# CLINICAL EMERGENCY MEDICINE

Scott C. Sherman • Joseph M. Weber
Rahul G. Patwari • Michael A. Schindlbeck

Mc Graw Hill Education
LANGE®

a LANGE medical book

# Clinical Emergency Medicine

**Scott C. Sherman, MD**
Medical Student Clerkship Director
PA Residency Director
Associate Residency Director
Department of Emergency Medicine
Cook County (Stroger) Hospital
Rush Medical College
Chicago, Illinois

**Joseph M. Weber, MD**
EMS Medical Director
Department of Emergency Medicine
Cook County (Stroger) Hospital
Assistant Professor of Emergency Medicine
Rush Medical College
Chicago, Illinois

**Michael A. Schindlbeck, MD**
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Assistant Residency Director
Cook County (Stroger) Hospital
Chicago, Illinois

**Rahul G. Patwari, MD**
Medical Student Clerkship Director
Assistant Professor
Attending Physician
Department of Emergency Medicine
Rush Medical College
Chicago, Illinois


New York Chicago San Francisco Athens London Madrid Mexico City
Milan New Delhi Singapore Sydney Toronto

ISBN: 978-0-07-179461-9

MHID: 0-07-179461-1

The material in this eBook also appears in the print version of this title: ISBN: 978-0-07-179460-2,
MHID: 0-07-179460-3.

eBook conversion by codeMantra
Version 1.0



Notice

Medicine is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment and drug therapy are required. The authors and the publisher of this work have checked with sources believed to be reliable in their efforts to provide information that is complete and generally in accord with the standards accepted at the time of publication. However, in view of the possibility of human error or changes in medical sciences, neither the authors nor the publisher nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they disclaim all responsibility for any errors or omissions or for the results obtained from use of the information contained in this work. Readers are encouraged to confirm the information contained herein with other sources. For example and in particular, readers are advised to check the product information sheet included in the package of each drug they plan to administer to be certain that the information contained in this work is accurate and that changes have not been made in the recommended dose or in the contraindications for administration. This recommendation is of particular importance in connection with new or infrequently used drugs.

To my parents, for teaching me the meaning of hard work and reminding me when to slow down. To Mason and Colin, you bring me all the joy and happiness that a father could imagine. To Michelle, for your constant love and support.
**Scott C. Sherman, MD**

To my parents for a lifetime of encouragement; to Bridget, Elsie, and Jane, who give meaning to my life; and to our patients, who give us the opportunity to learn something new every shift.
**Joseph M. Weber, MD**

To my beautiful wife, loving parents, and gracious sisters, without whose compassion and support my career would not be possible. And to teachers everywhere, helping the next generation achieve their dreams.
**Mike Schindlbeck, MD**

To my students, who continually show me how much more I have to learn.
**Rahul Patwari, MD**

*This page intentionally left blank*

# Contents

# Contributors

**Negean Afifi, DO**
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Steven E. Aks, DO**
Director, The Toxikon Consortium
Division of Toxicology, Department of Emergency Medicine
Cook County (Stroger) Hospital
Associate Professor
Department of Emergency Medicine
Rush Medical College
Chicago, Illinois

**Amer Zia Aldeen, MD**
Assistant Professor
Department of Emergency Medicine
Northwestern University Feinberg School of Medicine
Attending Physician
Department of Emergency Medicine
Northwestern Memorial Hospital
Chicago, Illinois

**Kim L. Askew, MD**
Assistant Professor
Department of Emergency Medicine
Wake Forest University School of Medicine
Winston-Salem, North Carolina

**John Bailitz, MD, RDMS**
Emergency Ultrasound Director
Department of Emergency Medicine
Cook County (Stroger) Hospital
Assistant Professor of Emergency Medicine
Department of Emergency Medicine
Rush Medical College
Chicago, Illinois

**Jeffery A. Baker, MD**
Attending Physician
Department of Emergency Medicine
Ochsner Health System
Clinical Instructor
University of Queensland, Ochsner Clinical School
New Orleans, Louisiana

**Jonathan Bankoff, MD, FACEP**
Medical Director
Emergency Department
Middlesex Hospital
Middletown, Connecticut

**Eric H. Beck, DO, NREMT-P**
Assistant Professor
Section of Emergency Medicine
The University of Chicago
EMS Medical Director
Chicago EMS
Illinois EMS Region 11, Medical Directors Consortium
Chicago, Illinois

**Lauren Emily Bence, MD**
Department of Emergency Medicine
University of Chicago Hospital
Chicago, Illinois

**Steven H. Bowman, MD, FACEP**
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Program Director
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Sean M. Bryant, MD**
Associate Professor
Emergency Medicine
Assistant Fellowship Director
Toxikon Consortium
Cook County (Stroger) Hospital
Associate Medical Director
Illinois Poison Center
Chicago, Illinois

**Ann Buchanan, MD**
Assistant Director/Trauma Medical Director
Department of Emergency Medicine
St. David's Medical Center
Austin, Texas

**Paul E. Casey, MD**
Instructor in Clinical Medicine
Department of Emergency Medicine
Rush University Medical Center
Chicago, Illinois

**Esther H. Chen, MD**
Associate Professor
Emergency Medicine
University of California, San Francisco General Hospital
San Francisco, California

**George Chiampas, DO**
Assistant Professor, Department of Emergency Medicine
Northwestern University Feinberg School of Medicine
Team Physician, Northwestern University
Medical Director, Bank of America Chicago Marathon
Chicago, Illinois

**Kristine Cieslak, MD**
Assistant Professor
Department of Pediatrics
Northwestern University Feinberg School of Medicine
Chicago, Illinois
Director, Pediatric Emergency Medicine
Department of Pediatric Emergency Medicine
Children's Memorial at Central DuPage Hospital
Winfield, Illinois

**Michael T. Cudnik, MD, MPH**
Assistant Professor
Department of Emergency Medicine
The Ohio State University Medical Center
Columbus, Ohio

**Joanna Wieczorek Davidson, MD**
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**John Davis, MD, PhD**
Assistant Professor
Department of Medicine
The Ohio State University
Attending Physician
Department of Medicine
Wexner Medical Center at The Ohio State University
Columbus, Ohio

**Alex de la Fuente, MD**
Private Practice
Everett, Washington

**Nicole M. Deiorio, MD**
Associate Professor
Department of Emergency Medicine
Director, Medical Student Education
Oregon Health and Science University
Portland, Oregon

**E. Paul DeKoning, MD, MS**
Assistant Professor
Emergency Medicine
Dartmouth-Hitchcock Medical Center
Medical Student Education Director
Emergency Medicine
Dartmouth Medical School
Lebanon, New Hampshire

**Bradley L. Demeter, MD**
EMS Physician
Emergency Medicine
University of Chicago
Chicago, Illinois

**Vinodinee L. Dissanayake, MD**
Global Toxicology Fellow Emergency Medicine
University of Illinois at Chicago and Cook County (Stroger) Hospital
Clinical Instructor
University of Illinois at Chicago
Chicago, Illinois

**Marc Doucette, MD**
Associate Professor
Emergency Medicine
University of Colorado School of Medicine
Attending Physician
Emergency Medicine
St. Anthony Hospital System
Denver, Colorado

**Matthew T. Emery, MD**
Assistant Professor
Emergency Medicine
Michigan State University College of Human Medicine
Attending Physician
Department of Emergency Medicine
Spectrum Health Hospital-Butterworth Campus
Grand Rapids, Michigan

**Rakesh S. Engineer, MD**
Assistant Professor
Emergency Medicine
Case School of Medicine
Attending Physician
Emergency Services Institute
Cleveland Clinic
Cleveland, Ohio

**Jorge Fernandez, MD**
Assistant Professor of Clinical Emergency Medicine
Department of Emergency Medicine
University of Southern California
Director of Medical Student Education
Department of Emergency Medicine
LA County + USC Medical Center
Los Angeles, California

**Michael T. Fitch, MD, PhD, FACEP, FAAEM**
Associate Professor
Department of Emergency Medicine
Wake Forest School of Medicine
Winston-Salem, North Carolina

**Alison R. Foster, MD**
Department of Emergency Medicine
Northwestern University
Chicago, Illinois

**Douglas Franzen, MD, M.Ed, FACEP**
Assistant Professor
Department of Emergency Medicine
Virginia Commonwealth University Medical Center
Richmond, Virginia

**Casey Glass, MD**
Assistant Professor
Department of Emergency Medicine
Wake Forest Health Sciences
Winston-Salem, North Carolina

**David C. Gordon, MD**
Assistant Professor
Division of Emergency Medicine, Department of Surgery
Duke University
Durham, North Carolina

**Nihja O. Gordon, MD**
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Krista A. Grandey, DO**
Department of Emergencey Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Pilar Guerrero, MD**
Assistant Professor
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Marianne Haughey, MD**
Associate Professor of Emergency Medicine
Department of Emergency Medicine
Jacobi Medical Center, Albert Einstein College of Medicine
Bronx, New York

**Tarlan Hedayati, MD**
Assistant Program Director
Department of Emergency Medicine
Cook County (Stroger) Hospital
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Chicago, Illinois

**Corey R. Heitz, MD**
Assistant Professor
Department of Emergency Medicine
Virginia Tech Carilion School of Medicine
Roanoke, Virginia

**Ross A. Heller, MD, MBA**
Associate Professor
Department of Surgery/Division of Emergency Medicine
Saint Louis University School of Medicine
Saint Louis, Missouri

**Colleen N. Hickey, MD**
Assistant Professor
Department of Emergency Medicine
Northwestern University Feinberg School of Medicine
Attending Physician
Department of Emergency Medicine
Northwestern Memorial Hospital
Chicago, Illinois

**Katherine M. Hiller, MD, MPH, FACEP**
Associate Professor
Department of Emergency Medicine
University of Arizona College of Medicine
Tucson, Arizona

**Russ Horowitz, MD, RDMS**
Assistant Professor
Department of Pediatrics
Northwestern University Feinberg School of Medicine
Attending Physician, Director Emergency Ultrasound
Division of Emergency Medicine
Children's Memorial Hospital
Chicago, Illinois

**Craig Huston, MD**
Emergency Physician
Department of Emergency Medicine
Blessing Hospital
Quincy, Illinois

**Harry C. Karydes, DO**
Assistant Professor
Attending Physician
Department of Emergency Medicine
Rush Medical College
Chicago, Illinois

**Elizabeth W. Kelly, MD**
Assistant Professor
Department of Emergency Medicine
Wake Forest School of Medicine
Winston-Salem, North Carolina

**Chad S. Kessler, MD**
Section Chief, Emergency Medicine
Department of Medicine
Jesse Brown VA Medical Center
Chicago, Illinois

**Sorabh Khandelwal, MD**
Associate Professor
Department of Emergency Medicine
Assistant Dean for Clinical Sciences
College of Medicine
The Ohio State University
Columbus, Ohio

**Basem F. Khishfe, MD**
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Brian C. Kitamura, MD**
Emergency Medicine
Maricopa Integrated Health System
Phoenix, Arizona

**Nicholas E. Kman, MD, FACEP**
Assistant Professor
Department of Emergency Medicine
The Ohio State University College of Medicine
Columbus, Ohio

**Amy V. Kontrick, MD**
Assistant Professor
Emergency Medicine
Northwestern University Feinberg School of Medicine
Chicago, Illinois

**Carl M. Kraemer, MD, FAAEM, FACEP**
Assistant Professor
Department of Emergency Medicine
Saint Louis University School of Medicine
St. Louis, Missouri

**Brian Krieger, MD**
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Rashid E. Kysia, MD, MPH**
Attending Physician
Department of Emergency Medicine
Cook County (Stroger) Hospital
Assistant Professor
Rush Medical College
Chicago, Illinois

**Patrick M. Lank, MD**
Fellow
Division of Medical Toxicology
Toxikon Consortium
Cook County (Stroger) Hospital
Attending Physician
Department of Emergency Medicine
Northwestern Memorial Hospital
Chicago, Illinois

**William B. Lauth, MD, FACEP**
Clinical Professor
Department of Emergency Medicine
Rosalind Franklin University, The Chicago Medical School
Attending Physician
Department of Emergency Medicine
Captain James A. Lovell Federal Health Care Center
North Chicago, Illinois

**Moses S. Lee, MD, FAAEM, FACEP**
Assistant Professor
Emergency Medicine
Rush Medical College
Attending Physician
Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Trevor J. Lewis, MD**
Associate Professor
Department of Emergency Medicine
Rush Medical College
Medical Director Emergency Department
Cook County (Stroger) Hospital
Chicago, Illinois

**Nathan Lewis, MD**
Assistant Professor
Department of Emergency Medicine
Virginia Commonwealth University School of Medicine
Richmond, Virginia

**Chuang-yuan Lin, MD**
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Jenny J. Lu, MD, MS**
Assistant Professor
Department of Emergency Medicine, Division of Medical Toxicology
Cook County (Stroger) Hospital
Chicago, Illinois

**David E. Manthey, MD**
Professor
Emergency Medicine
Wake Forest School of Medicine
Winston-Salem, North Carolina

**Anitha E. Mathew, MD**
Clinical Instructor
Department of Emergency Medicine
Emory University School of Medicine
Attending Physician
Department of Emergency Medicine
Emory University Hospital and Grady Memorial Hospital
Atlanta, Georgia

**Alisa A. McQueen, MD**
Assistant Professor
Department of Pediatrics, Section of Pediatric Emergency Medicine
University of Chicago Pritzker School of Medicine
Attending Physician
Pediatric Emergency Medicine
University of Chicago Comer's Children Hospital
Chicago, Illinois

**Biswadev Mitra, MBBS, MHSM, PhD, FACEM**
Emergency & Trauma Centre
The Alfred Hospital
Melbourne, Australia

**Brooks L. Moore, MD**
Assistant Professor
Department of Emergency Medicine
Emory University School of Medicine
Attending Physician
Department of Emergency Medicine
Emory University Hospital and Grady Memorial Hospital
Atlanta, Georgia

**Tom Morrissey, MD, PhD**
Associate Professor
Department Emergency Medicine
University of Florida-Jacksonville
Jacksonville, Florida

**Jordan B. Moskoff, MD**
Associate Medical Director
Department of Emergency Medicine
Cook County (Stroger) Hospital
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Chicago, Illinois

**Mark B. Mycyk, MD, FACEP, FACMT**
Associate Professor
Department of Emergency Medicine
Rush Medical College
Northwestern University Feinberg School of Medicine
Attending Physician
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Isam F. Nasr, MD, FACEP**
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Attending Physician
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Michael E. Nelson, MD, MS**
Attending Physician, Medical Toxicology Fellow
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois
Attending Physician
Department of Emergency Medicine
Northshore University Health System
Evanston, Illinois

**Erik K. Nordquist, MD**
Assistant Professor
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Paula E. Oldeg, MD, FACEP**
Attending Physician
Department of Emergency Medicine
West Suburban Medical Center
Oak Park, Illinois
Adjunct Clinical Instructor
Department of Emergency Medicine
Rush Medical College
Chicago, Illinois

**S. Margaret Paik, MD**
Assistant Professor of Pediatrics
Department of Pediatrics
Associate Section Chief, Pediatric Emergency Medicine
The University of Chicago Comer Children's Hospital
Chicago, Illinois

**Lisa R. Palivos, MD**
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Attending Physician
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Jonathon D. Palmer, MD**
Assistant Professor
Department of Emergency Medicine
University of Arkansas for Medical Sciences
Little Rock, Arkansas

**Matthew S. Patton, MD**
Department of Emergency Medicine
Northwestern University Feinberg School of Medicine
Chicago, Illinois

**Rahul G. Patwari, MD**
Medical Student Clerkship Director
Assistant Professor
Attending Physician
Department of Emergency Medicine
Rush Medical College
Chicago, Illinois

**Monika Pitzele, MD, PhD**
Attending Physician
Department of Emergency Medicine
Mount Sinai Hospital
Chicago, Illinois

**Henry Z. Pitzele, MD, FACEP**
Deputy Director
Emergency Medicine
Jesse Brown VA Medical Center
Clinical Assistant Professor
Department of Emergency Medicine
University of Illinois at Chicago
Chicago, Illinois

**Natalie Radford, MD**
Associate Professor
Department of Clinical Medicine
Florida State University
Attending Physician
Bixler Emergency Department
Tallahassee Memorial Hospital
Tallahassee, Florida

**Christopher Reverte, MD**
Chief Resident
Department of Emergency Medicine
LA County + USC Medical Center
Los Angeles, California
Attending Physician
Department of Emergency Medicine
St. Luke's-Roosevelt
New York, New York

**Neil Rifenbark, MD**
Department of Emergency Medicine
University of Southern California
Department of Emergency Medicine
LA County + USC Medical Center
Los Angeles, California

**Rebecca R. Roberts, MD**
Director, Research Division
Attending Physician
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Sarah E. Ronan-Bentle, MD, MS, FACEP**
Assistant Professor
Department of Emergency Medicine
University of Cincinnati College of Medicine
Attending Physician
Center for Emergency Care
University Hospital
Cincinnati, Ohio

**David H. Rosenbaum, MD, FAAEM**
Attending Physician
Department of Emergency Medicine
WakeMed Health and Hospitals
Raleigh, North Carolina
Adjunct Professor
Department of Emergency Medicine
University of North Carolina School of Medicine
Chapel Hill, North Carolina

**Christopher Ross, MD, FRCPC, FACEP, FAAEM**
Assistant Professor
Department of Emergency Medicine
Associate Chair
Planning, Education, and Research
Cook County (Stroger) Hospital
Chicago, Illinois

**John Sarko, MD**
Attending Physician
Department of Emergency Medicine
Maricopa Medical Center
Assistant Professor
Department of Emergency Medicine
University of Arizona Phoenix School of Medicine
Phoenix, Arizona

**Shari Schabowski, MD**
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Attending Physician
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Conor D. Schaye, MD, MPH**
Department of Emergency Medicine
Northwestern Memorial Hospital
Chicago, Illinois

**Michael A. Schindlbeck, MD, FACEP**
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Assistant Residency Director
Cook County (Stroger) Hospital
Chicago, Illinois

**Suzanne M. Schmidt, MD, FAAP**
Clinical Instructor
Department of Pediatrics
Northwestern University Feinberg School of Medicine
Attending Physician
Department of Pediatrics
Ann & Robert H. Lurie Children's Hospital of Chicago
Chicago, Illinois

**Theresa M. Schwab, MD**
Attending Physician
Department of Emergency Medicine
Advocate Christ Medical Center
Oak Lawn, Illinois
Assistant Professor
Department of Emergency Medicine
University of Illinois at Chicago
Chicago, Illinois

**Brian R. Sellers, MD**
Department of Emergency Medicine
Northwestern University Feinberg School of Medicine
Chicago, Illinois

**Emily L. Senecal, MD**
Clinical Instructor
Department of Emergency Medicine
Harvard Medical School
Attending Physician
Department of Emergency Medicine
Massachusetts General Hospital
Boston, Massachusetts

**Michelle Sergel, MD**
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Attending Physician
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Scott C. Sherman, MD**
Medical Student Clerkship Director
PA Residency Director
Associate Residency Director
Department of Emergency Medicine
Cook County (Stroger) Hospital
Rush Medical College
Chicago, Illinois

**Jeffrey N. Siegelman, MD**
Assistant Professor
Department of Emergency Medicine
Emory University
Atlanta, Georgia

**Jessica Sime, MD**
Department of Emergency Medicine
Union Memorial Hospital
Baltimore, Maryland

**Lauren M. Smith, MD**
Assistant Professor
Department of Emergency Medicine
Rush Medical College
Attending Physician
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**William Thomas Smith, MD**
Emergency Medicine
Oregon Health and Sciences University
Portland, Oregon

**Shannon E. Staley, MD**
Pediatric Emergency Medicine Fellow
Department of Pediatrics
University of Chicago Comer Children's Hospital
Chicago, Illinois

**Christine R. Stehman, MD**
Clinical Fellow
Department of Surgery, Division of Trauma, Burn, and Surgical Critical Care
Associate Physician
Department of Emergency Medicine
Brigham and Women's Hospital, Harvard Medical School
Boston, Massachusetts

**Harsh Sule, MD, FAAEM, FACEP**
Assistant Professor
Department of Emergency Medicine
Thomas Jefferson University & Hospitals
Philadelphia, Pennsylvania

**Gim A. Tan, MBBS, FACEM**
Adjunct Lecturer
Department of Emergency Medicine
Monash University
Senior Emergency Physician
Emergency and Trauma Centre
The Alfred Hospital
Melbourne, Australia

**Katie L. Tataris, MD**
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Matthew C. Tews, DO**
Associate Professor
Department of Emergency Medicine
Medical College of Wisconsin
Milwaukee, Wisconsin

**S. Spencer Topp, MD**
Assistant Professor
Department of Emergency Medicine
University of Florida Health Science Center-Jacksonville
Jacksonville, Florida

**Brandon C. Tudor, MD**
Private Practice
Everett, Washington

**Katrina R. Wade, MD, FAAEM, FAAP**
Associate Professor
Department of Surgery, Emergency Medicine Division
Assistant Professor, Pediatrics
Department of Pediatrics
Saint Louis University School of Medicine
St. Louis, Missouri

**David A. Wald, DO**
Professor of Emergency Medicine
Medical Director, William Maul Measey Institute for Clinical Simulation and Patient Safety
Temple University School of Medicine
Philadelphia, Pennsylvania

**Joseph Walline, MD**
Assistant Professor
Department of Surgery, Division of Emergency Medicine
Saint Louis University School of Medicine
Saint Louis, Missouri

**Joseph M. Weber, MD**
EMS Medical Director
Department of Emergency Medicine
Cook County (Stroger) Hospital
Assistant Professor of Emergency Medicine
Rush Medical College
Chicago, Illinois

**Joanne C. Witsil, PharmD, RN, BCPS**
Adjunct Clinical Assistant Professor
Department of Pharmacy Practice
University of Illinois at Chicago
Clinical Pharmacist
Department of Emergency Medicine
Cook County (Stroger) Hospital
Chicago, Illinois

**Kathleen A. Wittels, MD**
Instructor in Medicine
Department of Emergency Medicine
Harvard Medical School
Associate Clerkship Director
Department of Emergency Medicine
Brigham and Women's Hospital, Harvard Medical School
Boston, Massachusetts

**Lynne M. Yancey, MD, FACEP**
Associate Professor
Department of Emergency Medicine
University of Colorado School of Medicine
Denver, Colorado
Attending Physician
Department of Emergency Medicine
University of Colorado Hospital
Aurora, Colorado

**Leslie S. Zun, MD**
Professor
Emergency Medicine
Chicago Medical School
Chair
Emergency Medicine
Mount Sinai Hospital
Chicago, Illinois

# Preface

We wrote this book because we remember our own experiences as medical students and junior residents working in the emergency department (ED). The ED is a unique environment that requires knowledge and skills often not covered in medical or physician assistant school. In this book, we attempt to create a resource for the medical student, physician assistant, nurse practitioner, and junior-level resident to use to get a grasp on the issues and scope of problems that they will confront while working in the ED.

The book's length and format are designed to allow the student and practitioner to begin to digest the broad range of topics inherent to emergency medicine (EM). Each chapter begins with a section on Key Points, followed by an Introduction, Clinical Presentation (History and Physical Examination), Diagnostic Studies, Medical Decision Making, Treatment, and Disposition. Whenever possible, we tried to give practical information regarding drug dosing, medical decision-making thought processes, treatment plans, and dispositions that will actually allow you to function more comfortably in the clinical environment. The diagnostic algorithms are a unique feature that attempt to simplify the problem and point the clinician in the right direction.

The book has 19 sections and 98 chapters that cover the entire contents of the EM clerkship curriculum (*Acad Emerg Med.* 2010;17:638-643). The authors are all practicing emergency physicians and EM educators from throughout the country. For medical student clerkship directors, we believe that this text is the perfect book for the student to pick up and digest during a 4-week rotation.

In summary, we hope this book will enhance the emergency medicine experience of all its users.

Scott C. Sherman, MD
Joseph M. Weber, MD
Michael Schindlbeck, MD
Rahul Patwari, MD

# Acknowledgments

We have many people to thank in helping us bring this project to fruition. First and foremost, this text would have never made it to print without the support and encouragement of our McGraw-Hill editor, Anne Sydor. Anne is a friend as much as an editor. She took a chance on us and for that we will always be grateful. One of Anne's many gifts has been providing us with such great editorial support in the form of Sarah M. Granlund. She has been the quarterback of this project from the onset, and without her planning and attention to detail, we would not be here today. We would also like to acknowledge our project manager, Charu Khanna, for her attention to detail during page proofs and willingness to go the extra mile.

We also want to thank our "bosses," Jeff Schaider and Steve Bowman. Jeff is a constant source of enthusiasm for the academic project in whatever form makes his faculty happy. He is a mentor, role model, and friend to us all. Steve, our residency director, also deserves so much credit. He shoulders the burden of one of the largest residencies in the country in a way that allows his assistants to pursue the true pleasures of the academic job in emergency medicine. Thank you both.

Estella Bravo, Ethel Lee, Mishelle Taylor, Deloris Johnson, and Hilda Nino also deserve a load of credit for the support they provide in the offices. Estella has been the dream clerkship coordinator, managing 24 students per month with grace and determination. She sets the bar high and makes our students feel comfortable during their time with us. For those who consider becoming a clerkship director one day, the most important consideration is making sure you have someone like Estella at the reins of the coordinator position.

Several groups of people also deserve high praise. Our authors have turned in an outstanding product, making the job of editing so much easier. We have tried to assemble an "all-star" group of contributors, and based on what came back to us, we were not disappointed. We all benefit from the hard work and expertise of our authors after "too many years to count" spent working in emergency departments and educating eager learners in the field. We also want to acknowledge our students and residents. You folks are the driving force behind all of our efforts. You inspire, test, and humble us on a daily basis. Lastly, and most importantly, we would like to thank our patients. We learn what our patients teach us, and so any learning we have accomplished over the years is attributed to them. They are the true educators of emergency medicine, and we owe them a debt of gratitude.

*This page intentionally left blank*

# 1 Incision and Drainage

David E. Manthey, MD

## Key Points

- Incision and drainage is the procedure of choice for subcutaneous abscesses.
- Antibiotics are not necessary unless there is associated cellulitis.
- Abscesses should be probed with curved hemostats to break up loculations and identify deeper tracks.
- Local anesthesia may be difficult and require additional field block, parenteral analgesics, or sedation.

## INDICATIONS

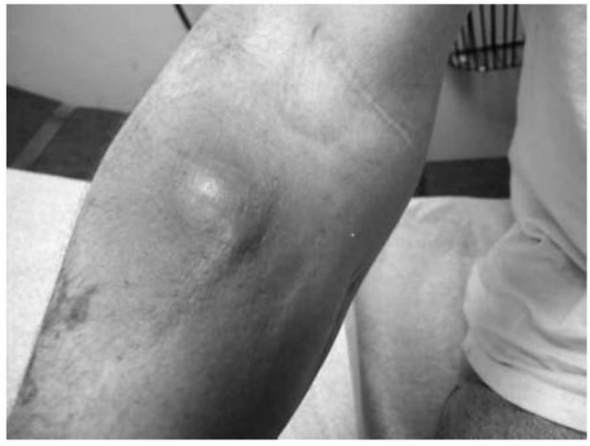
Incision and drainage (I&D) is the definitive treatment for any subcutaneous abscess. Abscesses should be drained if larger than 5 mm and accessible to percutaneous incision. Antibiotics alone are not adequate treatment of an abscess. In fact, skin abscesses without surrounding cellulitis, once drained, do not require any further treatment with antibiotics.

Abscesses can be diagnosed by physical examination based on swelling, pain, redness, and fluctuance (Figure 1-1). Some abscesses will spontaneously drain, leaving little diagnostic doubt. Bedside ultrasound may aid in diagnosis by identifying a hypoechoic area of fluid just under the skin. Needle aspiration may also be employed to prove the presence of pus.

Abscesses are often denoted by various names depending on their location and/or structure involved. The treatment remains the same. Paronychia and eponychia form around the nail (Figure 1-2). Felons occur with infection of the volar pad of the finger and require a specific approach for drainage. Bartholin gland abscesses occur in the paired glands that provide moisture to the vestibule of the vaginal mucosa. When the opening becomes occluded, either an abscess or a cyst can develop. After I&D, a Word catheter is placed to insure continued drainage of the gland. Removal or marsupialization of the gland may be required to prevent recurrence.

Hidradenitis suppurativa is a chronic relapsing inflammatory process affecting the apocrine glands in the axilla, inguinal area, or both. Multiple abscesses can form and eventually lead to draining fistulous tracts that require surgical management. I&D of these abscesses is frequently necessary and performed in the emergency department.

Incision and drainage may also be used to treat infected pilonidal or sebaceous cysts. Further treatment by a



▲ **Figure 1-1.** A subcutaneous abscess in an intravenous drug user.

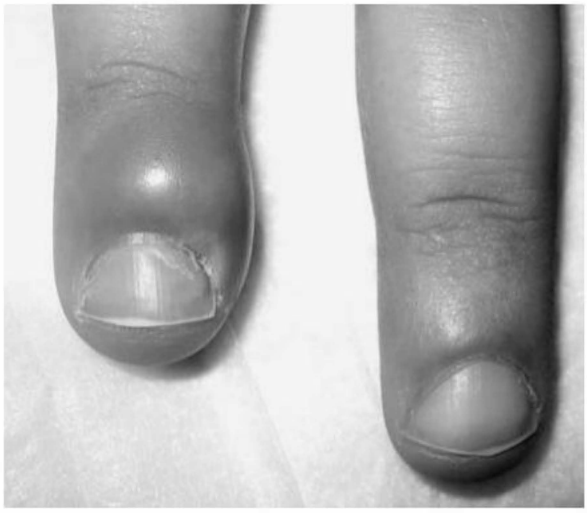


**Figure 1-2.** Paronychia.

surgeon will often include removing the capsule to prevent recurrence.

Perirectal abscesses include superficial abscesses (ie, perianal), which can be drained by emergency physicians, and deeper abscesses (ie, ischiorectal, intersphincteric, supralevator), which require operative surgical drainage. Perianal abscesses present as tender, fluctuant masses palpated around the anal verge. Deeper abscesses often present with rectal pain, pain with defecation, rectal and buttock erythema and tenderness, and systemic symptoms (ie, fever, lethargy).

## CONTRAINDICATIONS

Cellulitis without evidence of underlying abscess should not be incised. Pulsatile masses that may be infected pseudoaneuryms should not be incised.

Extremely large or deep abscesses should be considered for drainage under anesthesia. As a result of transient bacteremia, those patients at risk for endocarditis owing to an artificial or abnormal heart valve should be given appropriate perioperative antibiotics.

Abscesses of the palms, soles, nasolabial fold, breasts, finger pads (felons), face, and deeper perirectal region can be associated with complications. Consider consultation with the appropriate surgical subspecialty.

## EQUIPMENT

Povidone-iodine solution or chlorhexidine solution to cleanse the skin

Anesthetic of 1% lidocaine or 0.25% bupivacaine with epinephrine

18-gauge needle (to aspirate anesthetic)

27-gauge needle and syringe (to inject local anesthesia)

Splash guard or 18-gauge angiocatheter (without needle)

30-mL syringe for irrigation

Sterile water or normal saline

11-blade scalpel

Swab for bacterial culture

Curved hemostat

¼-inch iodoform packing

Scissors

Gloves, gown, and facemask with shield (universal precautions)

Gauze and tape

## PROCEDURE

Discuss the risks and benefits of the procedure with the patient before obtaining consent. Verify abscess location with ultrasound if necessary. Wash your hands and wear gloves, gown, and a face shield, as many abscesses are under pressure. Position the patient and lighting to allow for the best visualization and access to the abscess. Prepare the area with povidone-iodine solution or chlorhexidine.

Utilizing a 27-gauge needle, inject the anesthetic just under the dermis parallel to the surface of the skin. Blanching of the tissue will occur as the anesthetic spreads out through the skin. Cover the entire area to be incised. Avoid injecting lidocaine into the abscess cavity. This may increase the pressure in the cavity causing more pain. For larger abscesses, local field blocks, parenteral analgesics, and/or procedural sedation may be necessary.

If it is unclear whether an abscess exists, attempt aspiration of pus with a syringe and an 18- or 20-gauge needle. If confirmed, use an 11-blade scalpel to make a single incision in the skin. The incision should be at the point of maximal fluctuance oriented in the long axis of the abscess. In general, the incision should extend two thirds of the diameter of the abscess cavity (except when draining Bartholin gland abscesses, for which only an incision 0.5–1 cm should be made). Attempt to incise parallel to existing skin tension lines to promote cosmetic results.

Use gentle and steady pressure around the abscess to express pus from the cavity. Insert a curved hemostat to break loculations by working in a clockwise fashion around the entire abscess cavity. This will also help identify any deeper tracks. If desired, obtain a culture of the wound at this time.

Consider gentle irrigation of the wound until the fluid returning is clear. Pack the wound with enough iodoform gauze to keep the sides of the abscess from touching. This will allow for further drainage. Cover the wound with gauze.

When treating a Bartholin gland abscess, a small catheter (Word catheter) is placed in the opening instead of iodoform. The catheter should remain in place for several weeks to allow for the development of a fistula for continued drainage.

The patient is instructed to follow up in 48 hours to have the packing removed. If pus is no longer present and symptoms are resolving, the wound is allowed to heal by secondary intention.

## COMPLICATIONS

Scarring from the abscess and incision will occur. Numbness from cutaneous nerve injury may occur. Seeding of the blood with bacteria may transiently occur.

## SUGGESTED READING

Fitch MT, Manthey DE, McGinnis HD, et al. Abscess incision and drainage. *N Engl J Med* 2007;357:e20.

Hankin A, Everett WW. Are antibiotics necessary after incision and drainage of a cutaneous abscess? *Ann Emerg Med.* 2007;50: 49–51.

Kelly EW, Magilner D. Soft tissue infections. In: Tintinalli JE, Stapczynski JS, Ma OJ, Cline DM, Cydulka RK, Meckler GD. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide.* 7th ed. New York, NY: McGraw-Hill, 2011: Pages 1014–1024.

# 2

# Arterial Blood Gas

Brian C. Kitamura, MD
John Sarko, MD

## Key Points

- Arterial puncture for blood gas analysis is a common procedure performed in the emergency department (ED).
- Blood obtained from the radial artery can be used to quickly provide quantitative information on the patient's acid–base status and carboxyhemoglobin, methemoglobin, and electrolyte levels.
- Arterial puncture is a useful way to obtain blood for analysis when traditional phlebotomy is limited or difficult on the basis of patient characteristics.

## INDICATIONS

The primary indication for obtaining an arterial blood sample is for the assessment of the partial pressures of oxygen and carbon dioxide and accurate assessment of arterial pH. Secondarily, arterial blood can be analyzed for carboxyhemoglobin, methemoglobin, and basic electrolytes depending on the capabilities of the laboratory. Under certain circumstances it may be necessary to obtain a sample of arterial blood for other routine laboratory tests, such as in patients who are obese or have a history of intravenous drug abuse, in whom the radial artery is palpable, but venous access is difficult or may be delayed.

## CONTRAINDICATIONS

There are few absolute contraindications for arterial puncture for blood gas analysis. Trauma, infection, or abnormalities of the overlying skin such as a burn are contraindications because of concern for infection or further damage to the vascular structures. Patients with known coagulopathies, taking anticoagulants, or who may require thrombolytic agents should be approached with caution because of the increased risk of bleeding, hematoma formation, or rarely, compartment syndrome. Finally, a known history of insufficient blood flow through the palmar arch or previous surgery to the radial or ulnar arteries should also be considered a contraindication. The Allen test, described later, has been used as a way to determine adequacy of collateral circulation, however, its necessity has been questioned.

## EQUIPMENT

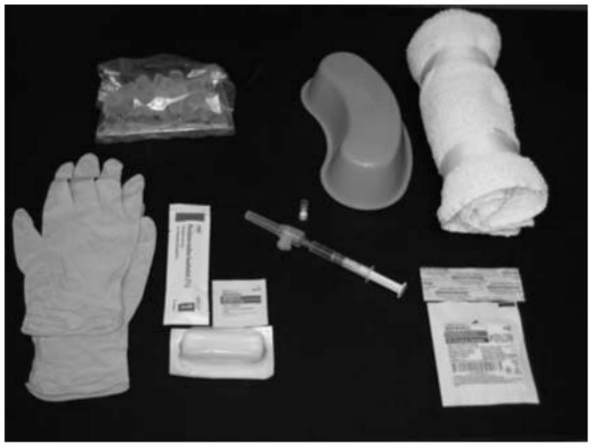
Many commercially prepared kits for arterial puncture are available, and if a commercial kit is not available, then equipment is easily found in most EDs. The following equipment is typically used to perform the procedure (Figure 2-1).

### Required Equipment

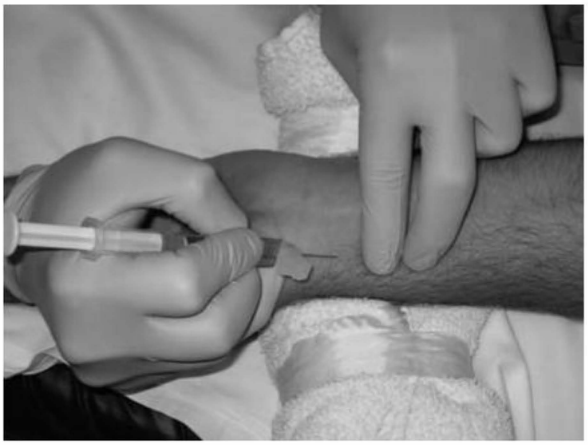
Alcohol, chlorhexidine, or iodine prep pads
2- to 3-mL heparinized syringe with a 23- to 25-gauge needle
Syringe cap
Appropriate personal protective equipment
Gauze or other dressing

### Suggested Equipment

Anesthetic (eg, lidocaine)
Ultrasound or Doppler (if the artery is difficult to palpate)



▲ **Figure 2-1.** Equipment used for an arterial puncture.



▲ **Figure 2-2.** Position of the forearm for puncture of the radial artery. A kidney basin or rolled towel may be helpful to hold the patient's wrist in this position.

Rolled towel or kidney basin (to stabilize and extend the wrist)

Ice (for specimen process times > 10 minutes)

Local anesthesia is not strictly required for the procedure; however, studies have shown that pain, as well as the number of attempts required to obtain a sample, are reduced when appropriate anesthesia is provided. Traditionally, 1% lidocaine is used, avoiding epinephrine because of concern for vasospasm. Recent studies have suggested that jet-injected 2% lidocaine also provides reasonable anesthesia.

## PROCEDURE

Before selecting an appropriate wrist, the Allen test may be used to assess collateral circulation. Manually occlude the radial and ulnar arteries using your fingers. Ask the patient to clench the fist to increase venous drainage from the hand for approximately 30 seconds. Ask the patient to open the hand, which should be noticeably pale. At this point, release only the ulnar artery. Rapid return of color signifies adequate collateral flow. Although the necessity of the test for arterial puncture is questioned, common sense dictates that if collateral flow in one wrist is noticeably decreased compared with the other, the wrist with better collateral flow should be accessed. In the absence of good collateral flow in both wrists, the necessity of the procedure should be weighed against the remote risk of serious vascular injury and distal extremity ischemia.

The radial artery is easily palpated in a majority of patients. It runs down the radial aspect of the forearm, generally located between the styloid process of the radius and the flexor carpi radialis tendon at the proximal crease of the wrist. The patient's wrist should be extended to bring the artery to a more superficial position. A kidney basin or rolled towel as well as tape may be helpful to hold the patient's wrist in this position (Figure 2-2). The skin overlying the artery should be cleaned. The skin and immediate subcutaneous tissue should then be appropriately anesthetized. The authors recommend massaging the area or letting it rest for 1–2 minutes for the anesthetic to take complete effect. This time may be used to prepare your other equipment.

After locating the impulse of the artery with the nondominate hand, take the syringe and needle in your dominate hand and slowly advance the needle toward the impulse at a 30- to 45-degree angle proximally toward the patient. If the impulse is difficult to detect, an ultrasound or Doppler may be helpful to locate the artery (Figure 2-3). Some practitioners use a direct 90-degree angle to the skin, but this is largely a matter of preference. When the artery is accessed, blood will passively fill the syringe. It should not be necessary to draw back on the syringe. Pulsatile or bright red blood signals the correct vessel has been accessed; however, this may not be apparent in the critically ill patient. If blood is not obtained, withdraw the needle to just below the skin and reattempt the procedure after slight adjustments have been made. Do not move the needle in an arc deep in the skin, as this risks damage to the vascular structures.

After blood is collected, the needle should be removed and disposed of appropriately. Remove air from the syringe and place the syringe cap, ensuring that blood contacts the cap. Maintain pressure over the arterial site for approximately 5 minutes to prevent development of a hematoma, and dress the wound appropriately.