

Get Full Access and More at

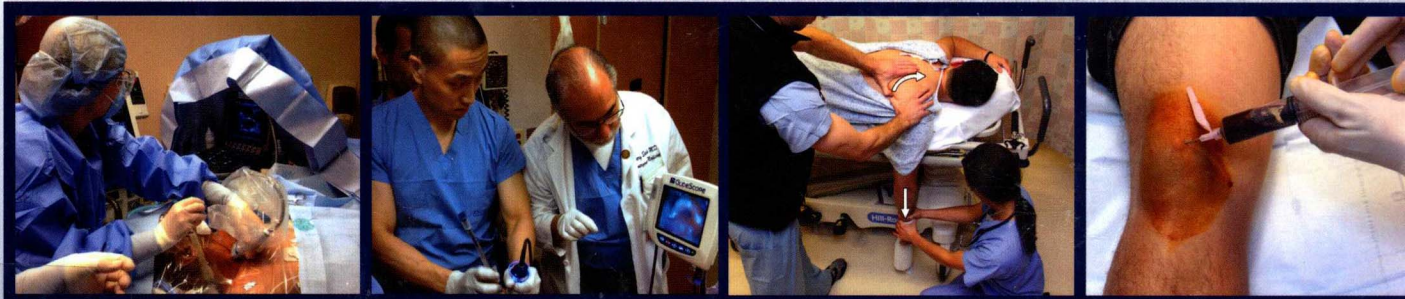
ExpertConsult.com

ROBERTS & HEDGES'

CLINICAL

PROCEDURES

in Emergency Medicine



ROBERTS
CUSTALOW
THOMSEN

CHANMUGAM
CHUDNOFSKY
DEBLIEUX
MATTU
SWADRON

SIXTH
EDITION

ELSEVIER
SAUNDERS

Roberts and Hedges' Clinical Procedures in Emergency Medicine

SIXTH EDITION

EDITOR-IN-CHIEF

James R. Roberts, MD, FACEP, FAAEM, FACMT

Professor of Emergency Medicine
Vice Chair, Department of Emergency Medicine
Senior Consultant, Division of Toxicology
The Drexel University College of Medicine
Chairman, Department of Emergency Medicine
Director, Division of Medical Toxicology
Mercy Catholic Medical Center
Philadelphia, Pennsylvania

SENIOR EDITOR

Catherine B. Custalow, MD, PhD

Associate Professor, Retired
Department of Emergency Medicine
University of Virginia School of Medicine
Charlottesville, Virginia

ILLUSTRATION EDITOR

Todd W. Thomson, MD
Department of Emergency Medicine
Mount Auburn Hospital
Cambridge, Massachusetts
Instructor in Medicine
Harvard Medical School
Boston, Massachusetts

EDITOR EMERITUS

Jerris R. Hedges, MD, MS, MMM

Professor and Dean
John A. Burns School of Medicine
University of Hawaii—Manoa
Honolulu, Hawaii
Professor and Vice-Dean, Emeritus
Department of Emergency Medicine
Oregon Health & Science University School of Medicine
Portland, Oregon

ELSEVIER
SAUNDERS

Copyright © 2014, 2010, 2004, 1998, 1991, 1985 by Saunders, an imprint of Elsevier Inc.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Details on how to seek permission, further information about the Publisher's permissions policies, and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods, they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility.

With respect to any drug or pharmaceutical products identified, readers are advised to check the most current information provided (i) on procedures featured or (ii) by the manufacturer of each product to be administered to verify the recommended dose or formula, the method and duration of administration, and contraindications. It is the responsibility of practitioners, relying on their own experience and knowledge of their patients, to make diagnoses, to determine dosages and the best treatment for each individual patient, and to take all appropriate safety precautions.

To the fullest extent of the law, neither the Publisher nor the authors, contributors, or editors assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence, or otherwise or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

Library of Congress Cataloging-in-Publication Data

Clinical procedures in emergency medicine.

Roberts and Hedges' clinical procedures in emergency medicine / editor-in-chief, James R. Roberts ; senior editor, Catherine B. Custalow ; illustration editor, Todd W. Thomsen ; editor emeritus, Jerris R. Hedges.—Sixth edition.

p. ; cm.

Clinical procedures in emergency medicine

Preceded by Clinical procedures in emergency medicine / editors, James R. Roberts, Jerris R. Hedges ; associate editors, Catherine B. Custalow ... [et al.]. 5th ed. c2010.

Includes bibliographical references and index.

ISBN 978-1-4557-0606-8 (hardcover : alk. paper)

I. Roberts, James R., 1946- editor of compilation. II. Custalow, Catherine B. editor of compilation. III. Thomsen, Todd W. editor. IV. Hedges, Jerris R. editor. V. Title. VI. Title: Clinical procedures in emergency medicine.

[DNLM: 1. Emergencies. 2. Emergency Medicine—methods. 3. Emergency Treatment—methods. WB 105]

RC86.7

616.02'5—dc23

2013017645

Senior Content Strategist: Stefanie Jewell-Thomas

Senior Content Specialist: Dee Simpson

Publishing Services Manager: Anne Altepeter

Senior Project Manager: Doug Turner

Designer: Lou Forgione

Printed in the People's Republic of China

Last digit is the print number: 9 8 7 6 5 4 3 2 1



Working together
to grow libraries in
developing countries

www.elsevier.com • www.bookaid.org

Roberts and Hedges' Clinical Procedures in Emergency Medicine

James R. Roberts, MD, FACP, FAEM

Professor of Emergency Medicine
Department of Emergency Medicine
University of California, Los Angeles
Vice Chair, Department of Emergency Medicine
Senior Consultant, Division of Emergency Medicine
The David Geffen School of Medicine
Chairman, Department of Emergency Medicine
Director, Division of Emergency Medicine
University of California, Los Angeles

Stuart P. Swadlow, MD, FRCPC

SENIOR EDITOR

Catherine B. Custalow, MD, PhD

Associate Professor
Department of Emergency Medicine
University of Virginia School of Medicine
Charlottesville, Virginia

ILLUSTRATION EDITOR

Todd W. Thomsen, MD

Department of Emergency Medicine
Mount Auburn Hospital
Cambridge, Massachusetts
Associate in Medicine
Harvard Medical School
Boston, Massachusetts



00163493

EDITOR EMERITUS

Jarris R. Hedges, MD, MS, MMM

Professor and Dean
John A. Burns School of Medicine
University of Hawaii - Manoa
Honolulu, Hawaii
Professor and Vice-Dean, Emergency
Department of Emergency Medicine
Oregon Health & Science University School of Medicine
Portland, Oregon

ELSEVIER
SAUNDERS

To Lydia, Matthew, Martha, and, of course, Jeanne.

J.R.R.

To my son, Nicholas, and to the memory of my daughter, Lauren.

C.B.C.

To my wonderful wife, Karen—thank you for your inspiration, support, and remarkable partnership; to Sydney, William, and Nathan, who will always be reminders of what is truly important; to my parents, who helped to foster the passion of medical education as a public service. To Cathy Custalow, MD, for her many, many hours and dedication to this book. And finally to those who practice and teach emergency medicine—may this book serve you well.

A.S.C.

To Marcy ... my wife, my best friend, and my soul mate.

C.R.C.

To my wife, Karen, and my sons, Joshua and Zachary—thank you for your unlimited patience and encouragement while I pursued this educational passion. None of this could happen without your love. To our residents, peer faculty, nurses, and patients at LSU and Charity Hospital—your example and inspiration for patient care keep me focused on the mission of “care for all.”

P.M.C.D.

To my wife, Sejal, and my three children, Nikhil, Eleena, and Kamran, for giving me purpose and inspiration. To my colleagues and my mentors for all that they have taught me through the years. To Jim Roberts, for continuing to be a driving force behind this text. And to emergency physicians around the world, who continually care and advocate for their patients despite the toughest of times and circumstances.

A.M.

To my amazing wife, Joyce; my supportive parents; the students and residents of the Keck School of Medicine; and the gracious patients of Los Angeles County—USC Medical Center.

S.P.S.

To Jim Roberts and Cathy Custalow, for the opportunity to collaborate on this project. To Gary Setnik, for your mentorship throughout the years. To my parents, Alfred and Beverly Thomsen, for everything. And most importantly, to my beautiful wife, Cristine, and wonderful sons, Henry and Cole, for your love and patience during the many months that this book took me away from you.

T.W.T.

ASSOCIATE EDITORS

Arjun S. Chanmugam, MD, MBA

Associate Professor
Department of Emergency Medicine
The Johns Hopkins School of Medicine
Baltimore, Maryland

Carl R. Chudnofsky, MD

Chairman
Department of Emergency Medicine
Albert Einstein Medical Center
Professor
Jefferson Medical College
Philadelphia, Pennsylvania

Peter M.C. DeBlieux, MD

Professor of Clinical Medicine
Louisiana State University Health Sciences Center
New Orleans, Louisiana

Amal Mattu, MD

Professor and Vice Chair
Department of Emergency Medicine
University of Maryland School of Medicine
Baltimore, Maryland

Stuart P. Swadron, MD, FRCPC

Associate Professor
Department of Emergency Medicine
Assistant Dean for Pre-Health Undergraduate Studies
Keck School of Medicine of USC
University of Southern California
Los Angeles, California

HOW THIS MEDICAL TEXTBOOK SHOULD BE VIEWED BY THE PRACTICING CLINICIAN AND THE JUDICIAL SYSTEM

The editors and authors of this textbook strongly believe that the complex practice of medicine, the vagaries of human diseases, the unpredictability of pathologic conditions, and the functions, dysfunctions, and responses of the human body cannot be defined, explained, or rigidly categorized by any written document. *Therefore it is neither the purpose nor the intent of our textbook to serve as an authoritative source on any medical condition, treatment plan, or clinical intervention; nor should our textbook be used to rigorously define a standard of care that should be practiced by all clinicians.*

Our written word provides the physician with a literature-referenced database and a reasonable clinical guide that is combined with practical suggestions from individual experienced practitioners. We offer a general reference source and clinical roadmap on a variety of conditions and procedures

that may confront clinicians who are experienced in emergency medicine practice. This text cannot replace physician judgment; cannot describe every possible aberration, nuance, clinical scenario, or presentation; and cannot define rigid standards for clinical actions or procedures. *Every medical encounter must be individualized, and every patient must be approached on a case-by-case basis.* No complex medical interaction can possibly be reduced to the written word. The treatments, procedures, and medical conditions described in this textbook do not constitute the total expertise or knowledge base expected to be possessed by all clinicians. Finally, many of the described complications and adverse outcomes associated with implementing or withholding complex medical and surgical interventions may occur, even when every aspect of the intervention has been performed correctly and as per any textbook or currently accepted standards.

The editors and authors of *Roberts and Hedges' Clinical Procedures in Emergency Medicine*, Sixth Edition

Benjamin S. Abella, MD, MPhil
Clinical Research Director
Department of Emergency Medicine
Center for Resuscitation Science
University of Pennsylvania
Artificial Perfusion during Cardiac Arrest

Bruce D. Adams, MD
Professor
Chief of Emergency Medicine
Center for Emergency Medicine
University of Texas School of Medicine
San Antonio, Texas
*Central Venous Catheterization and
Central Venous Pressure Monitoring*

Erik H. Adler, MD
Senior Resident
Department of Emergency Medicine
Denver Health
Denver, Colorado
Thoracentesis

Pablo F. Aguilera, MD
Instructor of Emergency Medicine
Department of Internal Medicine
Emergency Medicine Program
Pontificia Universidad Católica de
Chile
Santiago, Chile
Emergency Medicine Program
Coordinator
Hospital Dr. Sótero del Río
Puente Alto, Región Metropolitana
Puente Alto, Chile
Venous Cutdown

**James T. Amsterdam, DMD,
MD, MMM, FACEP, FACPE**
Chair/Service Line Director
Department of Emergency Medicine
York Hospital
York, Pennsylvania
Professor of Clinical Emergency
Medicine
Department of Emergency Medicine
Penn State University College of
Medicine
Hershey, Pennsylvania
Adjunct Professor of Emergency
Medicine
Department of Emergency Medicine
Drexel University College of Medicine
Philadelphia, Pennsylvania
Regional Anesthesia of the Head and Neck

Jennifer Avegno, MD
Clinical Assistant Professor
Department of Medicine
Section of Emergency Medicine
Louisiana State University Health
Sciences Center
New Orleans, Louisiana
*Educational Aspects of Emergency
Department Procedures*

David K. Barnes, MD, FACEP
Assistant Professor
Residency Program Director
Department of Emergency Medicine
University of California Davis Health
System
Sacramento, California
*Extensor and Flexor Tendon Injuries in the
Hand, Wrist, and Foot*

Steven J. Bauer, MD, MS
Staff Physician
Department of Emergency Medicine
Meritus Medical Center
Hagerstown, Maryland
*Alternative Methods of Drug
Administration*

Jason P. Becker, MD
Undergraduate Medical Education
Director
Emergency Medicine Residency
Program
Albert Einstein Medical Center
Philadelphia, Pennsylvania
*Treatment of Bursitis, Tendinitis, and
Trigger Points*

Lance B. Becker, MD, FAHA
Director
Center for Resuscitation Science
Professor
Department of Emergency Medicine
Perelman School of Medicine
University of Pennsylvania Health
System
Philadelphia, Pennsylvania
Artificial Perfusion during Cardiac Arrest

Kip R. Benko, MD, FACEP
Clinical Assistant Professor of
Emergency Medicine
University of Pittsburgh School of
Medicine
Faculty, Presbyterian University
Hospital
University of Pittsburgh Medical
Center
Pittsburgh, Pennsylvania
Emergency Dental Procedures

Edward S. Bessman, MD, MBA
Chairman and Clinical Director
Department of Emergency Medicine
Johns Hopkins Bayview Medical
Center
Assistant Professor
Department of Emergency Medicine
The Johns Hopkins School of
Medicine
Baltimore, Maryland
Emergency Cardiac Pacing

Barbara K. Blok, MD

Associate Professor
Department of Emergency Medicine
University of Colorado School of
Medicine
Aurora, Colorado
Associate Program Director
Denver Health Residency in
Emergency Medicine
Denver, Colorado
Thoracentesis

Heather A. Borek, MD

Attending Physician
Department of Emergency Medicine
Division of Medical Toxicology
Albert Einstein Healthcare Network
Philadelphia, Pennsylvania
Decontamination of the Poisoned Patient

Eduardo Borquez, MD

Staff Physician
Department of Emergency Medicine
Kaiser Permanente San Diego Medical
Center
San Diego, California
Noncardiac Implantable Devices

Sudip Bose, MD, FACEP, FAAEM

Associate Clinical Professor
Department of Emergency Medicine
University of Illinois
Chicago, Illinois
Attending Emergency Medicine
Physician
Partner, Basin Emergency Physicians,
LLC
Department of Emergency Medicine
Medical Center Hospital
Odessa, Texas
*Cricothyrotomy and Percutaneous
Translaryngeal Ventilation*

William J. Brady, MD

Professor of Emergency Medicine and
Medicine
Chair, Medical Emergency Response
(Formerly Resuscitation) Committee
Medical Director, Emergency
Management
University of Virginia Medical Center
Charlottesville, Virginia
Medical Director
Allianz Global Assistance
United States and Canada
Basic Electrocardiographic Techniques

G. Richard Braen, MD, FACEP

Professor and Chairman
Department of Emergency Medicine
Assistant Dean of Graduate Medical
Education
School of Medicine and Biomedical
Sciences
University at Buffalo
Buffalo, New York
Culdcentesis

Christine Butts, MD

Clinical Assistant Professor of
Emergency Medicine
Director of Division of Emergency
Ultrasound
Louisiana State University Health
Sciences Center
New Orleans, Louisiana
Ultrasound

Sharon K. Carney, MD

Clinical Assistant Professor of
Emergency Medicine
Drexel University College of Medicine
Chief Medical Officer
Mercy Catholic Medical Center
Philadelphia, Pennsylvania
Intravenous Regional Anesthesia

Merle A. Carter, MD

Residency Director
Department of Emergency Medicine
Albert Einstein Medical Center
Philadelphia, Pennsylvania
Compartment Syndrome Evaluation

Theodore C. Chan, MD

Professor
Department of Emergency Medicine
University of California, San Diego
Health Sciences
San Diego, California
Basic Electrocardiographic Techniques

Carl R. Chudnofsky, MD

Professor
Department of Emergency Medicine
Jefferson Medical College
Chair, Department of Emergency
Medicine
Albert Einstein Healthcare Network
Philadelphia, Pennsylvania
*Alternative Methods of Drug
Administration
Splinting Techniques*

Ilene Claudius, MD

Assistant Professor
Department of Emergency Medicine
Los Angeles County and University of
Southern California
Los Angeles, California
*Pediatric Vascular Access and Blood
Sampling Techniques*

Joseph E. Clinton, MD

Professor and Head
Department of Emergency Medicine
University of Minnesota Medical
School
Chief of Service
Department of Emergency Medicine
Hennepin County Medical Center
Minneapolis, Minnesota
*Basic Airway Management and Decision
Making
Tracheal Intubation*

Wendy C. Coates, MD

Professor of Clinical Medicine
David Geffen School of Medicine at
University of California, Los Angeles
Los Angeles, California
Director, Medical Education
Director, Fellowship in Medical
Education
Department of Emergency Medicine
Harbor-UCLA Medical Center
Torrance, California
Anorectal Procedures

Jonathan E. Davis, MD

Associate Professor
Department of Emergency Medicine
Georgetown University School of
Medicine Program Director
Emergency Medicine Residency
Program
Georgetown University Hospital/
Washington Hospital Center
Washington, District of Columbia
Urologic Procedures

Anthony J. Dean, MD

Associate Professor of Emergency
Medicine
Associate Professor of Emergency
Medicine in Radiology
Director, Division of Emergency
Ultrasonography
Department of Emergency Medicine
University of Pennsylvania Medical
Center
Philadelphia, Pennsylvania
*Bedsides Laboratory and Microbiologic
Procedures*

Kenneth Deitch, DO

Research Director
Department of Emergency Medicine
Albert Einstein Medical Center
Philadelphia, Pennsylvania
Intraosseous Infusion

William R. Dennis, MD, MPH

Chair of EMS
Assistant Professor of Emergency
Medicine
University of Missouri
Columbia, Missouri
Ophthalmologic Procedures

Denis J. Dollard, MD

Clinical Assistant Professor
Department of Emergency Medicine
Drexel University College of Medicine
Director, Department of Emergency
Medicine
Mercy Hospital of Philadelphia
Philadelphia, Pennsylvania
*Radiation in Pregnancy and Clinical Issues
of Radiocontrast Agents*

**Timothy B. Erickson, MD,
FACEP, FACMT, FAACT**

Professor
Department of Emergency Medicine
Division of Medical Toxicology
University of Illinois
Chicago, Illinois
*Procedures Pertaining to Hypothermia and
Hyperthermia*

Brian D. Euerle, MD

Associate Professor
Department of Emergency Medicine
University of Maryland School of
Medicine
Baltimore, Maryland
*Spinal Puncture and Cerebrospinal Fluid
Examination*

Michael T. Fitch, MD, PhD

Associate Professor
Department of Emergency Medicine
Wake Forest University School of
Medicine
Winston-Salem, North Carolina
Abdominal Hernia Reduction

Molly Furin, MD, MS

Attending Physician
Associate Fellowship Director Division
of EMS/Disaster Medicine
Department of Emergency Medicine
Albert Einstein Medical Center
Philadelphia, Pennsylvania
Prehospital Immobilization

Robert T. Gerhardt, MD, MPH

Chief Medical Officer, Tactical Combat
Casualty Care Research Program
U.S. Army Institute of Surgical
Research
Associate Professor
Department of Military and Emergency
Medicine
Uniformed Services University of the
Health Sciences
Bethesda, Maryland
Adjunct Faculty
San Antonio Uniformed Services
Health Education Consortium
Emergency Medicine Residency
Program and EMS/Disaster
Fellowship
San Antonio Military Medical Center
Joint Base San Antonio-Fort Sam
Houston
Houston, Texas
Assessment of Implantable Devices

Kevin B. Gerold, DO, JD

Assistant Professor
Departments of Anesthesiology and
Critical Care Medicine and
Emergency Medicine
The Johns Hopkins School of
Medicine
Director, Critical Care Medicine
Department of Anesthesiology
Johns Hopkins Bayview Medical
Center
Baltimore, Maryland
Burn Care Procedures

Mariana R. Gonzalez, BA

Department of Emergency Medicine
Hospital of the University of
Pennsylvania
Philadelphia, Pennsylvania
Artificial Perfusion during Cardiac Arrest

Diane L. Gorgas, MD

Associate Professor and Residency
Director
Department of Emergency Medicine
The Ohio State University
Columbus, Ohio
*Vital Sign Measurement
Transfusion Therapy: Blood and Blood
Products*

Steven M. Green, MD

Professor of Emergency Medicine and
Pediatrics
Department of Emergency Medicine
Loma Linda University Medical Center
and Children's Hospital
Loma Linda, California
*Systemic Analgesia and Sedation for
Procedures*

John C. Greenwood, MD

Chief Resident
Clinical Instructor Department of
Emergency Medicine
University of Maryland School of
Medicine
Baltimore, Maryland
Tracheostomy Care

Richard A. Harrigan, MD

Professor
Department of Emergency Medicine
Temple University School of Medicine
Philadelphia, Pennsylvania
Basic Electrocardiographic Techniques

Jeffrey Harrow, MD

Emergency Medicine Physician
Department of Emergency Medicine
The Johns Hopkins School of
Medicine
Baltimore, Maryland
Incision and Drainage

Micelle Haydel, MD

Associate Clinical Professor
Program Director
Section of Emergency Medicine
Louisiana State University Health
Sciences Center
New Orleans, Louisiana
*Medications and Equipment for
Resuscitation*

Randy B. Hebert, MD

Clinical Assistant Professor
Department of Emergency Medicine
Advocate Illinois Masonic Medical
Center
Chicago, Illinois
*Cricothyrotomy and Percutaneous
Translaryngeal Ventilation*

Eveline Hitti, MD, MBA

Assistant Professor in Clinical
Emergency Medicine
Interim Chair
Department of Emergency Medicine
American University of Beirut Medical
Center
Beirut, Lebanon
Incision and Drainage

Christopher P. Holstege, MD

Associate Professor
Department of Emergency Medicine
and Pediatrics
Chief, Division of Medical Toxicology
University of Virginia School of
Medicine
Medical Director
Blue Ridge Poison Center
University of Virginia Health System
Charlottesville, Virginia
Decontamination of the Poisoned Patient

Liam C. Holtzman, DO, FACEP

Assistant Professor
Department of Emergency Medicine
The Johns Hopkins University School
of Medicine
Senior Medical Officer
Center for Law Enforcement Medicine
The Johns Hopkins Medical
Institutions
Baltimore, Maryland
Incision and Drainage

Amanda E. Horn, MD

Assistant Professor
Assistant Residency Director
Department of Emergency Medicine
Temple University Hospital
Philadelphia, Pennsylvania
Management of Common Dislocations

J. Stephen Huff, MD

Professor of Emergency Medicine and
Neurology
Department of Emergency Medicine
University of Virginia
Charlottesville, Virginia
Special Neurologic Tests and Procedures

Charlene Irvin Babcock, MD

Department of Emergency Medicine
University of Michigan Hospital
Ann Arbor, Michigan
Autotransfusion

Paul Jhun, MD

Assistant Professor of Clinical
Emergency Medicine
Assistant Residency Director
Department of Emergency Medicine
University of Southern California
Los Angeles, California
Noncardiac Implantable Devices

Russell F. Jones, MD

Assistant Professor
Department of Emergency Medicine
University of California Davis Health
System
Sacramento, California
Resuscitative Thoracotomy

Colin G. Kaide, MD

Associate Professor
Department of Emergency Medicine
The Ohio State University
Columbus, Ohio
*Transfusion Therapy: Blood and Blood
Products*

Eric D. Katz, MD

Associate Professor
Department of Emergency Medicine
University of Arizona College of
Medicine—Phoenix Campus
Program Director and Vice-Chair for
Education
Department of Emergency Medicine
Maricopa Integrated Health Center
Phoenix, Arizona
*Commonly Used Formulas and
Calculations*

John J. Kelly, DO

Associate Chair
Department of Emergency Medicine
Albert Einstein Medical Center
Professor of Emergency Medicine
Jefferson Medical College
Philadelphia, Pennsylvania
*Nerve Blocks of the Thorax and
Extremities*

Kevin P. Kilgore, MD

Assistant Professor
Department of Emergency Medicine
University of Minnesota School of
Medicine
Minneapolis, Minnesota
Senior Staff Physician
Department of Emergency Medicine
Regions Hospital
St. Paul, Minnesota
Regional Anesthesia of the Head and Neck

Hyung T. Kim, MD

Assistant Professor of Clinical
Emergency Medicine
Department of Emergency Medicine
University of Southern California
Los Angeles, California
Arterial Puncture and Cannulation

Thomas D. Kirsch, MD, MPH

Associate Professor
Department of Emergency Medicine
The Johns Hopkins School of
Medicine
Department of International Health
The Johns Hopkins Bloomberg School
of Public Health
Baltimore, Maryland
Tube Thoracostomy

Brian C. Kitamura, BS, MD

Resident Physician
Department of Emergency Medicine
Maricopa Integrated Health Center
Phoenix, Arizona
*Commonly Used Formulas and
Calculations*

Anne Klimke, MD, MS

EMS Faculty
Assistant Director of EMS Fellowship
Department of Emergency Medicine
Albert Einstein Medical Center
Philadelphia, Pennsylvania
Prehospital Immobilization

Kevin J. Knoop, MD, MS

Commanding Officer
Medical Treatment Facility
USNS Comfort
Norfolk, Virginia
Ophthalmologic Procedures

J. Michael Kowalski, DO

Medical Director, Observation Unit
Attending Physician
Division of Medical Toxicology
Department of Emergency Medicine
Einstein Medical Center
Consulting Toxicologist
Poison Control Center at Children's
Hospital of Philadelphia
Philadelphia, Pennsylvania
Physical and Chemical Restraint

Baruch Krauss, MD, EdM

Senior Associate Physician in Medicine
Division of Emergency Medicine
Children's Hospital Boston
Associate Professor of Pediatrics
Department of Pediatrics
Harvard Medical School
Boston, Massachusetts
*Devices for Assessing Oxygenation and
Ventilation*
*Systemic Analgesia and Sedation for
Procedures*

Diann M. Krywko, MD

Associate Professor
Division Director of Faculty
Development and Mentoring
Division of Emergency Medicine
Department of Medicine
Medical University of South Carolina
Charleston, South Carolina
*Indwelling Vascular Devices: Emergency
Access and Management*

Richard L. Lammers, MD

Assistant Dean for Simulation
 Professor of Emergency Medicine
 Research Director
 Department of Emergency Medicine
 Western Michigan University School of
 Medicine
 Kalamazoo, Michigan
Principles of Wound Management
Methods of Wound Closure

David C. Lee, MD

Department of Emergency Medicine
 North Shore University Hospital
 Manhasset, New York
*Bedside Laboratory and Microbiologic
 Procedures*

George H. Lew, MD, PhD

Associate Professor
 Department of Emergency Medicine
 Loyola University Medical Center
 Maywood, Illinois
Emergency Childbirth

Shan W. Liu, MD, SD

Instructor
 Department of Surgery
 Harvard Medical School
 Attending Physician
 Department of Emergency Medicine
 Massachusetts General Hospital
 Boston, Massachusetts
Peripheral Intravenous Access

**Sharon E. Mace, MD, FACEP,
FAAP**

Professor of Medicine
 Department of Emergency Medicine
 Cleveland Clinic
 Director of Research
 Director of Observation Unit
 Director of Pediatric Education/
 Quality Improvement
 Emergency Services Institute
 Cleveland Clinic
 Faculty, Emergency Medicine
 Residency
 MetroHealth Medical Center/
 Cleveland Clinic
 Cleveland, Ohio
*Cricothyrotomy and Percutaneous
 Translaryngeal Ventilation*

Haney A. Mallemat, MD

Assistant Professor
 Department of Emergency Medicine
 and Critical Care
 University of Maryland School of
 Medicine
 Baltimore, Maryland
Pericardiocentesis

David E. Manthey, MD

Professor
 Vice Chair of Education
 Department of Emergency Medicine
 Wake Forest University School of
 Medicine
 Winston-Salem, North Carolina
Abdominal Hernia Reduction

**Joshua E. Markowitz, MD,
RDMS, FACEP**

Assistant Professor
 Department of Emergency Medicine
 Thomas Jefferson Medical School
 Director of Emergency Ultrasound
 Albert Einstein Healthcare Network
 Philadelphia, Pennsylvania
*Treatment of Bursitis, Tendinitis, and
 Trigger Points*

†John A. Marx, MD

Chair Emeritus
 Department of Emergency Medicine
 Carolinas Medical Center
 Adjunct Professor
 Department of Emergency Medicine
 University of North Carolina-Charlotte
 Campus
 Charlotte, North Carolina
Peritoneal Procedures

Phillip E. Mason, MD

Emergency Medicine Physician
 San Antonio Military Medical Center
 San Antonio, Texas
*Basic Airway Management and Decision
 Making*

**Anthony S. Mazzeo, MD, FACEP,
FAAEM**

Clinical Assistant Professor
 Department of Emergency Medicine
 Drexel University College of Medicine
 Philadelphia, Pennsylvania
 Attending Physician
 Medical Director
 Department of Emergency Medicine
 Mercy Fitzgerald Hospital
 Darby, Pennsylvania
Burn Care Procedures

Douglas L. McGee, DO, FACEP

Associate Professor
 Chief Academic Officer
 Albert Einstein Healthcare Network
 Department of Emergency Medicine
 Albert Einstein Medical Center
 Philadelphia, Pennsylvania
Local and Topical Anesthesia
Podiatric Procedures

John W. McGill, MD

Associate Professor
 Department of Emergency Medicine
 University of Minnesota School of
 Medicine
 Senior Associate Faculty
 Department of Emergency Medicine
 Hennepin County Medical Center
 Minneapolis, Minnesota
Tracheal Intubation

Jillian L. McGrath, MD

Assistant Professor
 Department of Emergency Medicine
 Associate Residency Program Director
 The Ohio State University Wexner
 Medical Center
 Columbus, Ohio
Vital Sign Measurement

Christopher R. McNeil, MD

Assistant Professor
 Residency Program Director
 Center for Emergency Medicine
 University of Texas School of Medicine
 San Antonio, Texas
*Central Venous Catheterization and
 Central Venous Pressure Monitoring*

Bohdan M. Minczak, MD, PhD

EMS Division Head
 EMS Fellowship Director
 Department of Emergency Medicine
 Drexel University College of Medicine
 Philadelphia, Pennsylvania
 Medical Director
 MidAtlantic MedEvac
 Hahnemann University
 Pottstown, Pennsylvania
*Techniques for Supraventricular
 Tachycardias*
Defibrillation and Cardioversion

Dean Moore II, MD

Attending Physician
 Emergency Department
 Albert Einstein Medical Center
 Philadelphia, Pennsylvania
Management of Amputations

Aimee Moulin, MD, FACEP

Assistant Professor
 Department of Emergency Medicine
 University of California Davis Medical
 Center
 Sacramento, California
*Standard Precautions and Infectious
 Exposure Management*

David W. Munter, MD, MBA

Associate Clinical Professor
Department of Emergency Medicine
Eastern Virginia Medical School
Norfolk, Virginia
Associate Clinical Professor
Department of Emergency Medicine
Edward Via College of Osteopathic
Medicine
Blacksburg, Virginia
Esophageal Foreign Bodies

Joshua Nagler, MD

Assistant Professor
Department of Pediatrics
Harvard Medical School
Fellowship Director
Division of Emergency Medicine
Children's Hospital Boston
Boston, Massachusetts
*Devices for Assessing Oxygenation and
Ventilation*

Mark J. Neavyn, MD

Clinical Faculty
Department of Emergency Medicine
St. John Hospital and Medical Center
Wayne State University School of
Medicine
Detroit, Michigan
Autotransfusion

Jessica L. Osterman, BS, MS, MD

Assistant Residency Director
Assistant Professor of Clinical
Emergency Medicine
Emergency Department
University of Southern California
Medical Center
Los Angeles, California
*Management of Increased Intracranial
Pressure and Intracranial Shunts*

Edward A. Panacek, MD, MPH

Professor
Department of Emergency Medicine
University of California Davis Medical
Center
Sacramento, California
*Balloon Tamponade of Gastroesophageal
Varices*

Margarita E. Pena, MD, FACEP

Associate Professor of Emergency
Medicine
Wayne State University School of
Medicine
Assistant Residency Director and
Medical Director, Clinical Decision
Unit
Department of Emergency Medicine
St. John Hospital and Medical Center
Detroit, Michigan
Autotransfusion

James A. Pfaff, MD

Staff Emergency Physician
San Antonio Uniformed Services
Health Education Consortium
Emergency Medicine Residency
San Antonio Military Medical Center
Joint Base San Antonio-Fort Sam
Houston
Houston, Texas
Assessment of Implantable Devices

Heather M. Prendergast, MD, MPH

Associate Professor
Vice Chair Academic Affairs
Department of Emergency Medicine
University of Illinois
Chicago, Illinois
*Procedures Pertaining to Hypothermia and
Hyperthermia*

Leigh Ann Price, MD

Assistant Professor
Department of Plastic and
Reconstructive Surgery
The Johns Hopkins University School
of Medicine
Director, Burn Fellowship Program
Director, Burn Residency Training
The Johns Hopkins Burn Center
Baltimore, Maryland
Burn Care Procedures

Michael S. Pulia, MD, FAAEM, FACEP

Assistant Professor
Division of Emergency Medicine
University of Wisconsin School of
Medicine and
Public Health
Madison, Wisconsin
Emergency Childbirth

Robert F. Reardon, MD

Associate Professor
Department of Emergency Medicine
University of Minnesota
Faculty Physician
Department of Emergency Medicine
Hennepin County Medical Center
Minneapolis, Minnesota
*Basic Airway Management and Decision
Making
Tracheal Intubation*

Salim R. Rezaie, MD

Assistant Program Director of
Emergency Medicine
Assistant Clinical Professor of
Emergency Medicine
Assistant Clinical Professor of Internal
Medicine
Center for Emergency Medicine
University of Texas School of Medicine
San Antonio, Texas
*Central Venous Catheterization and
Central Venous Pressure Monitoring*

Megan L. Rischall, MD

Resident
Department of Emergency Medicine
Hennepin County Medical Center
Minneapolis, Minnesota
*Management of Increased Intracranial
Pressure and Intracranial Shunts*

Emanuel P. Rivers, MD, MPH

Clinical Professor
Department of Emergency Medicine
and Surgery
Wayne State University
Vice Chairman and Research Director
Senior Staff Attending
Department of Emergency Medicine
and Surgical Critical Care
Henry Ford Hospital
Detroit, Michigan
Resuscitative Thoracotomy

Ralph J. Riviello, MD, MS, FACEP, FAAEM

Associate Professor
Department of Emergency Medicine
Drexel University College of Medicine
Attending Physician
Hahnemann University Hospital
Philadelphia, Pennsylvania
Otolaryngologic Procedures

James R. Roberts, MD, FACEP, FAAEM, FACMT

Professor of Emergency Medicine
Vice Chair, Department of Emergency Medicine
Senior Consultant, Division of Toxicology
The Drexel University College of Medicine
Chairman, Department of Emergency Medicine
Director, Division of Toxicology
Mercy Catholic Medical Center
Philadelphia, Pennsylvania
Intravenous Regional Anesthesia

Adam K. Rowden, DO

Assistant Professor of Emergency Medicine
Jefferson Medical College
Director of Operations
Department of Emergency Medicine
Associate Director, Fellowship in Medical Toxicology
Einstein Medical Center
Consulting Toxicologist
Children's Hospital of Philadelphia
Philadelphia, Pennsylvania
Physical and Chemical Restraint

Michael S. Runyon, MD

Associate Professor and Research Director
Department of Emergency Medicine
Carolinas Medical Center
University of North Carolina—Charlotte Campus
Charlotte, North Carolina
Peritoneal Procedures

Brent E. Ruoff, MD

Chief
Division of Emergency Medicine
Washington University School of Medicine
St. Louis, Missouri
Commonly Used Formulas and Calculations

Carolyn Joy Sachs, MD, MPH

Professor of Clinical Medicine
Department of Emergency Medicine
University of California, Los Angeles
Los Angeles, California
Medical Advisor
Forensic Nurse Specialists, Inc.
Long Beach, California
Examination of the Sexual Assault Victim

Leonard E. Samuels, MD

Assistant Professor
Department of Emergency Medicine
Drexel University College of Medicine
Philadelphia, Pennsylvania
Nasogastric and Feeding Tube Placement

Stewart O. Sanford, MD

Attending Physician
Department of Emergency Medicine
Albert Einstein Medical Center
Philadelphia, Pennsylvania
Arthrocentesis

Jairo I. Santanilla, MD

Clinical Assistant Professor of Medicine
Department of Medicine
Sections of Emergency Medicine and Pulmonary/Critical Care Medicine
Louisiana State University Health Sciences Center
Department of Pulmonary/Critical Care Medicine
Ochsner Medical Center
New Orleans, Louisiana
Mechanical Ventilation

Genevieve Santillanes, MD

Assistant Professor
Department of Emergency Medicine
Keck School of Medicine of USC
University of Southern California
Los Angeles, California
Pediatric Vascular Access and Blood Sampling Techniques

Jordan Sax, MD

Resident
Department of Emergency Medicine
The Johns Hopkins University
Baltimore, Maryland
Tube Thoracostomy

Richard B. Schwartz, MD

Professor and Chairman
Department of Emergency Medicine
Georgia Regents University
Augusta, Georgia
Pharmacologic Adjuncts to Intubation

David J. Scordino, MD

Resident
Department of Emergency Medicine
The Johns Hopkins University
Baltimore, Maryland
Foreign Body Removal

Greene Shepherd, PharmD

Clinical Professor
Eshelman School of Pharmacy
University of North Carolina
Asheville, North Carolina
Pharmacologic Adjuncts to Intubation

Michael A. Silverman, MD

Chairman
Department of Emergency Medicine
The Virginia Hospital Center
Arlington, Virginia
Instructor
Department of Emergency Medicine
The Johns Hopkins University School of Medicine
Baltimore, Maryland
Urologic Procedures

Zachary E. Smith, MMS, PA-C

Senior Physician Assistant
Departments of Anesthesiology/Critical Care and Emergency Medicine
The Johns Hopkins School of Medicine
Baltimore, Maryland
Principles of Wound Management
Methods of Wound Closure

Peter E. Sokolove, MD, FACEP

Professor
Vice Chair for Academic Affairs
Department of Emergency Medicine
University of California Davis Health System
Sacramento, California
Extensor and Flexor Tendon Injuries in the Hand, Wrist, and Foot
Standard Precautions and Infectious Exposure Management

Mark Spektor, DO, MBA, FACEP

President and CEO
Bayonne Medical Center
Bayonne, New Jersey
Nerve Blocks of the Thorax and Extremities

Daniel B. Stone, MD, MBA

Clinical Assistant Professor
Department of Medicine
Florida International University
Herbert Wertheim College of Medicine
Miami, Florida
Regional Medical Director
TeamHealth SouthEast
Fort Lauderdale, Florida
Foreign Body Removal

Amita Sudhir, MD

Assistant Professor
Department of Emergency Medicine
University of Virginia
Charlottesville, Virginia
Educational Aspects of Emergency Department Procedures

Semhar Z. Tewelde, MD

Clinical Instructor/Emergency
Cardiovascular Fellow
Department of Emergency Medicine
University of Maryland Medical Center
Baltimore, Maryland
Pericardiocentesis

Jacob W. Ufberg, MD

Professor
Department of Emergency Medicine
Temple University School of Medicine
Residency Director
Department of Emergency Medicine
Temple University Hospital
Philadelphia, Pennsylvania
Management of Common Dislocations

Veronica Vasquez, MD

Assistant Professor
Director of Quality Improvement
Department of Emergency Medicine
Keck School of Medicine of USC
University of Southern California
Los Angeles, California
Venous Cutdown

Malinda Wheeler, RN, MN, FNP, SANE

Director
Forensic Nurse Specialists, Inc.
Long Beach, California
Examination of the Sexual Assault Victim

Michael E. Winters, MD, FACEP, FAAEM

Associate Professor of Emergency
Medicine and Medicine
Co-Director, Combined Emergency
Medicine/Internal Medicine/Critical
Care Program
Director, Combined Emergency
Medicine/Internal Medicine Program
University of Maryland School of
Medicine
Medical Director, Adult Emergency
Department
Department of Emergency Medicine
University of Maryland Medical Center
Baltimore, Maryland
Tracheostomy Care
*Balloon Tamponade of Gastroesophageal
Varices*

Scott H. Witt, MD

Resident Physician
Department of Medicine
Division of Emergency Medicine
Medical University of South Carolina
*Indwelling Vascular Devices: Emergency
Access and Management*

Richard D. Zane, MD

Professor and Chair
Department of Emergency Medicine
University of Colorado School of
Medicine
Aurora, Colorado
Peripheral Intravenous Access

Video Contributors

Carlo Astini, MD, FRCS

Chief Consultant Surgeon
General Surgery
Hopital Italien de Balbala
Balbala, Djibouti

Anna Bargren, MD

Emergency Medicine
University of Chicago
Chicago, Illinois

Joe Bellezo, MD

Emergency Medicine
Sharp Memorial Hospital
San Diego, California

Darren Braude, MD

Department of Emergency Medicine
University of New Mexico
Albuquerque, New Mexico

James Bryant, RN, VA-BC

Clinical Coordinator
Vascular Access Department
Chesapeake Regional Medical Center
Chesapeake, Virginia

Adam Bystrzycki, MBBS, FACEM

Senior Lecturer
Department of Medicine
Monash University
Melbourne, Victoria, Australia

Lance Carter, BS, MSA, AA-C

UMKC MSA Assistant Program
Director, Allied Health
UMKC School of Medicine
Kansas City, Missouri

Kevin Chason, DO

Department of Emergency Medicine
Mount Sinai School of Medicine
New York, New York

Panna Codner, MD

Division of Trauma and Critical Care
Department of Surgery
Medical College of Wisconsin
Milwaukee, Wisconsin

Daniel Cook, MD

President, Cookgas LLC
St. Louis, Missouri

Neil Cunningham, MBBS, FACEM

Honorary Senior Fellow
Faculty of Medicine, Dentistry and
Health Sciences
University of Melbourne
Melbourne, Victoria, Australia

Matt Dawson, MD, RDMS, RDCS

Assistant Professor
Director of Emergency Ultrasound
Emergency Medicine
University of Kentucky
Lexington, Kentucky

George Douros, BMBS, AFCEM

Emergency Department
Austin Health
Melbourne, Australia

James DuCanto, MD

Clinical Assistant Professor
Department of Anesthesiology
Medical College of Wisconsin
Milwaukee, Wisconsin

David K. Duong, MD MS

Assistant Professor
Emergency Medicine
University of California, San Francisco
San Francisco, California

Anton J. Fakhouri, MD, FACS, FICS

Assistant Clinical Professor
Department of Orthopaedic Surgery
University of Illinois College of
Medicine
Chicago, Illinois

Gerard Fennessy, MD

Honorary Senior Fellow
Faculty of Medicine, Dentistry and
Health Sciences
University of Melbourne
Melbourne, Victoria, Australia

Whit Fisher, MD

Department of Emergency Medicine
The Westerly Hospital
Westerly, Rhode Island

William Fleischman, MD

Department of Emergency Medicine
Mount Sinai School of Medicine
New York, New York

Daniel Gromis, MD, RDMS

Emergency Medicine Physician
Advocate Christ Medical Center
Oak Lawn, Illinois
St Joseph's Hospital
Orange, California
Long Beach Memorial Medical Center
Long Beach, California

Fayaz Gulamani, RRT

BOMImed
Bensenville, Illinois

Mel Herbert, MD

Professor of Emergency Medicine
Keck School of Medicine of the
University of Southern California
Los Angeles County-USC Medical
Center
Los Angeles, California

Scott A. Joing, MD

Emergency Department
Hennepin County Medical Center
Minneapolis, Minnesota

Randy Kardon, MD, PhD

Director of Neuro-Ophthalmology
University of Iowa
Iowa City, Iowa

Raashee Kedia, MD

Department of Emergency Medicine
Mount Sinai School of Medicine
New York, New York

Heidi Harbison Kimberly, MD

Instructor
Harvard Medical School
Emergency Department
Brigham and Women's Hospital
Boston, Massachusetts

The sixth edition of *Roberts and Hedges' Clinical Procedures in Emergency Medicine* continues the book's original concept of providing complete, detailed, and up-to-date descriptions of many common, and some uncommon, procedures encountered during emergency medical practice. The novice may find the discussions and figures devoted to the many procedures somewhat daunting or overwhelming at first; but it is hoped that most will eventually appreciate the simple discussion and complex verbiage contained in the text. The goal is to describe clinical procedures—from simple Steri-Strip application, to loop drainage of an abscess, to skull trephination—as though each were the nascent clinician's first exposure to the concept, but with a depth and attention to detail that the seasoned operator would also deem helpful.

In previous editions it was difficult to find figures or photographs that conveyed the details or elucidated the vagaries to the extent one might want. The newly added color photographs, mostly digital quality, and a cornucopia of additional figures were a much needed update and morphed this edition into an obvious improvement over previous iterations. To make the text more user friendly, procedure boxes have been created, comprising a mini-atlas that allows the clinician to see the entire procedure at a glance. One can even bring the text to the bedside, viewing a single page of sequential images, the quintessential teaching tool for house staff and students. Many of the photographs were taken by me over 42 years of emergency department shifts or created or supplied by Todd W. Thomsen, MD. Some illustrations were borrowed from other sources, such as the wonderful text by Catherine B. Custalow, MD, PhD. This edition has more than 3500 images, half of which are new. More than 70 percent of the new images are the result of the artistic genius of graphics editor Dr. Thomsen. Frank Netter, watch out for Dr. Thomsen; he is rapidly attaining your status and may have already surpassed it in emergency medicine parlance. No doubt Dr. Thomsen has found his calling, blending amazing original art and electronic and digital prowess with equally impressive clinical medicine expertise.

The addition of the ultrasound-guided sections, presented in easily found and readily deciphered boxes, is the result of a gargantuan effort from our new ultrasound editor, Catherine Butts, MD, an ultrasonographer extraordinaire. One of the greatest achievement of this edition is the addition of a video procedures library, expertly crafted by Rob Orman, MD, and Scott Weingart, MD. Only wished for in past editions, many sections now reference online content that allows the reader to view videos of the procedures actually being performed. "See one, do one, teach one" has taken on new meaning with this text. This edition is now available electronically on such devices as the Kindle and iPad and is still fully searchable online at expertconsult.com.

There are, of course, many ways to approach any patient or any procedure, so this text is not a dictum. This book does not attempt to define standard of care. It is a compendium of

self-proclaimed techniques—some tried and some true, but occasionally prospectively tested—practical hints, and successful tactics gleaned from the literature and by years of practice, adeptly described by skilled clinicians. As with prior editions, this version also significantly incorporates the personal opinions of the authors and editors. This book is intended to help the clinician and the patients who rely upon them. But it is simply a clinical guide, not a legal document. Do not reference this book if you testify in court, for either the defense or the plaintiff. Today's dogma too often becomes tomorrow's heresy, and physician hubris is worse than incompetence. Simply stated, emergency medicine and the human body too often defy the written word, personal opinion, or local custom and humble even the venerable and the universally praised gray-haired professor.

Many new authors have been added, as well as a number of new concepts and approaches. All procedures have been tweaked. Trigger point injection has been resurrected, as well as skull trephination; both were mistakenly removed from the previous edition. You will not find the novel loop abscess drainage technique so nicely described elsewhere.

My personal thanks are hereby conveyed to those who contributed to previous editions. The updated chapters often merely refine or further manipulate the scholarly work of others who originally assisted us. The current contributors include an enviable blend of friends and colleagues, former students of mine, up-and-coming rising stars in their own right, and my prior mentors and role models—all are accomplished physicians and leaders in their own milieu. We have added three new associate editors, names well known to anyone who reads the literature or attends a continuing medical education activity. All the associate editors portray and embody the pinnacle of emergency medicine excellence. Most of the contributors, and all the associate editors, probably know more than I know, and most are likely infinitely more capable and facile with procedures. All are capable of writing a text themselves, and some have already done so; however, some are now enlightened and eschew that primal urge since they now know how difficult it is to write even a single chapter. My able and erudite associate editors, all from prestigious academic teaching programs in emergency medicine, are Arjun S. Channugam, MD, MBA; Carl R. Chudnofsky, MD; Peter M.C. DeBlieux, MD; Amal Mattu, MD; Stuart P. Swadron, MD, FRCPC; and Dr. Thomsen. They provided the bulk of the original editing, but senior editor, Dr. Custalow, read every single word and reviewed every table and chart. Dr. Custalow is a more tenacious editor than the proverbial honey badger in regard to dealing with details, grammar, organization, and style. In the end, my personal bias may be evident, but Dr. Custalow was the fire and fuel for the book's framework. As already stated, Dr. Thomsen made the text come to life with images.

If any of our editing changed, altered, or misinterpreted the original thoughts of the contributors (and I know in some