

The Walls Manual of
**Emergency
Airway
Management**

FIFTH EDITION



Calvin A. Brown III

John C. Sakles

Nathan W. Mick

 Wolters Kluwer

the **difficult**
airwaycourse™

FIFTH EDITION

THE WALLS MANUAL OF EMERGENCY AIRWAY MANAGEMENT

EDITOR-IN-CHIEF

Calvin A. Brown III, MD

Assistant Professor of Emergency Medicine
Director of Faculty Affairs
Department of Emergency Medicine
Brigham and Women's Hospital
Harvard Medical School
Boston, Massachusetts

ASSOCIATE EDITORS

John C. Sakles, MD

Professor
Department of Emergency Medicine
University of Arizona College of Medicine
Tucson, Arizona

Nathan W. Mick, MD, FACEP

Associate Professor
Department of Emergency Medicine
Tufts University School of Medicine
Associate Chief
Department of Emergency Medicine

Maine Medical Center
Portland, Maine



Philadelphia • Baltimore • New York • London
Buenos Aires • Hong Kong • Sydney • Tokyo

Acquisitions Editor: Sharon Zinner
Developmental Editor: Ashley Fischer
Editorial Coordinator: Maria M. McAvey, Annette Ferran
Production Project Manager: Kim Cox
Design Coordinator: Stephen Druding
Manufacturing Coordinator: Beth Welsh
Marketing Manager: Rachel Mante Leung
Prepress Vendor: S4Carlisle Publishing Services

Fifth edition

Copyright © 2018 Wolters Kluwer

Copyright © 2012 (4th edition) LWW; 2008 (3rd edition) LWW; 2004 (2nd edition) LWW; 2000 (1st edition) LWW. All rights reserved. This book is protected by copyright. No part of this book may be reproduced or transmitted in any form or by any means, including as photocopies or scanned-in or other electronic copies, or utilized by any information storage and retrieval system without written permission from the copyright owner, except for brief quotations embodied in critical articles and reviews. Materials appearing in this book prepared by individuals as part of their official duties as U.S. government employees are not covered by the above-mentioned copyright. To request permission, please contact Wolters Kluwer at Two Commerce Square, 2001 Market Street, Philadelphia, PA 19103, via email at permissions@lww.com, or via our website at lww.com (products and services).

9 8 7 6 5 4 3 2 1

Printed in China

Library of Congress Cataloging-in-Publication Data

Names: Brown, Calvin A., III, editor. | Sakles, John C., editor. | Mick, Nathan W., editor.

Title: The Walls manual of emergency airway management / editor-in-chief,
Calvin A. Brown III, MD, assistant professor of Emergency Medicine,
Director of Faculty Affairs, Brigham and Women's Hospital, Harvard Medical
School, Boston, Massachusetts ; associate editors, John C. Sakles, MD,
professor, Department of Emergency Medicine, University of Arizona
College of Medicine, Tucson, Arizona, Nathan W. Mick, MD, associate
professor, Tufts University School of Medicine, associate chief,
Department of Emergency Medicine, Maine Medical Center, Portland, Maine.

Other titles: Manual of emergency airway management.

Description: Fifth edition. | Philadelphia : Wolters Kluwer, [2018] | Revised
edition of: Manual of emergency airway management / editors, Ron Walls,
Michael Murphy, 4th edition, 2012. | Includes bibliographical references and index.

Identifiers: LCCN 2017012521 | ISBN 9781496351968 (paperback)

Subjects: LCSH: Respiratory emergencies—Handbooks, manuals, etc. |
Respiratory intensive care—Handbooks, manuals, etc. | Airway
(Medicine)—Handbooks, manuals, etc. | BISAC: MEDICAL / Emergency Medicine.

Classification: LCC RC735.R48 M36 2018 | DDC 616.2/00425—dc23 LC record available at
<https://lcn.loc.gov/2017012521>

ISBN-13: 978-1-4963-5199-9

Cataloging-in-Publication data available on request from the Publisher.

This work is provided “as is,” and the publisher disclaims any and all warranties, express or implied, including any warranties as to accuracy, comprehensiveness, or currency of the content of this work.

This work is no substitute for individual patient assessment based upon healthcare professionals’ examination of each patient and consideration of, among other things, age, weight, gender, current or prior medical conditions, medication history, laboratory data and other factors unique to the patient. The publisher does not provide medical advice or guidance and this work is merely a reference tool. Healthcare professionals, and not the publisher, are solely responsible for the use of this work including all medical judgments and for any resulting diagnosis and treatments.

Given continuous, rapid advances in medical science and health information, independent professional verification of medical diagnoses, indications, appropriate pharmaceutical selections and dosages, and treatment options should be made and healthcare professionals should consult a variety of sources. When prescribing medication, healthcare professionals are advised to consult the product information sheet (the manufacturer’s package insert) accompanying each drug to verify, among other things, conditions of use, warnings and side effects and identify any changes in dosage schedule or contraindications, particularly if the medication to be administered is new, infrequently used or has a narrow therapeutic range. To the maximum extent permitted under applicable law, no responsibility is assumed by the publisher for any injury and/or damage to persons or property, as a matter of products liability, negligence law or otherwise, or from any reference to or use by any person of this work.

LWW.com

Dedication



This book is dedicated to four pioneers in emergency medicine (left to right): Drs. Robert Schneider, Ron Walls, Mike Murphy and Robert Luten. Their vision and tireless devotion to education led to the creation of The Difficult Airway Course and this comprehensive text of emergency airway management. They have defined and refined safe, evidence-based airway management practices for generations of emergency providers and, in the process, have saved countless lives.”

Preface

It is with pride and immense joy that we present this fifth edition of The Walls Manual of Emergency Airway Management, from here on known simply as “The Walls Manual.” This book has been extensively updated from cover to cover and expanded with exciting new chapters. It contains the latest in evidence-based approaches to airway management presented in a practical, yet creative style by our highly talented authors, who teach with us in The Difficult Airway Course: Emergency and The Difficult Airway Course: Anesthesia, The Difficult Airway Course: Critical Care and The Difficult Airway Course: EMS. As with previous editions, each topic has undergone a critical appraisal of the available literature to ensure the content is on the vanguard of clinical medicine.

New information sparks vigorous debate and oftentimes a departure from previous thinking. To this end, the fifth edition contains several fundamental changes. The seven Ps of rapid sequence intubation (RSI), unadulterated fixtures in previous editions, have undergone a transformative change with the elimination of Pretreatment as a discrete pharmacologic action, now replaced by Preintubation Optimization. With new information surfacing about the hemodynamic consequences of RSI in critically ill emergency department patients, this new step emphasizes the importance of maximizing cardiopulmonary physiology prior to induction and positive pressure ventilation in order to prevent hypoxic insult and circulatory collapse. A new chapter on intubating the unstable patient dovetails nicely with this approach and provides a solid framework that addresses the metabolic, physiologic, and hemodynamic factors that make emergency airway management complex and challenging. Cutting-edge information on flush flow rate oxygen for emergency preoxygenation provides us with new insight and options for maximizing the safety of RSI. Lidocaine, previously advocated as a pretreatment agent for patients with elevated intracranial pressure and reactive airways disease, no longer plays a role and has been removed from our lexicon; however, fentanyl remains as a sympatholytic option in patients with hypertensive crises, although is now considered part of a holistic approach to cardiovascular optimization and is no longer thought of as an independent pharmacologic maneuver. We present updated mnemonics for difficult airway detection with the “MOANS” mnemonic for difficult bag and mask ventilation refreshed to create “ROMAN,” which better highlights our newly understood association between radiation changes (the “R” in ROMAN) and difficult bagging. In

addition, we cover the latest in airway tools as old standbys like the GlideScope and C-MAC videolaryngoscopes continue to transform into more streamlined and affordable devices with improved image quality and overall performance.

This compendium embodies what we believe to be the knowledge and skill set required for emergency airway management in both the emergency department and the prehospital environment. The principles, however, are applicable to a wide array of clinical settings. As inpatient care continues to evolve and roles become redefined, we are witnessing the emergence of hospitalists and critical care physicians as primary airway managers being called upon frequently to intubate on hospital floors and in intensive care units. The concepts we present in the fifth edition can be extrapolated to any arena where urgent airway management might take place and is as relevant to inpatient clinicians as it is to emergency medicine specialists. Tapping yet again into Terry Steele's vision and creativity, we drew upon the combined knowledge base from both the anesthesia and emergency medicine courses to develop The Difficult Airway Course: Critical Care in 2016, a comprehensive and robust new curriculum to meet the educational needs of this unique group of airway managers. New chapters on intubating the unstable patient and safe extubation techniques augments this new curriculum and helps to make this latest edition the most versatile manual ever.

We are fortunate for the opportunity to provide this resource and are hopeful that the material in this book will play an important role when, late at night, faced with little information, less help, and virtually no time for debate we are called to act, make extraordinary decisions, and save lives.

Calvin A. Brown III, MD

Boston, Massachusetts

John C. Sakles, MD

Tucson, Arizona

Nathan W. Mick, MD, FACEP

Portland, Maine

Acknowledgments

One of the most precious gifts in medicine is that of mentorship and I have been fortunate beyond measure. My development as an academic emergency physician would not have been possible without the frequent advice, incredible opportunities, and genuine friendship from Dr. Ron Walls. While professional aspirations are important, family is paramount. I must thank my wife Katherine and our two wonderful boys, Calvin and Caleb. Their steadfast love and support despite years of travel and long office hours has provided me with the privilege to pursue my professional goals. Finally, I would like to acknowledge the national teaching faculty of our airway courses as well as the faculty, residents, and medical students at Brigham and Women's Hospital and Harvard Medical School who help keep me energized, challenged, and intellectually honest on a daily basis.

Calvin A. Brown III, MD

Boston, Massachusetts

There are many people in my life, including my family, professional colleagues, and patients, who have greatly enriched my career and have made my participation in the airway course and manual possible. I thank them all for their understanding, continued support, and faith in me. I would like to dedicate this manual to all the frontline providers, of every specialty and discipline, who manage the airways of critically ill and injured patients. It is through their tireless efforts, working in uncontrolled environments and under difficult circumstances, that the lives of our loved ones are saved.

John C. Sakles, MD

Tucson, Arizona

Ten years ago, I was contacted by Dr. Ron Walls asking if I would be available to help teach at the Difficult Airway Course and it was with great honor and pleasure that I accepted his offer. Today, I remain immensely grateful to him for his teaching and mentorship during residency and in the early portion of my academic career. A decade has passed, and I feel blessed to have interacted with such an amazing group

of airway educators and often feel as if I have received as much as I have given during those long weekends. A special thanks to Dr. Bob Luten, who has a special place in my heart as one of the founding fathers of Pediatric Emergency Medicine and a true pioneer in pediatric airway management. Thank you as well to my family, wife Kellie, daughters Gracyn and Afton, for putting up with the frequent travel, with only the occasional “snow globe” present on my return. Know that time away from the family is never easy, but we feel we are truly making a difference.

Nathan W. Mick, MD, FACEP
Portland, Maine

Contributors

Jennifer L. Avegno, MD

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

Aaron E. Bair, MD

Professor
Department of Emergency Medicine
University of California Davis School of Medicine
Sacramento, California

Jeff Birrer, EMT-P

Paramedic
American Medical Response
Portland, Oregon

Darren A. Braude, MD

Paramedic Chief
Division of Prehospital, Austere, and Disaster Medicine
Professor of Emergency Medicine and Anesthesiology
University of New Mexico Health Sciences Center
Medical Director, The Difficult Airway Course: EMS
Albuquerque, New Mexico

Calvin A. Brown III, MD

Assistant Professor of Emergency Medicine
Director of Faculty Affairs
Department of Emergency Medicine
Brigham and Women's Hospital
Harvard Medical School
Boston, Massachusetts

Stephen Bush, MA (Oxon), FRCS, FRCEM

Consultant in Emergency Medicine
Emergency Department
Leeds Teaching Hospitals Trust
United Kingdom

Steven C. Carleton, MD, PhD

Professor
W. Brian Gibler Chair of Emergency Medicine Education

Department of Emergency Medicine
University of Cincinnati College of Medicine
Cincinnati, Ohio

David A. Caro, MD

Associate Professor
Department of Emergency Medicine
University of Florida College of Medicine
Jacksonville, Florida

Ken Davis EMT-P, FP-C, BA

EMSRx LLC
Waxahachie, Texas

Peter M.C. DeBlieux, MD

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

Brian E. Driver, MD

Assistant Professor
Department of Emergency Medicine
University of Minnesota Medical School
Faculty Physician
Department of Emergency Medicine
Hennepin County Medical Center
Minneapolis, Minnesota

Laura V. Duggan, MD

Clinical Associate Professor
Department of Anesthesiology, Pharmacology, and Therapeutics
University of British Columbia
Vancouver, British Columbia, Canada

Jan L. Eichel, RN, CFRN, BA, EMT-P

Director of Clinical Operations
West Michigan Air Care
Kalamazoo, Michigan

Frederick H. Ellinger, Jr., NRP

Flight Paramedic
MidAtlantic MedEvac
AtlantiCare Regional Medical Center
Atlantic City, New Jersey

Megan L. Fix, MD

Assistant Professor
Division of Emergency Medicine
University of Utah Hospital
Salt Lake City, Utah

Kevin Franklin, RN, EMT-P, CFRN

Flight Nurse
West Michigan Air Care
Kalamazoo, Michigan

Michael A. Gibbs, MD

Professor and Chairman
Department of Emergency Medicine
Carolinas Medical Center
Levine Children's Hospital
Charlotte, North Carolina

Steven A. Godwin, MD, FACEP

Professor and Chair
Department of Emergency Medicine
University of Florida College of Medicine
Jacksonville, Florida

Michael G. Gonzalez, MD, FACEP, FAAEM

Assistant Professor
Emergency Medicine
Baylor College of Medicine
Associate Medical Director
Houston Fire Department
Houston, Texas

Alan C. Heffner, MD

Director of Critical Care
Director of ECMO Services
Professor
Department of Internal Medicine
Department of Emergency Medicine
Carolinas Medical Center
University of North Carolina
Charlotte, North Carolina

Cheryl Lynn Horton, MD

Associate Physician
Department of Emergency Medicine
Kaiser Permanente East Bay

Oakland, California

Andy S. Jagoda, MD

Professor and System Chair
Department of Emergency Medicine
Icahn School of Medicine at Mount Sinai
New York, New York

Michael Keller, BS, NRP

Curriculum Faculty
Department for EMS Education
Gaston College
Dallas, North Carolina

Erik G. Laurin MD

Professor
Department of Emergency Medicine
Vice Chair for Education
University of California, Davis, School of Medicine
Sacramento, California

Robert C. Luten, MD

Professor
Department of Emergency Medicine
Division of Pediatric Emergency Medicine
University of Florida College of Medicine
Jacksonville, Florida

Nathan W. Mick, MD, FACEP

Associate Professor
Tufts University School of Medicine
Associate Chief
Department of Emergency Medicine
Maine Medical Center
Portland, Maine

Jarrold M. Mosier, MD

Associate Professor
Department of Emergency Medicine
Department of Medicine
Division of Pulmonary, Allergy, Critical Care, and Sleep
University of Arizona College of Medicine
Tucson, Arizona

Michael F. Murphy MD, FRCPC

Professor Emeritus

University of Alberta
Edmonton, Alberta, Canada

Joshua Nagler, MD, MHPEd

Assistant Professor
Harvard Medical School
Division of Emergency Medicine
Boston Children's Hospital
Boston, Massachusetts

Justen Naidu, MD

Anesthesiology Resident
Department of Anesthesiology, Pharmacology and Therapeutics, University of British Columbia
Vancouver, British Columbia, Canada

Bret P. Nelson, MD

Associate Professor
Department of Emergency Medicine
Icahn School of Medicine at Mount Sinai
New York, New York

Ali S. Raja, MD, MBA, MPH

Vice Chairman and Associate Professor
Department of Emergency Medicine
Massachusetts General Hospital
Harvard Medical School
Boston, Massachusetts

Robert F. Reardon, MD

Professor of Emergency Medicine
University of Minnesota Medical School
Department of Emergency Medicine
Hennepin County Medical Center
Minneapolis, Minnesota

John C. Sakles, MD

Professor
Department of Emergency Medicine
University of Arizona College of Medicine
Tucson, Arizona

Leslie V. Simon, DO

Assistant Professor
Department of Emergency Medicine
Mayo Clinic Florida
Jacksonville, Florida

Mary Beth Skarote, EMT-P, LPN

All Hazards Planner
Veteran Corps of America
Jacksonville, North Carolina

Julie A. Slick, MD

Assistant Professor
Louisiana State University Health Sciences Center
Chief, Emergency Medicine
Southeast Louisiana Veterans Health Care System
New Orleans, Louisiana

Michael T. Steuerwald, MD

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

Eli Torgeson, MD

Assistant Professor
Department of Anesthesiology and Critical Care Medicine
University of New Mexico School of Medicine
Albuquerque, New Mexico

Katren R. Tyler, MD

Associate Professor
Associate Residency Director
Geriatric Emergency Medicine Fellowship Director
Vice Chair for Faculty Development, Wellbeing, and Outreach
Department of Emergency Medicine
University of California Davis School of Medicine
Sacramento, California

Ron M. Walls, MD

Executive Vice President and Chief Operating Officer
Brigham and Women's Health Care
Neskey Family Professor of Emergency Medicine
Harvard Medical School
Boston, Massachusetts

Richard D. Zane, MD

Professor and Chair
Department of Emergency Medicine
University of Colorado School of Medicine
University of Colorado Hospital
Denver, Colorado

Contents

Preface

Acknowledgments

SECTION I PRINCIPLES OF AIRWAY MANAGEMENT

- 1** The Decision to Intubate
Calvin A. Brown III and Ron M. Walls
- 2** Identification of the Difficult and Failed Airway
Calvin A. Brown III and Ron M. Walls
- 3** The Emergency Airway Algorithms
Calvin A. Brown III and Ron M. Walls
- 4** Applied Functional Anatomy of the Airway
Michael F. Murphy

SECTION II OXYGEN DELIVERY AND MECHANICAL VENTILATION

- 5** Principles of Preparatory Oxygenation
Robert F. Reardon, Brian E. Driver, and Steven C. Carleton
- 6** Noninvasive Mechanical Ventilation
Alan C. Heffner and Peter M.C. DeBlieux
- 7** Mechanical Ventilation
Alan C. Heffner and Peter M.C. DeBlieux
- 8** Oxygen and Carbon Dioxide Monitoring
Robert F. Reardon and Jennifer L. Avegno

SECTION III BASIC AIRWAY MANAGEMENT

9 Bag-Mask Ventilation

Steven C. Carleton, Robert F. Reardon, and Calvin A. Brown III

10 Extraglottic Devices: Supraglottic Type

Michael F. Murphy and Jennifer L. Avegno

11 Extraglottic Devices: Retroglottic Type

Erik G. Laurin, Leslie V. Simon, Darren A. Braude, and Michael F. Murphy

12 Managing the Patient with an Extraglottic Device in Place

Darren A. Braude, Michael T. Steuerwald, and Eli Torgeson

SECTION IV TRACHEAL INTUBATION

13 Direct Laryngoscopy

Robert F. Reardon and Steven C. Carleton

14 Video Laryngoscopy

John C. Sakles and Aaron E. Bair

15 Optical and Light-Guided Devices

Julie A. Slick

16 Flexible Endoscopic Intubation

Alan C. Heffner and Peter M.C. DeBlieux

17 Fiberoptic and Video Intubating Stylets

Cheryl Lynn Horton and Julie A. Slick

18 Blind Intubation Techniques

Michael T. Steuerwald, Darren A. Braude, and Steven A. Godwin

19 Surgical Airway Management

Aaron E. Bair and David A. Caro

SECTION V PHARMACOLOGY AND TECHNIQUES OF AIRWAY MANAGEMENT

- 20** Rapid Sequence Intubation
Calvin A. Brown III and Ron M. Walls
- 21** Sedative Induction Agents
David A. Caro and Katren R. Tyler
- 22** Neuromuscular Blocking Agents
David A. Caro and Erik G. Laurin
- 23** Anesthesia and Sedation for Awake Intubation
Alan C. Heffner and Peter M.C. DeBlieux

SECTION VI PEDIATRIC AIRWAY MANAGEMENT

- 24** Differentiating Aspects of the Pediatric Airway
Robert C. Luten and Nathan W. Mick
- 25** Pediatric Airway Techniques
Robert C. Luten, Steven A. Godwin, and Nathan W. Mick
- 26** The Difficult Pediatric Airway
Joshua Nagler and Robert C. Luten
- 27** Foreign Body in the Pediatric Airway
Robert C. Luten and Joshua Nagler

SECTION VII EMS AIRWAY MANAGEMENT

- 28** Introduction to EMS Airway Management
Frederick H. Ellinger Jr, Michael Keller, and Darren A. Braude
- 29** Techniques in EMS Airway Management
Kevin Franklin, Darren A. Braude, and Michael G. Gonzalez

30 Difficult and Failed Airway Management in EMS
Jan L. Eichel, Mary Beth Skarote, and Darren A. Braude

31 Controversies in EMS Airway Management
Jeff Birrer, Ken Davis, and Darren A. Braude

SECTION VIII **SPECIAL CLINICAL CIRCUMSTANCES**

32 The Unstable Patient: Cardiopulmonary Optimization for Emergency Airway Management
Jarrod M. Mosier, Alan C. Heffner, and John C. Sakles

33 The Trauma Patient
Michael A. Gibbs, Ali S. Raja, and Michael G. Gonzalez

34 Elevated ICP and HTN Emergencies
Bret P. Nelson and Andy S. Jagoda

35 Reactive Airways Disease
Bret P. Nelson and Andy S. Jagoda

36 Distorted Airways and Acute Upper Airway Obstruction
Ali S. Raja and Erik G. Laurin

37 The Pregnant Patient
Richard D. Zane and Cheryl Lynn Horton

38 The Patient with Prolonged Seizure Activity
Stephen Bush and Cheryl Lynn Horton

39 The Geriatric Patient
Katren R. Tyler and Stephen Bush

40 The Morbidly Obese Patient
Megan L. Fix and Richard D. Zane

41

Foreign Body in the Adult Airway

Ron M. Walls and Erik G. Laurin

42

Safe Extubation of the Emergency Patient

Justen Naidu and Laura V. Duggan

Index