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# Radiology in Global Health

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# Radiology in Global Health

Strategies, Implementation,  
and Applications

Second Edition

 Springer

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*Dedicated to the loving memory of my mother, Gina Mollura, and my daughter, Nicole. To my wife, Laura, and our children, Anna and Daniela, whose love brings inspiration and hope. To all the RAD-AID members, supporters, and volunteers who teach me the example of self-sacrifice and vision for a better world.*

–Daniel J. Mollura

*With love to Edmund, Ian, and Nathaniel;  
With gratitude to my family, friends, and colleagues.*

–Melissa P. Culp

*“Hope is the thing with feathers” by Emily Dickenson  
“Hope” is the thing with feathers  
That perches in the soul  
And sings the tune without the words  
And never stops at all  
And sweetest in the Gale is heard  
And sore must be the storm  
That could abash the little Bird  
That kept so many warm  
I’ve heard it in the chilliest land  
And on the strangest Sea  
Yet never in Extremity,  
It asked a crumb of me.*

–Matthew P. Lungren

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## Foreword

I am honored to write the Foreword to the second edition of *Radiology in Global Health: Strategies, Implementation, and Applications*. As amazing as it sounds, so much has occurred in both medical imaging and in the state of the world's health during the 4 years since the book's original publication that a new edition is warranted. Most importantly, co-editor Dan Mollura's vision in founding RAD-AID has grown at a remarkable pace. RAD-AID and its partner institutions now provide previously unavailable medical imaging services to 53 sites in 27 countries. As a result, an estimated 40 million people residing in medically underdeveloped regions around the globe have new access to the same life-saving diagnostic imaging and image-guided treatment technologies that over the past four decades have revolutionized medical care in more prosperous countries. As a result of RAD-AID's efforts, people residing in these regions enjoy safer, more effective care than previously.

The covers of this book house the fruits of these labors. *Radiology in Global Health* is a comprehensive "how-to" as well as a guide to imaging diagnosis. What RAD-AID has accomplished and its promise of future work are a precious gift not only to the people that directly benefit from RAD-AID's work but to all of us. The world grows ever smaller. Jet travel and 24-h news cycles link all of us, one to another. An outbreak of infectious disease in one locale bears with it a greater risk of dissemination to our corner of the globe than ever before. War, famine, and rapidly morphing vectors of disease threaten to spread annihilation to populations that previously thought themselves immune.

Better access to modern medical imaging, in and of itself, does not proffer protection. Imaging technology alone cannot surmount these deadly problems. The third world scourges of drug-resistant tuberculosis, malaria, AIDS, and unpredictable infectious epidemics continue to claim hundreds of millions of lives annually and will continue to do so until every human on the planet enjoys better sanitation, reliable access to clean water, and improvements in nutrition, and education. However, RAD-AID's enabling the application of cross-sectional imaging technologies like ultrasound, CT, and magnetic resonance imaging will lead to earlier disease detection, improved diagnosis and treatment, and reduced suffering and death.

This book is a look backward, a reflection of what RAD-AID has already achieved and guidance for the future. RAD-AID has accomplished much, often working on a metaphorical shoestring. There is a great deal more to do.

An estimated three to four billion people still have no access to modern medical imaging. Many of these people live so remotely or are dispersed over such wide geographic areas that conventional fixed imaging facilities would be ineffective. Working with corporate partners, RAD-AID is beginning to address these populations with novel movable approaches that may soon further progress toward the overriding goal of providing access to the benefits of diagnostic imaging and image-guided therapy to every person, regardless of where they reside.

To the editors and authors of this book go my heartiest congratulations. The publication of this second edition of *Radiology in Global Health* is a sentinel event. May its contents help power the light of modern medical imaging to shine on those corners of the world that still remain in darkness.

January, 2018

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## Preface

Welcome to this second edition of *Radiology in Global Health*. We are pleased that the success and impact of our first edition in 2014 warranted this updated text for discussing the role of radiology in international health and underserved regions.

As over half the world has little or no access to medical imaging and radiology, this text focuses on the questions of *why this disparity is important and what we can do to address it*. To begin that discussion, it is first essential to envision what the absence of radiology at the global level really means at the local and individual human level:

A little boy is carried into an emergency room in urban Africa after suffering serious injuries in a car accident. Physicians see a likely leg fracture on physical exam, but an x-ray machine is not available to image the leg and determine whether surgery is needed. A pregnant woman in rural South America is in labor that fails to progress after 24 h and there is unexplained bleeding, but there is no ultrasound available to diagnose the problem. A refugee camp in the Middle East shows signs of a spreading respiratory illness defined by increasing cough and fever, but no chest radiography is available to diagnose possible pneumonia or tuberculosis. A woman in India is losing weight and has a lump in her left breast, but she does not have access to mammography or ultrasound in her community for further evaluation.

These are just a few examples of the worldwide need for medical imaging, and the failures in medical care that result from radiology's scarcity. These vignettes also highlight radiology as a fundamental infrastructure component in health care systems containing interdependent and interlocking parts, including (i) screening, (ii) diagnosis, (iii) treatment, and (iv) long-term disease management, all of which have interfaces with radiology. The central implication is that radiology's absence interrupts patient-referral networks and treatment pipelines, such that individual patients are unable to access definitive care.

Radiologic services common to the industrialized economies of the world are scarce in the impoverished and low-resource regions of the world. Among the wealthier health care systems, medical imaging plays a vital role in patient care. When a patient sees a physician or health care provider in a high-resource health care system, it is widely acknowledged by both patient and provider that imaging plays a significant role in the diagnostic work-up: women routinely undergo breast cancer screening via mammography; patients with heart disease receive angiography and CT; trauma patients are

evaluated by CT and radiography; the patient's response to cancer therapy is monitored by CT, MRI, and PET; expecting mothers are monitored by fetal ultrasound; and the list goes on and on. In underserved areas, particularly in low and middle-income countries (LMICs), these medical imaging services may be absent or inaccessible due to remote location, wait-time, personnel-shortages, equipment failure or inoperability, thereby leaving patients with few or no options for diagnosis and care.

In addition to the patient-care clinical impact of radiology scarcity across the world, the radiology divide has technological and economic development impacts, interwoven as a strong theme throughout this text, because radiology has consistently been the entrance gateway for advanced health technology adoption at the facility and regional levels. Hospitals that adopted digital imaging in radiology in well-resourced contexts over the last decade also rapidly adopted other health information technologies, such as electronic medical records (EMR), radiology information systems (RIS), picture archiving and communications systems (PACS), health information systems (HIS). Since imaging is now digital in the high-income countries, radiology is at the forefront of hospitals advancing these other data management systems that are now also driving the arrival of artificial intelligence in automated data processing, simulated human learning, and cognitive computing in medicine. However, the radiology divide between wealthier and low-resource regions, therefore, reinforces an information technology chasm that ripples not just within the radiology departments, but to the entire health care systems of low and middle-income countries unable to join this advancing edge of imaging informatics and information technologies.

Who is the intended audience of this book? This is an important question because solution development requires dialogue with the correct audience and professional participants. This book is intended for a broad audience of health care providers (such as physicians, nurses, technologists, and sonographers), hardware/software engineers, policy-makers, business leaders, researchers, and public health specialists, at all levels who utilize or implement health care services for underserved populations. This encompasses the medical imaging community, including radiologists, radiology residents, radiology technologists, and radiology nurses. Moreover, as health care providers utilize radiology in the process of clinical decision-making, this text is also designed for clinical physicians, nurses, nurse-practitioners, physician assistants, and paramedical personnel who recognize and utilize the strong role of imaging in patient care. Administrators and public health personnel are important constituencies in this dialogue and text, as the planning of radiology services for health care systems at both the facility level and at the population level requires a clear understanding of the technological challenges and management opportunities.

Perhaps you are a medical volunteer aiming to use, implement, or improve a clinical service using radiology. Perhaps you are a humanitarian aid specialist trying to implement, manage, or evaluate an existing screening service in a refugee camp or other low-resource facility. Perhaps you are a radiology resident, trainee, or a resident in any related field of medicine, pediatrics, surgery, and Ob-Gyn, needing adequate background for international health



rotations and global health training. Perhaps you are a radiology technologist, radiation therapist, medical physicist, or sonographer, aiming to teach the best-practice imaging techniques, protocols, and procedures for low-resource hospitals trying to take better care of patients. All of these perspectives are encompassed in this text to bridge the vital components of medical imaging and radiologic work for patient care in underserved regions.

With such a broad audience in mind, this text has an interdisciplinary format based on RAD-AID's 10 years of work (2008–2018) serving indigent communities around the world, mixing approaches and perspectives to analyze solutions for radiology in global health efforts. Such an interdisciplinary approach entails the synthesis of business management, government policy formulation, clinical methods, and engineering, in order to integrate economic development, technology innovation, clinical model planning, educational strategies, and public health.

This multidisciplinary approach is also intended in this text to address a diverse set of global health contexts including acute emergency care, communicable (infectious) outbreaks, disaster response, chronic health services, community screening, and long-term care of cancer and cardiovascular diseases. As radiology is a strong component of all these contexts, this text delivers a multidisciplinary perspective for radiology's role across this wide range of settings and applications. Since the expertise required to assess, plan, implement, and monitor these radiology programs is also multifactorial, this text aims to comprehensively cover this planning process from diverse vantage points.

We welcome you to the exciting adventure of radiology in global health covered in the chapters that follow. It is our hope that this text will give you new tools, ideas, and strategies for bringing vital radiology to low-resource areas and underserved populations. This text hopefully can empower you to think of tomorrow's solutions in radiology serving the world.

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