



mHealth

FROM SMARTPHONES TO SMART SYSTEMS

EDITED BY

Rick Krohn, MA, MAS
David Metcalf, PhD



HIMSS® mHIMSS

MHEALTH FROM SMARTPHONES TO SMART SYSTEMS

EDITED BY

Rick Krohn, MA, MAS

David Metcalf, PhD

himss[®]

*m***himss**[®]

HIMSS Mission

To lead healthcare transformation through effective use of health information technology.

© 2012 by Healthcare Information and Management Systems Society (HIMSS).

All rights reserved. No part of this publication may be reproduced, adapted, translated, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publisher.

Printed in the U.S.A. 5 4 3 2 1

Requests for permission to make copies of any part of this work should be sent to:

Permissions Editor
HIMSS
33 West Monroe Street, Suite 1700
Chicago, IL 60603-5616
mschlossberg@himss.org

The inclusion of an organization name, product or service in this publication should not be considered as an endorsement of such organization, product, or service, nor is the failure to include an organization name, product or service to be construed as disapproval.

ISBN: 978-0-9844577-6-2

For more information about HIMSS, please visit www.himss.org.

About the Editors

Rick Krohn, MA, MAS

An expert in healthcare corporate strategy and strategic marketing, business development, corporate communications, technology development and commercialization, Mr. Krohn has served as President of HealthSense since 1998. His industry experience spans the health plan, hospital, physician practice and vendor spaces. He has published more than 80 articles on a wide range of healthcare subjects, and has written two industry texts. In addition to writing, Mr. Krohn has delivered presentations at national healthcare conferences sponsored by VHA, Premier, AMGA, ACHE, MGMA, HIMSS, NMHCC, TEPR, AIC and others about strategic, business, technology and operations issues in healthcare. Mr. Krohn has earned degrees from Towson University, American University and Johns Hopkins University. Further information about Mr. Krohn may be found on his web site: www.healthsen.com.

David Metcalf, PhD

David Metcalf has a more than 20 years' experience in design and research of web-based and mobile technologies converging to enable learning and healthcare. Recent efforts include the development of mobile technology strategies for Tufts University and University of Central Florida medical schools. He combines an academic grounding and continued university involvement with a strong history of industry-centered training and simulation, providing learning innovations for Google, Johnson & Johnson, Microsoft, Tyco and many others. As a research faculty member with the University of Central Florida's Institute for Simulation and Training and head of the Mixed Emerging Technology Integration Lab, which he founded in 2006, Dr. Metcalf continues to bridge the gap between corporate learning and simulation techniques and non-profit and social entrepreneurship. Simulation, mobilization, mobile patient records and medical decision support systems, visualization systems, scalability models, secure mobile data communications, gaming, innovation management and operational excellence are current research topics. Dr. Metcalf frequently presents at industry and research events, shaping business strategy and use of technology to improve learning, health and human performance.

About the Contributors

Susan Albright is Director of Technology for Learning in the Health Sciences, School of Medicine, Tufts University, Boston. Ms. Albright collaborates with deans, faculty, administrators and students to enhance the administrative, research, clinical and educational functions of an academic health center through the use of technology. With grants from Tufts Medical School, the National Library of Medicine and the US Department of Agriculture, Ms. Albright implemented the Tufts University Sciences Knowledgebase (TUSK), a robust infrastructure that implements content delivery, including mobile access, course evaluation, clinical assessment and tools for personal knowledge management for Tufts' Health Sciences schools. The system is used by medical schools in the United States, as well as Tufts' partner schools in India and Africa. Ms. Albright serves on committees tasked with building and sharing medical educational software and content throughout the world, including MedBiquitous, where she sits on the standards and working groups for virtual patients and competencies. To facilitate the use of technology for teaching and learning in the developing world, Ms. Albright travels to Africa and India to work with medical schools in the implementation of TUSK. Ms. Albright graduated from Tufts University and studied urban planning at New York University.

Jeff Brandt graduated from the University of Oklahoma with a bachelor's degree in Computer Science. He is enrolled in the biomedical informatics graduate program at Oregon Health Sciences University, Portland. Mr. Brandt held the position of Adjunct Instructor of Database Design at Oregon State University. With more than 20 years of experience in healthcare, mobile data/telecom, online banking and the Internet industry, he serves as Chief Technology Officer of Communication Software, which provides consulting services for such clients as Siemens, Warner Music, Cybercash/Verisign and the Mississippi State Department of Health. He also developed the first secure medical apps for iPhone and Android.

Gai Elhanan, MD, MA, is Chief Medical Information Officer of Halfpenny Technologies Inc. in Pennsylvania. A veteran physician with more than 12 years of experience in internal medicine and infectious diseases, Dr. Elhanan has more than 15 years of experience with health information systems and research, design, development and implementation in clinical and administrative environments. Dr. Elhanan received his Medical Informatics master's degree from Columbia University, and completed a post-doctoral fellowship at the Medical Informatics Department, New York Presbyterian Medical Center, with a broad skill set in the informatics field, as well as unique knowledge in the field of semantic networks and medical/healthcare ontologies.

Debbi Gillotti is the Vice President and General Manager for Healthcare and Marketing at nVoq. She previously held senior executive roles at Quest Diagnostics/MedPlus, Healthphone Solutions, Microsoft and Starbucks. Ms. Gillotti received a bachelor's degree from the University of Pittsburgh and a master's from Georgetown University. She has received numerous national awards for her leadership in information technol-

ogy, has served as a mentor to the University of Washington School of Business for the past decade and is an advisor to the University of Pittsburgh College of Arts and Sciences.

Jill Graygo, MA, MPH, is the Program Director at the William Lehman Injury Research Center, University of Miami Miller School of Medicine. Ms. Graygo manages a variety of federal and industry related research projects and has been involved with the MobileCARE project since commencement. She is responsible for the MobileCARE project's oversight and evaluation along with Carl I. Schulman, MD, MSPH.

Terrell W. Herzig, MSHI, CISSP, is Information Security Officer of the University of Alabama at Birmingham (UAB) Health System, the UAB HIPAA Security Officer and an Adjunct Professor of Health Informatics at UAB. Mr. Herzig teaches graduate courses in Information Engineering, Programming, Computer Networks and Information Security in the UAB School of Health Professions. During his tenure at UAB, he served as Director of Information Technology for the Civitan International Research Center and Director of Informatics for the Pittman General Clinical Research Center. Mr. Herzig also has consulted on numerous informatics projects with external groups, including Southern Nuclear and the US Army Medical Command. Mr. Herzig is the editor of *Information Security in Healthcare: Managing Risk* (HIMSS, 2010).

Lynette Jones, RN, PhD, MBA, is a Clinical Informatics Consultant. She has consulted for numerous healthcare provider organizations, healthcare payer organizations, government and healthcare technology vendors. She is the author of numerous publications on technology and its value proposition in healthcare. Ms. Jones is the founder of Point of CareWare, a technology vendor for the post-acute-care space. Ms. Jones received her degrees from the University of Washington.

Tony Karam is Director of Marketing for Wave Systems Corp., where he is responsible for shaping the company's technology direction and driving the market adoption of emerging endpoint security technologies. Additionally, he is responsible for strategic alliances, business development and training. Prior to joining Wave Systems, Mr. Karam served as Principal Product Manager for RSA, the Security Division of EMC, responsible for all aspects of product management for RSA's authenticator line, including one-time passwords and smartcards. Over his 15-year career, Mr. Karam has held product management and engineering positions at Hayes Corp., Intek and Uniden. He holds a bachelor's from Western New England College, Springfield, MA.

Mary Y. Lee, MD, FACP, is Associate Provost for Tufts University and Professor of Medicine and former Dean for Educational Affairs at Tufts University School of Medicine, Boston. As Associate Provost, Dr. Lee facilitates multidisciplinary educational and global health initiatives spanning Tufts' nine undergraduate, graduate and professional schools. As founder and chair of the Tufts Global Health Council, Dr. Lee facilitates transinstitutional collaboration and commitment to active citizenship. Since the mid 1990s, Dr. Lee has worked with a multidisciplinary team to develop Tufts University Sciences Knowledgebase (TUSK), an enterprise curriculum and knowledge

management system that has won national recognition, which is used by a growing number of institutions in the United States, India and Africa. Dr. Lee guides Open Access and OER initiatives, including Tufts OpenCourseWare and other projects that involve growing global health partnerships. To advance related information and data management, Dr. Lee is responsible for Tufts' Digital Collections and Archives with its open-access Digital Repository, University Library Technology Services. She is an *ex officio* member and sponsor of the University Library Council. As former Dean for Educational Affairs at Tufts University School of Medicine, Dr. Lee directed curricula, evaluation, faculty development and grants that supported the evolving education of future physicians.

Hussam Mahgoub, MSC, MBA, is responsible for Corporate Development, Marketing and Intellectual Properties at Diversinet, which provides a secure application platform that enables healthcare organizations to rapidly deploy HIPAA-compliant mHealth applications. He has more than 30 years of electronic product and service development experience in security, e-mail and EDI. Previously, Mr. Mahgoub held senior positions at Canada Post Corporation, Bell Canada and Bank of Montreal. He holds a bachelor of engineering (MSC) in computer science from McGill University, and a master of business administration degree from Ottawa University.

Robert B. McCray is the Co-Founder, President and CEO of the Wireless-Life Sciences Alliance, Chairman of Alliance Healthcare Foundation, Special Advisor to TripleTree LLC, Member of Midmark Corporation Board of Directors, Member of Board of Directors of CONNECT and an active advisor to several companies. Mr. McCray leverages more than 25 years of experience as a business owner, senior operating executive, legal and transactional advisor to private and public companies. Mr. McCray has served as President, COO and an early investor in Digital On-Demand Inc., a retail services technology company that operates under the brand name Red-DotNet in chains including Barnes & Noble, Best Buy, Blockbuster and Fred Meyer. Previously, he served as Chairman, President and CEO of HealthCap Inc., a venture capital-backed physician practice management company that returned 90 percent CAGR to its investors. Mr. McCray also served as managing director of Caremark Physician Resources, directing its formation during its initial high-growth years prior to its sale to MedPartners Inc. He also co-founded OnCall Medicine Inc., a medical house calls company. Prior to his success as a business operator, he was a managing partner in his law firm and a partner in a predecessor and transactional legal and consulting services to the healthcare industry for more than 20 years.

Mehran Mehregany, MS, PhD, received his degrees in electrical engineering from the Massachusetts Institute of Technology in 1986 and 1990. He joined Case Western Reserve University as an Assistant Professor in 1990, and is currently the Goodrich Professor of Engineering Innovation. He served as the founding Executive Vice President of Engineering and Chief of Engineering Research at the West Wireless Health Institute. He is Director of the Case School of Engineering, San Diego Programs. He is known for his research in microsystems technology and has more than 350 publications describing his work; holds 19 US patents; is the recipient of a number of awards/honors; and has founded several technology start ups. His research interests

are micro/nano-electro-mechanical systems, silicon carbide technology and microsystems, and wireless health.

Chase Pattison, MBA, is the Marketing Director for Entrada, where he is responsible for marketing strategy and brand management. Prior to joining Entrada, Mr. Pattison held management positions with various technology companies including FiledBy Inc. and Uloop Inc. Mr. Pattison graduated from the University of Tennessee with a degree in Business Administration and earned a master of business administration degree from Vanderbilt's Owen Graduate School of Management.

Derek Plansky, SM, BAsc, is the Senior Director of Healthcare Solutions at nVoq. Prior to joining nVoq, he worked for MedPlus, a Quest Diagnostics Company, as the company's HIE solution architect and was involved in a number of national and state HIE interoperability committees. He also has worked for LexisNexis, IBM, Space Systems/Loral and a number of start ups, including Seisint and iBeam Broadcasting. Mr. Plansky received a master's degree from the Massachusetts Institute of Technology, and he earned his bachelor of science degree from the University of Toronto.

Thomas Samuel Ram, MBBS, MD, is Associate Professor of Radiation Oncology, Department of Radiation Oncology, Christian Medical College (CMC), Vellore, India. As faculty in oncology, he is involved in various outreach activities, teaching and research programs apart from the clinical care in oncology. Dr. Ram also has been involved with the mission hospital network of CMC for more than 20 years, where he spent almost five years in remote hospitals. He is co-coordinating the e-learning linkage between CMC Vellore and peripheral mission hospitals. Dr. Ram has a special interest in using educational technology to bridge the gap between the tertiary and peripheral centers. In collaboration with the TUSK team at Tufts University and as coordinator for e-learning linkage between CMC Vellore and peripheral hospitals, he is involved in capacity building and training the faculty in using the e-learning platform.

David Rogers is a researcher at the Institute for Simulation & Training (IST) and CEO of Allogy Interactive. Mr. Rogers's research is focused on mobile software development for healthcare, education, and humanitarian and disaster response. His company develops learning and performance support applications in support of the federal government, nonprofit organizations, universities, the Department of Defense and various industry partners. Mr. Rogers served in the Air Force as a training officer, graduating from the Air Force Academy. He spent four years in East Africa, managing aid and development programs. At IST, he is leading a multi-year research initiative on mobile EMR support, and has authored a number of publications on the use of mobile technology in research and learning. Mr. Rogers also manages the development of disaster response, data collection and learning management systems for mobile platforms and is a doctoral candidate in the Text & Technology program at the University of Central Florida. Mr. Rogers serves as a technology adviser on the board of David C. Cook, and founded the software company Allogy Interactive in 2009. His applications have been featured in the *New York Times* and *Information Week*, and his emerging market LMS software is currently deployed throughout sub-Saharan Africa.

Enrique Saldivar, MD, MS, PhD, received his medical degree from the Universidad La Salle, Mexico City, his master's in Biomedical Engineering from Universidad Autonoma Metropolitana, Mexico City, and his PhD in Bioengineering from the University of California, San Diego. His expertise includes digital signal processing of biomedical signals, image processing, microcirculation, platelet engineering, medical microsystems, nanotechnology and wireless health. Dr. Saldivar has been a key contributor to a number of leading-edge medical research and development programs, most recently as a Senior Member of Technical Staff at the West Wireless Health Institute. He is a consultant to Case Western Reserve University, developing professional and graduate education programs in wireless health.

Carl I. Schulman, MD, MSPH, is Director of Injury Prevention/Education at the William Lehman Injury Research Center at the Ryder Trauma Center. Dr. Schulman earned his medical degree from the University of South Florida College of Medicine in 1995. He completed his training in general surgery and received additional training in trauma and surgical critical care at the University of Miami/Jackson Memorial Medical Center. Certified by the American Board of Surgery in general surgery and surgical critical care, his prior experience includes a two-year NIH Research Training Fellowship looking at the complex issue of acute lung injury after burns. He also completed his master's of science in Public Health to enhance his current research interests on the epidemiology of burns and trauma, especially as it relates to aging populations. His current project, supported by the Robert Wood Johnson Foundation, is entitled "Prevention of Elderly Pedestrian Injury." It employs the new case-crossover study design to investigate the risk factors associated with elderly pedestrian injuries. Dr. Schulman is also the Principal Investigator on numerous epidemiological studies and clinical trials. His clinical practice includes trauma, burns and surgical critical care at the Ryder Trauma Center, where he is also Director of the Medical Student Trauma and ICU clerkships.

Thaddeus Seymour, Jr., PhD, leads strategic planning and business development for Lake Nona Medical City in Orlando, FL, as Vice President and General Manager in Health and Life Sciences. His role includes the supervision of all health and life sciences strategy, new business ventures and institutional recruitment. Dr. Seymour also serves as Chairman of the Board of the newly formed Lake Nona Institute, whose mission includes innovating and modeling best practices in healthy community development. Prior to joining Lake Nona, Dr. Seymour was a Senior Executive with biotech distributor CuraScript Inc., a subsidiary of Express Scripts Inc. He also has extensive experience in healthcare informatics, including co-founding a venture-backed electronic medical records company. A Board Member of bioOrlando and BioFlorida, and Chair-Elect of the Florida Research Consortium, Dr. Seymour is active in promoting the importance of research in the acceleration of economic development in the state. Dr. Seymour is also Chair-Elect for Shepherd's Hope, Board Member of Florida's Blood Centers and has served on the boards of multiple healthcare technology businesses. Dr. Seymour holds a bachelor's from Dartmouth College, a master's and PhD from the University of Wisconsin and an MBA from the Kellogg Graduate School of Management at Northwestern University.

T. Taliaferro Smith, III, PsyD, MA, has more than 17 years of experience in the world of psychology. He received his doctor of psychology degree from the American School of Professional Psychology/Virginia Campus in 2004; a master's in Clinical Psychology from the Georgia School of Professional Psychology in 1995; and his bachelor's from Hampden-Sydney College in 1990. Dr. Smith was Assistant Administrator at Anchor Hospital, Atlanta, where he worked closely with the CEO to oversee both business and clinical operations. During this time he played an integral role in developing and launching a mental health telemedicine line of business for the hospital, and has extensive experience in the design, implementation and training necessary to build successful telemedicine programs. In addition to experience in a hospital setting, Dr. Smith worked as the Adult Mental Health Coordinator for The Clayton Center in Jonesboro, GA. Dr. Smith works part time at Sandy Springs Psychotherapy. His professional interests include work with addictions, as well as troubled adolescents and their families. He also enjoys study in group relations and dynamics, including systems analysis and strategy, organizational transformation, leadership development and crisis intervention.

Claudia Tessier, RHIA, is an internationally recognized expert on mobile health, healthcare documentation, personal health records and the continuity of care record. She is Co-Founder and President of the Boston-based mHealth Initiative, a membership organization that promotes adoption of mobile technologies in healthcare as the catalyst toward participatory health. Ms. Tessier's previous positions include Vice President of Medical Records Institute, Executive Director of the Mobile Healthcare Alliance and CEO of American Association for Medical Transcription. She is the author of *The Surgical Word Book* (Elsevier, 2005), *The AAMT Book of Style for Medical Transcription* (AAMT, 1995) and *Management and Security of Health Information on Medical Devices* (AHIMA, 2010).

Rashmi Vyas, MBBS, MD, MHPE, is a Professor in the Department of Physiology at Christian Medical College, Vellore, India. She is a 2003 FAIMER Institute Philadelphia Fellow. She also has been awarded the International Fellowship in Medical Education by FAIMER in Philadelphia. Dr. Vyas completed her master's degree in Health Professions Education at the University of Illinois at Chicago in 2010. Her main interests are in curriculum innovations, faculty development, program evaluation and qualitative research. Dr. Vyas is course co-organizer for the Integrated Post-Graduate Diploma in Family Medicine, a distance-learning program for MBBS graduates working in secondary hospitals run by CMC Vellore. She holds the post of Core Educator in the Medical Education Unit. She also is the Convener for the MCI Regional Centre for National Faculty Development at CMC Vellore. Dr. Vyas is an international faculty member for FAIMER Institute. She also is a national faculty member for the three FAIMER Regional Institutes in India. She has been an invited faculty for advanced workshops in health professions education in various medical colleges, including the Department of Medical Education, Maharashtra University of Health Sciences. Dr. Vyas is the author of many national and international conference presentations and publications. She is a reviewer for six journals in health education.

C. Peter Waagemann is President of the mHealth Initiative and a consultant to corporations, professional organizations and providers. He was previously the CEO of Medical Records Institute. Mr. Waagemann also was Chair of the American National Standards Institute's Healthcare Informatics Standards Board for two terms. His book *Knowledge Capital: Management of Intelligence, Human Software and the Net* will be published in 2012.

Anand Zachariah, MD, PhD, is Professor of Medicine at Christian Medical College, India. His professional interests are in clinical toxicology, clinical infectious disease, HIV/AIDS and medical education. Dr. Zachariah was involved in setting up clerkship training, integrated learning programs and the secondary hospital program in the undergraduate medical curriculum. He also developed two distance education courses—Fellowship in HIV Medicine and Integrated Postgraduate Diploma in Family Medicine—that support doctors working at the primary and secondary level. Dr. Zachariah also is involved in training doctors in secondary care hospitals in acute poisoning care through a telemedicine approach. He recently edited *Towards a Critical Medical Practice: Reflections on the Dilemmas of Medical Culture Today* (Orient Black Swan, 2010).

Table of Contents

Acknowledgments.....	xii
Foreword	xv
<i>By Robert B. McCray</i>	
Introduction	xix
<i>By Rick Krohn, MA, MAS, and David Metcalf, PhD</i>	
Chapter 1: The Case for an mHealth Ecosystem	1
<i>By Rick Krohn, MA, MAS</i>	
Chapter 2: Opportunities and Obstacles in the Adoption of mHealth	7
<i>By Mehran Mehregany, MS, PhD, and Enrique Saldivar, MD, MS, PhD</i>	
Case Study 2A. Using Tablet Computers to Improve Clinical Workflow and Information Security	21
<i>By Terrell W. Herzig, MSHI, CISSP</i>	
Chapter 3: The mHealth Stakeholder	25
<i>By Claudia Tessier, RHIA</i>	
Case Study 3A. Clinical Lab Results Around the Clock: Mobile Applications for the Active Physician	35
<i>By Gai Elhanan, MD, MA</i>	
Chapter 4: Mobile Building Blocks of the mHealth Ecosystem	41
<i>By Rick Krohn, MA, MAS, and David Metcalf, PhD</i>	
Case Study 4A. U.S. Army mCare for Wounded Warriors: Secure Two-Way Messaging Program Improves Care, Appointment Attendance	52
<i>By Hussam Mahgoub, MSC, MBA</i>	
Chapter 5: The Integrated mHealth Ecosystem	55
<i>By David Metcalf, PhD</i>	
Case Study 5A. Bringing Mobile Health to Life in a Community Setting: Lake Nona, Orlando, FL	68
<i>By Thaddeus Seymour, Jr., PhD</i>	
Chapter 6: Devising an mHealth Strategy	71
<i>By Rick Krohn, MA, MAS</i>	
Case Study 6A. Mobile Telemedicine: Reshaping Rural Communities' Access to Quality Healthcare	79
<i>By T. Taliaferro Smith, III, PsyD, MA</i>	

Chapter 7: Business Modeling for the mHealth Ecosystem85

By Rick Krohn, MA, MAS

Case Study 7A. Voice-Enabled Mobile Workflow96

*By Derek Plansky, SM, BASc; Chase Pattison, MBA;
Debbi Gillotti; and Lynette Jones, RN, PhD, MBA*

Chapter 8: Security & Compliance..... 103

By Jeff Brandt

**Case Study 8A. Boston Medical Center: Providing Centrally
Managed Data Security for 400 Laptops..... 114**

By Tony Karam

**Chapter 9: Practical Applications and Complementary
mHealth Technologies..... 117**

By David Metcalf, PhD

**Case Study 9A. Using Mobile Technology to Transform
Education for Health Workers at Remote Areas 124**

*By Mary Y. Lee, MD, FACP; Susan Albright; Rashmi Vyas,
MBBS, MD, MHPE; Thomas Samuel Ram, MBBS, MD;
and Anand Zachariah, MD, PhD*

**Case Study 9B. Developing a Next-Generation Mobile
Electronic Health Record System for the Ryder Trauma Center 130**

*By David Rogers; Jill Graygo, MA, MPH; and
Carl I. Schulman, MD, MSPH*

Chapter 10: The Future of mHealth 135

By C. Peter Waagemann

Epilogue..... 145

By Rick Krohn, MA, MAS, and David Metcalf, PhD

Index..... 147

Acknowledgments

I would like to thank the chapter and case study contributors, the staff of HIMSS and our HIMSS editor, Matt Schlossberg, without whom the writing of this book would not have been possible.

—*Rick Krohn*

I would like to thank my teams at both UCF College of Medicine and the Institute for Simulation and Training, Mixed Emerging Technology Integration Lab. The knowledge sharing and direct projects that informed my early understanding of mHealth has been invaluable. In particular, I'd like to thank Dr. Jonathan Kibble, Dr. Juan Cendan, Dr. Roger Smith, David Rogers, Angela Hamilton and the rest of the METIL lab. Kate Stannard provided invaluable editing and transcription. Our friends and sponsors throughout the mHealth ecosystem rallied around this effort to make it successful. Most of all, I thank my lovely wife, Katy, and sons Adam and Andrew for their patience and teaching me about health on a daily basis, whether mobile-enabled or not. Finally, I thank Jesus Christ for my abilities and opportunities to make this book possible.

—*David Metcalf*

Foreword

By Robert B. McCray

Co-Founder, President and CEO, Wireless-Life Sciences Alliance

Chairman, Alliance Healthcare Foundation, San Diego

The healthcare information management industry is dead! Long live the healthcare information access industry!

This is an exaggeration, of course; however, it may not be as far from the truth as many would like. Wirelessly enabled connected health is already disrupting the traditional service model where healthcare information, security and access is centrally managed, maintained and limited, respectively. Just as digital media transformed the entertainment sector and revolutionized the music industry, wireless health will transform the healthcare sector and destroy components that are slow to adapt.

What is the role of the traditional health IT manager in a business swept by huge changes, where information exchange involves billions of sensors and the user base expands to just as many people? This is a key question—among many—posed and answered in this book, *mHealth: From Smartphones to Smart Systems*, edited by Rick Krohn, MA, MAS, and David Metcalf, PhD.

Wireless healthcare could not have arrived at a more crucial time. Large segments of the US and global populations are dealing with overwhelming growth rates in major health problems, most acutely conditions related to obesity and aging. In response, many developed nations are devoting close to or more than 10 percent of their annual GDP to healthcare costs, with the United States claiming the unfortunate top position at 16 percent. These already alarming costs will only rise as the number of patients in these disease categories swells, forcing countries to allocate a greater portion of their GDP every year, thereby placing debilitating financial pressure on their citizens, families, businesses and institutions.

For example, growth in US healthcare costs in the past 10 years has erased income gains for the average family. This is in addition to the ever-present problems of access to quality care, rising and inefficient costs and the growing number of uninsured patients. Add a global economic crisis, major debt issues and changing demographics into the mix, and we face a global disaster of monumental proportions.

Seeking a Solution

While the timely emergence of wireless health alone will not resolve these myriad problems, it offers unique opportunities to reduce cost, increase efficiencies and improve the quality of and access to care.

Wireless technology can reduce costs. Home-based monitoring will help hospitals track patient recovery and compliance, thereby minimizing costly episodes of re-admission. (After Oct. 1, 2012, Medicare will penalize hospitals that inadequately prevent re-admission.) Coordination between departments and providers will reduce wasteful spending and improve quality of care. Lastly, financial sponsors of healthcare

can measure the costs and outcomes for competing providers and technologies and make better purchasing decisions.

Wireless technology will help improve quality. Patient care can be improved using wireless health. A study involving patients with implanted cardiac defibrillators demonstrated that the five-year survival rate for patients who followed up with only in-office visits was 50 percent lower than patients who followed up on the network using a connected bedside monitor.¹

Wireless technology can increase access and transparency. With rapid consumer adoption of smartphones, physicians can now perform two-way videoconferencing. Patients and physicians both will have access to medical records and vital signs. Wireless technology also allows physicians to serve more patients despite geographical limitations.

How is all this to be accomplished? Wireless healthcare has many available tools. There are more than 5 billion cell-phone subscribers across the globe. Collaboration between IT and the medical device industry will produce most of the wearable wireless devices. The cost of data storage and analytics will decline faster than the already declining cost of content creation. Migration to cloud computing and the improvement of its security will help accelerate the whole process. The list goes on, happily.

I am an optimist and a realist. My optimism leads me to believe that we will deliver more of the potential benefits of the life sciences sector to more of the world's population at a reasonable cost, as is the case with mobile services, energy, water and automobiles. Realistically, institutional resistance to change will slow the realization of this future.

Looking Ahead

I have no doubt that fundamental change is coming to healthcare. The pace of change can be stunning—even where entrenched institutions resist. The music industry's challenges with the digital revolution are a well-documented example.

I will close with two suggestions and a prediction:

- If a device or service can be connected, it should be. How else will a manufacturer be able to answer questions about how its product works in the field or why someone should buy it? How will holdouts sell against the benefits of connectivity?
- In the developing world, incidence of chronic disease and demand for access to health services rival or exceed our challenges in the developed world. US institutions are the world's biggest owner and creator of life sciences knowledge, and 5 billion cell-phone users constitute the largest distribution channel ever created. The US healthcare industry should increasingly focus on the entire world and recognize that the developing world is both a source of customers and of "frugal innovation."
- Heuristic diagnosis is moving toward free. Access to medical knowledge, including personal genomics, is being distributed directly to consumers. So far, these trends have primarily influenced a motivated minority of consumers, especially the "healthy wealthy," but over time they will shift power and responsibility to patients who will have to manage more healthcare decisions

for themselves and their families. Similar to the impact of digital technology in music, consumer electronics, automobile, microchips and others, wireless health will empower customers and change the landscape in healthcare.

The potential of wireless health will be realized in the effective blending of three bodies of learning: high technology, life sciences and human factors. In the long run, the end users (consumers, patients and clinicians) will ultimately determine the successes and failures in wireless health.

WHAT YOU WILL LEARN FROM THIS BOOK

This book explores the emergence of mHealth in the healthcare setting. While the book focuses on the broad range of technologies available, it also tackles the *effect* wireless technology will have on the industry and myriad stakeholders. What infrastructure and architecture is needed to support these technologies? How will the role of various stakeholders evolve? What impact will mHealth have on existing technology? What sort of business model will be needed to ensure success and reduce costs? How do we ensure security and compliance? Looking forward, how might mHealth impact the coming era of consumer-centric healthcare, and how might it reshape access, quality and treatment?

The contributors to this book offer their expertise and analysis to answer these questions, as well as pose new avenues of inquiry essential to the success of every healthcare organization and stakeholder moving forward. In addition, it serves as a practical guide in strategizing and executing an mHealth market and product venture. Finally, this book includes several case studies from healthcare organizations across the country, which will give readers a clear notion of the opportunities and obstacles of implementing mHealth.

Topics discussed include:

- The evolution of the mHealth market.
- Barriers to adoption and opportunities to exploit.
- The role of stakeholders.
- The deployment of current mHealth technologies.
- Infrastructure requirements.
- Business modeling.
- Crafting an mHealth market strategy.
- Security and compliance.
- Complementary technologies.
- The future of mHealth.

Who Should Read this Book?

This book was edited to appeal to stakeholders throughout the healthcare industry, and will be of particular interest to public and commercial payers, providers, employers and consumers who have a stake in technology solutions. This book also is essential reading for IT staff, operations staff, corporate administrators, network staff, clinicians and vendors. The topics covered in the following chapters and case studies will offer readers a broad overview of mHealth and its major issues. It offers stakeholders

information on key points on the journey to wireless technology and provides real-world initiatives by a variety of healthcare organizations.

I hope this book serves as a useful map for your own journey toward wireless healthcare.

REFERENCE

1. Saxon LA, Hayes DL, Gilliam FR, Heidenreich PA, Seth M, Meyer TE, Jones PW, Boehmer JP. Long-term outcome after ICD and CRT implantation and influence of remote device follow-up: the ALTITUDE survival study. *Circulation*. 2010;122(23):2359-67. Epub 2010 Nov 22.

Introduction

“That it will ever come into general use, notwithstanding its value, is extremely doubtful because its beneficial application requires much time and gives a good bit of trouble, both to the patient and the practitioner.”

That’s an appraisal of the stethoscope from the *London Times* in 1834, but it could just as easily refer to our contemporary experience in attempting to introduce useful health technologies like computerized provider order entry and the electronic medical record (EMR)—an experience characterized by skepticism and tepid growth. The failure of healthcare technologies to establish a commanding presence is symptomatic of a larger issue: an industry undergoing transition. Coupled with societal trends, healthcare’s venues, workflows, economics and touch points are undergoing rapid and unstructured transformation, without a clear signpost to guide health IT.

Today, technology and societal trends are converging to create new communication patterns that connect and coordinate the roles of every healthcare stakeholder, including the patient, provider, payer, employer, pharma, public health and more. At the same time, our healthcare industry is steering inexorably toward a distributed-service architecture in which key decision making occurs at the point of care. One of the primary engines of this shift towards decentralization and reorientation of healthcare services is mobile healthcare, or mHealth. mHealth can be broadly defined as the delivery of healthcare services via mobile communication devices. A fuller description refers to the delivery, facilitation and communication of health-related information via mobile telecommunication and multimedia technologies, including cell phones, tablet devices, PDAs and wireless infrastructure in general.

mHealth describes the use of a broad range of telecommunication and multimedia technologies within wireless care delivery architecture. But it is more than simply extending communications channels—its reach can establish true healthcare communities in which every stakeholder can participate. In the space of two short years, mobile health—thanks in no small part to the smartphone—has catapulted to the forefront of essential healthcare technologies. With amazing speed, mHealth is becoming the clinical data medium of choice for clinicians and consumers, typified by compact devices and tools that are cheap, reliable, persistent and convenient. It’s the care management platform that the EMR always should have been, with an important distinction—it’s reaching its potential.

The scale of mHealth interventions range from simple, direct-to-consumer/direct-to-patient communications to more complex applications and systems that remotely coordinate and actively manage patient care. In its fullest flowering, mHealth will serve as a springboard to address healthcare’s most intractable problems—quality and cost—and may well become the centerpiece of healthcare programs aimed at chronic disease management, public health, wellness and prevention. But mHealth isn’t just about the smartphone—and its impact on the industry is just beginning to be felt.

mHealth offers an elegant solution to a chronic problem facing clinicians: accessing the right information where and when it is needed within highly fluid, distributed organizations. Healthcare is fertile ground for mobile solutions, because they remove geography and time as barriers to care by establishing connectivity with remote locations and remote workers, and by creating new points of contact with patients. mHealth changes the frequency and intensity of healthcare delivery, allowing for persistent, pervasive healthcare services to be delivered anytime, anywhere. It establishes effective new treatment modalities—telehealth, remote patient monitoring, self-care and home health, among others. But beyond clinical connectivity, mHealth holds the promise of quality improvement, cost reduction, wholesale gains in population health, access to care and a better allocation of health-delivery resources. With mHealth, clinicians, patients and other stakeholders are able to continuously monitor and manage health conditions on the fly. It's becoming embedded into healthcare operations—mHealth is integral to a number of care delivery strategies, including the medical home, the health information exchange, the care team and patient-centric healthcare.

Mobile solutions hold great promise for keeping people healthy, managing diseases and reducing healthcare costs. For years, telehealth has provided clinical services for individuals who lack physical access: farmers in remote communities, soldiers near the battlefield and prison inmates. Now, these technologies have demonstrated the ability to directly impact the health characteristics of all consumers. Mobile devices are the most personal technologies that consumers own—they enable consumers to establish personal preferences for sharing and communicating, and they enable health and wellness to be delivered through mass personalization.

Mobile devices and applications have come a long way from the “bag” phone and walkie-talkie-sized devices of the mid-1990s, and are now a truly practical—and ubiquitous—feature of daily life. The healthcare industry has taken note and is deploying mobile networks and point-of-care devices to support the electronic exchange of medical information.

Mobile development in healthcare is being driven by innovation in the tech sector, cost-saving initiatives by providers and payers and overwhelming demand by consumers. The tools of mobile computing—smartphones and PDAs, tablet PCs, patient monitoring devices and laptops—are opening new vistas of opportunity for clinical collaboration. Telemedicine, voice recognition and home monitoring have been around for years, but the wave of mHealth adoption owes its popularity to a convergence of form and function. Mobile devices have made dramatic leaps forward in terms of cost, bulk, weight, durability and performance. Innovative applications of mobile technologies like GPS, radio frequency and cellular, as well as evolving wireless standards like 4G and ZigBee are producing an explosion of mHealth tools and applications.

The potential universe of mHealth applications spans the payer, provider and healthcare consumer markets. To meet this demand, vendors and developers are offering an ever-widening array of devices, such as wearable monitors and testing devices, and delivering innovative mobile applications such as GPS for Alzheimer's patients, OTC drug reference for consumers, a handheld EMR viewer and text-based medication reminders. There are thousands of mobile apps for healthcare already on the market, with more on the way. They include e-prescribing, medical calculators, deci-

mHealth Applications	Sample Deployments	Benefits
Chronic disease management.	Wearable monitors.	Pre-emptive interventions.
Medication adherence.	Medication reminders and safety alerts via text, e-mail and or smartphone application.	Increased patient satisfaction.
Remote patient monitoring.	Safety and location tracking systems.	Reduced cost.
Access to personal health information.	Personal health records.	Aging in place and nursing home diversion.
Communication among clinicians, patients and other caregivers.	Web-based social networking.	Increased self-management.
Personal fitness and wellness.	Nutrition, activity and quality of life web-based monitoring systems.	Improved health and wellness.
		Increased quality of life.
		Decreased caregiver burden.
		Improved communication among clinicians, patients and other caregivers.

Table 1. Technology Applications and Potential Outcomes of mHealth.

sion support tools, personal health records, patient medical and eligibility queries, for starters. A general market scan of mHealth applications include:

- Public and population health.
- Emergency response systems.
- Professional and patient communications (e-mail, texting, social networking).
- Point-of-care documentation.
- Mobile synchronous (voice) and asynchronous (SMS) telemedicine diagnostic and decision support to remote clinicians.
- Mobile EMR.
- Financial and administrative applications.
- Clinical care and remote patient monitoring.

- Health extension services.
- Health services monitoring and reporting.
- Consumer education.
- Pharmaceutical clinical trials.
- Health promotion and community mobilization.

A closer look at several of these applications reveals the cause-and-effect relationship of mHealth that can be translated into improved clinical workflow, improved quality and patient satisfaction, and reduced costs. (See Table 1.)

We're still in the opening rounds of mHealth, and there are significant unknowns that will determine its ultimate course. Will multiple communication channels translate into a deluge of resource consuming and electronic patient-provider conversations? Will new privacy and security protocols evolve to "bulletproof" wireless data exchange? Will the next generation of wireless standards push mHealth beyond communications and into the realm of diagnostic imaging? Within the next few years mHealth is likely to evolve in unexpected ways, but one thing seems clear: mHealth is going to deliver EMR functionality to a worldwide audience—faster, cheaper and with a much steeper adoption curve.

Rick Krohn, MA, MAS

David Metcalf, PhD