Huntsville (Faculty Distinguished Research grant recipient). She is an active member of the American Association of Nurse Practitioners, the North American Transplant Coordinators Organization, and the Medical Automation Organization. She was the recipient of the 2011 American Association of Nurse Practitioners State Award for Excellence and the Advanced Transplant Provider Award. She is board certified by the American Nurses Credentialing Center and continues to practice as a nurse practitioner at Vanderbilt Medical Center in the Department of Lung Transplantation.