

TEXTBOOK *of* CHRONIC WOUND CARE

*An Evidence-Based Approach
to Diagnosis and Treatment*

TEXTBOOK *of* CHRONIC WOUND CARE

*An Evidence-Based Approach
to Diagnosis and Treatment*

Jayesh B. Shah, MD
Paul J. Sheffield, PhD
Caroline E. Fife, MD
Editors



BEST PUBLISHING COMPANY

Cover photos courtesy of Jayesh B. Shah, MD and Caroline E. Fife, MD

The opinions expressed in this work are those of the authors and content editors and do not reflect the opinions of Best Publishing Company, editors, or designers.

Information contained in this work has been obtained by Best Publishing Company from sources believed to be reliable. However, neither Best Publishing Company nor its authors and editors guarantees the accuracy or completeness of any information published herein and neither Best Publishing Company nor its authors and editors shall be responsible for any errors, omissions, or claims for damages, including exemplary damages, arising out of use, inability to use, or with regard to the accuracy or sufficiency of the information contained in this publication.

No responsibility is assumed by the publisher or editors for any injury and/or damage to persons or property as a matter of product liability, negligence or otherwise, or from any use or operation of any methods, product, instructions, or ideas contained in the material herein. No suggested test or procedure should be carried out unless, in the reader's judgment, the risk is justified. Because of rapid advances in the medical sciences, we recommend that the independent verification of diagnoses and drug dosages should be made. Information in this publication is current as of the date of the printing.

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

Photos included in this edition without specific recognition were provided by the specific chapter authors.

Copyright 2018 by Best Publishing Company

International Standard Book Number: 978-1-947239-07-4

Library of Congress Control Number: 2018930683

Best Publishing Company
631 US Highway 1, Suite 307
North Palm Beach, FL 33408

Printed in the United States of America

CONTENTS

Foreword	xvii
Preface	xix
About the Authors	xxi
Contributors List	xxvii
Acknowledgments.	xxix
Dedication	xxxix
Disclaimer and Editorial Viewpoint from Caroline E. Fife, MD.	xxxiii

SECTION 1: Anatomy, Physiology and Biochemistry of Wound Healing

Editor - Herbert B. Slade

Chapter 1: Anatomy of the Skin	3
<i>Herbert B. Slade, Jamie M. Slade</i>	
I. Epidermis	6
II. Dermis	7
III. Dermal-epidermal junction	9
IV. Hypodermis and dermal attachment	10
V. Vascularization	10
VI. Innervation	12
VII. Cells of the immune system	14
VIII. Skin proteins	15
IX. Aging	15
X. Cellular therapies.	16
Chapter 2: Physiology and Biochemistry of Wound Healing	23
<i>Gregory S. Schultz, Daniel J. Gibson</i>	
I. Overview of the four stages of normal skin wound healing	27
II. Overview of molecular and cellular abnormalities in chronic wounds	36
III. Wound bed preparation: removing the barriers to healing	42

SECTION 2: Essentials of Wound Healing

Editor - Robert J. Snyder

Chapter 3: Etiology of Wounds.	51
<i>Robert J. Snyder, Timothy M. Graham</i>	
I. History taking	53
II. Physical examination	55
III. Components of the Wound Bed Preparation Model including the DIME in wound care	58
IV. Case studies.	59
Chapter 4: Nutritional Assessment and Management	79
<i>Elizabeth Friedrich</i>	
I. Case study	81
II. Pathway	83
III. Overview of nutrition and wound healing	84
IV. Nutrients needed to support wound healing	84
V. Nutrition screening and assessment	87
VI. Components of a comprehensive nutrition assessment	89
VII. Nutrition diagnosis	91
VIII. Nutrition intervention: using Clinical Practice Guidelines to estimate nutritional needs.	91
IX. Nutrition interventions for specific situations	93
X. Translating evidence-based recommendations into a plan of care	95
XI. Nutrition monitoring and evaluation	97
Chapter 5: Wound Assessment.	103
<i>Robert J. Snyder, Joey K. Ead, Cherison Cuffy</i>	
I. MEASURE: best practice for wound assessment	105
II. Wound classification systems	111
Chapter 6: Wound Bed Preparation	127
<i>Kevin Y. Woo, Dimitri Beckman</i>	
I. Case study	129
II. Wound bed preparation	129
III. Wound etiologies and comorbidities	130
IV. Patient-oriented outcomes	132
V. Local wound care.	133

Chapter 7: Dressings in Wound Care	147
<i>Dot Weir, Pamela Scarborough</i>	
I. Case study	150
II. Goal-directed wound care and dressing selection.	153
III. Overall purposes of wound dressings	153
IV. Decision making for dressing product selection	155
V. Gauze dressings	159
VI. Primary dressings	161
VII. Secondary dressings.	161
VIII. Protecting the periwound skin	162
IX. Dressing categories	163
X. Dressing change practices	171
XI. Topical management of wound bioburden	173
Chapter 8: Evidence-Based Use of Advanced Wound Care Modalities in Chronic Wound Patients.	189
<i>Jayesh B. Shah, Caroline E. Fife</i>	
I. Case study	192
II. When to use advanced wound modalities	194
III. Use of advanced wound modalities according to phases of wound healing	194
IV. Phases of wound healing and recommended advanced wound modalities	196
V. Advanced wound modalities	197
Chapter 9: Plastic Surgery Approach to Wound Management and Closure	229
<i>Regina M. Fearmonti</i>	
I. Case study	231
II. Types of wounds requiring surgical intervention	231
III. Wound optimization and management	232
IV. Defect analysis: the reconstructive ladder	234
V. Skin grafts	235
VI. Local and regional flaps	236
VII. Distant flaps	239
VIII. Pressure ulcers	240
IX. Postoperative care	242

SECTION 3: Pathophysiology, Diagnosis, and Management of Special Wound Patients

Editor - Kelly Johnson-Arbor

Chapter 10: Diabetic Foot Ulcers	249
<i>Javier La Fontaine, Suzanne Van Asten, Lawrence Lavery</i>	
I. Case study	253
II. Pathways.	254
III. Epidemiology of foot ulcers	259
IV. Pathophysiology	259
V. Importance of the management of blood glucose in a diabetic patient	259
VI. Evaluating a diabetic foot ulcer patient	260
VII. Neuropathy assessment.	260
VIII. Evaluating foot deformity in diabetic patients	262
IX. Noninvasive vascular assessment	263
X. Evaluating diabetic foot infections	267
XI. Imaging of the diabetic foot	271
XII. Management of noninfected diabetic foot ulcer	272
XIII. Surgical approach to managing the diabetic foot	275
XIV. Adjunctive therapies for diabetic foot ulcers	279
XV. Education of patients with diabetic foot ulcers.	280
XVI. Foot amputations.	281
Chapter 11: Pressure Ulcers	295
<i>Aimee D. Garcia</i>	
I. Pathophysiology	297
II. Pathway	299
III. Case study: evaluation of the pressure ulcer patient	300
IV. Managing infection in a pressure ulcer patient.	305
V. Plastic surgery approach in management of a pressure ulcer	306
VI. Support surfaces for patients with pressure ulcers	307
VII. Preventing recurrence of pressure ulcers	309
Chapter 12: Venous Insufficiency Ulcer	315
<i>Samih Bittar, John Fish, Fedor Lurie</i>	
I. Case study	317
II. Pathways.	318
III. Epidemiology and economic impact of venous stasis ulcer	320
IV. Pathophysiology of venous stasis ulcers	320
V. Evaluating patient with venous stasis ulcer	321

VI. Role of different venous procedures in venous stasis ulcer patient	323
VII. Wound management in patients with venous stasis ulcer	326
VIII. Preventing recurrence of venous stasis ulcers	327
Chapter 13: Lymphedema	331
<i>Heather Hettrick, Robyn Bjork</i>	
I. Case study	333
II. Epidemiology and economic impact of lymphedema and integumentary dysfunction on lymphedema patients	334
III. Starling's law and ultrafiltration	336
IV. Composition of lymph and the lymphatic load	336
V. Pathophysiology	337
VI. Examination and differential diagnosis	337
VII. Lymphedema staging	338
VIII. History and physical exam	340
IX. Vascular assessment	340
X. Stemmer's sign.	340
XI. Clinical features	341
XII. Lipedema	343
XIII. Volumetric measurements and diagnostic tests	344
XIV. Role of surgery in lymphedema	345
XV. Interventions: complete decongestive therapy	346
Chapter 14: Arterial Ulcers: Evaluation and Treatment.	365
<i>Boulos Toursarkissian, Mellick T. Sykes</i>	
I. Case study	367
II. Epidemiology	367
III. Pathway	368
IV. Pathophysiology	369
V. Classification of PAD	370
VI. Diagnosis of PAD.	371
VII. Assessment of healing potential	374
VIII. Imaging studies	375
IX. Treatment options	375
X. Prognosis	379
XI. Follow-up	379

SECTION 4: Atypical Wounds and Burns

Editor - Jayesh B. Shah

Chapter 15: Approach to Commonly Misdiagnosed Ulcers and Atypical Ulcers	385
<i>Jayesh B. Shah</i>	
I. Case study: unusual wound	387
II. Pathway for approach to commonly misdiagnosed wounds and unusual leg ulcers	388
III. Differential diagnosis of commonly misdiagnosed wounds and unusual leg ulcers .	394
Chapter 16: Arthropod-Related Wounds	433
<i>Dirk Elston</i>	
I. Case history: arthropod-related wound	435
II. Approach to arthropod-related wounds	435
III. Pathogenesis	436
IV. Treatment	437
Chapter 17: The Effects of Radiation on Wound Healing	441
<i>John J. Feldmeier</i>	
I. Case study	447
II. A brief review of the wound healing timeline	447
III. Radiation and surgical wounds: the importance of timing.	450
IV. Radiation's broad effects on wound healing	450
V. Preclinical models of irradiated wound healing	451
VI. Clinical experience in irradiated wounds	455
VII. Strategies to prevent and treat problem irradiated wounds	457
VIII. The role of hyperbaric oxygen	459
IX. Possible future strategies to prevent or treat irradiated wounds	462
Chapter 18: Practical Approach to Burns	471
<i>Julie A. Rizzo, Matthew P. Rowan, Kevin K. Chung</i>	
I. Case history	473
II. Pathway	473
III. Epidemiology of burns	474
IV. Pathophysiology of burn wounds	474
V. Diagnosis	475
VI. Treatment	478

SECTION 5: Wound Care in Special Populations

Editor - Dianne Rudolph

Chapter 19: Wound Care in Pediatric Patients	489
<i>Margie Rodriguez</i>	
I. Cases	491
II. Difference between adult and pediatric skin	494
III. Definition of wounds	494
IV. Guidelines in healing pediatric wounds within the three major intentions of healing	495
V. Treatment of wounds in the pediatric population.	498
VI. Dressings	499
VII. Prevention	500
Chapter 20: Skin Care Issues in the Older Adult	505
<i>Dianne Rudolph</i>	
I. Senescent changes in the skin	507
II. Pathway: skin tears	508
III. Classification of skin tears	509
IV. Best practices for care and prevention	510
V. Moisture-associated skin damage	511
VI. Peristomal skin damage	514
VII. Skin and wound care issues at the end of life	516
Chapter 21: Management of Enterocutaneous Fistula	529
<i>Dianne Rudolph</i>	
I. Case study	531
II. Definition	531
III. Postoperative ECF	533
IV. Spontaneous ECF.	533
V. Surgical management	534
VI. Nonsurgical management	535
VII. Nutritional requirements of ECF patients	535
VIII. Options for management of fistulas	536
IX. Prognosis	542
X. Psychosocial aspects.	543

SECTION 6: Wound Care in Different Settings

Editor - Helen B. Gelly

Chapter 22: Wound Care in Hospital-Based Outpatient Wound Clinics	551
<i>Michael White</i>	
I. Why	554
II. Who	554
III. What	555
IV. Where	556
V. When	556
VI. How	556
Chapter 23: Reimbursement and Compliance Issues with HOPD (Hospital Outpatient Department) – Hospital-Based Wound Healing Centers	563
<i>Caroline E. Fife</i>	
I. Provider-based requirements.	565
II. Direct supervision	566
III. Site of service	567
IV. Daily billing versus monthly billing	568
Chapter 24: Wound Care and Hyperbaric Oxygen Therapy in the Physician’s Office	573
<i>Helen B. Gelly</i>	
I. Medicare Part B utilization data for 99183	575
II. Regulatory landscape	575
III. Clinical requirements for an effective wound care center: site of service neutral	576
IV. The hyperbaric patient in the office setting	576
V. Managing the wound care/hyperbaric patient in the office setting	577
VI. Licensing requirements.	578
VII. Cost to the patient	578
Chapter 25: Wound Care in the Acute Long-Term Care Hospital	583
<i>David A. Johnson, Jaime Wise, Pedram Zendehrouh</i>	
I. The wound patient in the LTCH.	585
II. Case study	585
III. LTCH as a resource	587
IV. LTCH criteria	588
Chapter 26: Wound Care in the Nursing Home Setting	593
<i>Christina Ramsey</i>	
I. Evolution of wound care in long-term care.	595
II. Components of a comprehensive wound care program	596

SECTION 7: Challenges and Opportunities in Wound Care Practice in the New Era

Editor - Caroline E. Fife

Chapter 27: Incorporating Research into Wound Care and Hyperbaric Medicine Practice. 607
Thomas E. Serena

I. Incorporating research in wound care: research culture 609

II. Research facility 609

III. Current trends in research. 613

Chapter 28: Telemedicine 619
Stephen D. Guthrie, Barbara R. Guthrie

I. Objectives 621

II. History 621

III. Available resources and applications 622

IV. Current utilization 622

V. General features and benefits of telemedicine in a wound care clinic 623

VI. Clinical examples 626

VII. Establishing a telemedicine facility. 628

VIII. The future 629

Chapter 29: Electronic Health Records in Wound Care Challenges and Opportunities 637
Caroline E. Fife

I. Structured data, the key to interoperability 639

II. Point-of-care charting and workflow management 640

III. e-Prescribing 641

IV. EHRs and billing 641

V. HIPAA and EHRs 642

VI. Photographs and protected health information 643

VII. Photographs and the designated record set 644

VIII. Understanding metadata 644

IX. Storage and backup 645

X. Security and sign-off 645

XI. Copying and pasting 645

XII. What's next 646

XIII. Capitalizing on the opportunities 647

XIV. Core principles for EHR adoption in the wound and hyperbaric center 648

Chapter 30: Moving from Volume to Value in Wound Care	653
<i>Caroline E. Fife</i>	
I. The cost of chronic wounds to Medicare	656
II. Quality reporting	657
III. The role of qualified clinical data registries (QCDR)	658
IV. Registry reporting and advancing care information	660
V. Registry reporting and clinical practice improvement activities	661
VI. Resource use and bundled payments	661
VII. A new way of allocating resources	664
VIII. The future of comparative effectiveness research in wound care and hyperbaric medicine	665
 Chapter 31: Patient-Centered Decision Making in Wound Care & Hyperbaric Medicine	 671
<i>Caroline E. Fife</i>	
I. Patient-centered wound care practice	673
II. Fiduciary ethics	674
III. A patient-centered approach to off-label use of HBO ₂ therapy	678
IV. Guidelines for off-label informed consent	679
V. The controversy of low-pressure oxygen	681
VI. Patient-reported outcomes and registry participation	682

SECTION 8: Wound Care in Other Countries

Editor - Julio E. Garcia

Chapter 32: Wound Care Practice in India	691
<i>Tarun Sahni, Arun Prasad, Abhishek Tiwari</i>	
I. Case studies.	693
II. Wound care modalities used in India	695
III. Diagnostic services used for wound care in India.	696
IV. Therapeutic devices used in wound care in India.	697
V. Reimbursement issues in India	697
VI. Wound care associations in India	698
Chapter 33: The Current State of Wound Care in Australia	701
<i>Iestyn Marc Lewis</i>	
I. Case study	703
II. Health-care delivery of wound care in Australia	704
III. Wound care modalities.	705
IV. Reimbursement issues	705
V. Wound care associations	705
Chapter 34: Pressure Ulcers & Other Chronic Wounds in Spain	
A Living Epidemic in the Twenty-First Century 707	
<i>J. Javier Soldevilla Agreda, Julio Garcia</i>	
I. Dimension of the problem of chronic wounds in Spain.	709
II. Wound care in Spain: health policy, management, and involved professionals .	710
III. Scientific associations in Spain related to chronic wounds.	711
Chapter 35: Wound Care in Thailand	715
<i>Supaporn Opananon, Apirag Chuangsuwanich</i>	
I. Case study	717
II. Health-care delivery for wound care in Thailand	718
III. Wound care modalities used in Thailand	718
IV. Advanced wound care product categories in Thailand	719
V. Reimbursement issues in Thailand.	719
VI. Wound care association in Thailand	720
Chapter 36: Wound Care in Malaysia	723
<i>Harikrishna K. R. Nair</i>	
I. Case study	725
II. Health-care delivery for wound care in Malaysia	726
III. Wound care modalities used in Malaysia.	726

IV. Reimbursement issues in Malaysia	726
V. Wound care association	726
Chapter 37: Treatment of Wounds in Africa	729
<i>Terry Treadwell</i>	
I. Case studies.	731
II. Wound care in Africa	732
Chapter 38: Wound Care in Korea	735
<i>Hyunsuk (Peter) Suh, JoonPio (JP) Hong</i>	
I. Case study	737
II. Health-care delivery for wound care in Korea	738
III. Wound care modalities used in Korea.	738
IV. Reimbursement issues in Korea	739
V. Wound care associations in Korea	740

APPENDIX: Clinical Decision-Making Pathways in Chronic Wound Care . . . 743

INDEX 759

FOREWORD

Chronic wounds may have cost the U.S. Medicare system as much as \$95 billion dollars in 2014, which rivals the gross domestic product (GDP) of a small European country. Nearly 15% of all Medicare patients are affected, far more than have heart failure, although unlike heart disease, there are no recognized specialty training programs producing wound care experts to manage the growing epidemic of problem wounds. This is in part because a nonhealing wound is not actually a *disease* so much as it is a *symptom*. The typical patient with a nonhealing wound has an average of six serious comorbid conditions and takes an average of ten medications. If a wound fails to achieve healing, there is always a reason, and often more than one reason, with several different organ systems involved.

The most common reason wounds fail to heal is tissue hypoxia. There was a time when we did not know that basic fact. The critical role of hypoxia in chronic wounds was identified in the 1970s through the pioneering work of Paul Sheffield and his colleagues at Brooks Air Force Base in San Antonio, Texas, some of whom implanted gas permeable electrodes in the subcutaneous tissue of their own thighs to better understand oxygen diffusion. It has been four decades since Paul first helped to elucidate the role of oxygen in healing, during which new methods of improving vascular supply have become available. Yet, we continue to struggle with implementing simple, noninvasive vascular screening to identify patients with ischemia. In some ways we have advanced very far, and in other ways, we have made little progress. In the absence of a recognized medical specialty, the training programs and textbooks developed by pioneers like Paul Sheffield continue to fill a vital role in moving the field forward. Jay Shah and I are immeasurably grateful for Paul's guidance and leadership in this latest contribution to the field of wound care. We will borrow a quote from him to express our gratitude to say that in working with him on this project, we have been, "strutting in high cotton."

With Paul's guidance, Jay and I have tried, although perhaps not always succeeded, to do justice to those predecessor texts. With the advent of the Quality Payment Program on January 1, 2017, practitioners have a new focus—how to heal wounds in the shortest period of time at the lowest cost. We hope this textbook will help prepare clinicians for their new role as stewards of resources, providing the right care to the right patient at the right time.

Caroline E. Fife, MD

Editor

PREFACE

The co-editors of this book, Paul J. Sheffield, PhD and Caroline E. Fife, MD, have also edited the *Wound Care Practice*'s first edition in 2004 and its second edition in 2007. Instead of a third edition of *Wound Care Practice*, we decided to write a new textbook focused on evidence-based pathways and that is how the *Textbook of Chronic Wound Care* was created. We realized the traditional experienced-based criteria for selecting wound care interventions is being replaced with evidence-based practice. This textbook has made an attempt to focus on the evidence-based practice approach with case studies, pathways, and key concepts outlined in a majority of the chapters.

The value of evidence-based approach for providing optimal care is established, but the process used to generate this evidence continues to evolve. Many guidelines for wound care are published on clinicalguidelines.gov but a textbook that can put all those guidelines in a simple manner to help wound care practitioners in their daily practice was lacking. This book makes a sincere attempt to help the reader apply those guidelines into their clinical practice.

Another reason for this new textbook was to create a companion to our study guide, *Wound Care Certification Study Guide, 2nd edition* (Best Publishing Company, 2016), which will give in-depth knowledge and evidence-based pathway to handle different kinds of chronic wounds. I want to thank all my colleagues and the chapter contributors for their outstanding support for *Wound Care Certification Study Guide, 2nd edition*. Their response to our study guide gave strength to the present editors to venture into this new textbook. All editors and more than 50 contributors are committed in the field of wound care and they believe in making a difference in the lives of our patients through education.

This textbook is organized into eight sections. The first section explores the anatomy, physiology, and biochemistry of wound healing. The second section explores all essentials of wound healing including discussion on etiology of wound, nutritional assessment and management, wound assessment, wound bed preparation, evidence-based selection of wound dressings, advanced wound modalities, and advanced plastic surgical techniques in wound care. The third section discusses pathophysiology, diagnosis, and management of special wound patients including discussion of diabetic foot ulcer, pressure ulcers, venous insufficiency ulcers, lymphedema, and arterial insufficiency ulcers. The fourth section explores atypical wounds, arthropod bites, stings and infestation, radiation wounds, and burns.

The fifth section discusses wound care in special populations like pediatrics, geriatrics and patients with fistulae. The sixth section discusses wound care in different settings like outpatient hospital wound clinic, physician's outpatient office, acute long-term care facility, and nursing home setting. It also discusses ways to incorporate research in wound care practice. The seventh section explores challenges and opportunities in wound care practice in the new era, discusses use of telemedicine in wound care, and presents challenges and opportunities with electronic health records. There is also a discussion on the future of wound care moving from volume to value in the wound care arena and a discussion on patient-centered decision making in wound care and hyperbaric

TEXTBOOK *of* CHRONIC WOUND CARE

medicine. Finally, section eight looks at disparities in health care in different countries and how wound care is being done in other countries.

A disclaimer by Dr. Fife concerning the NPUAP 2016 Terminology controversy is provided to give you some clarification on certain terminology regarding pressure ulcer throughout the textbook.

Thank you for the opportunity to present this textbook that will assist wound care professionals, caregivers, patients, and their families. By working as a team, we can drastically improve the care of our wound care patients globally.

With regards,

Jayesh B. Shah, MD
Editor



JAYESH B. SHAH MD, UHM(ABPM), CWSP, FAPWCA, FCCWS, FUHM, FACP, FACHM

Dr. Jayesh B. Shah is President of South Texas Wound Associates, PA, San Antonio, Texas, where he has provided clinical wound care services in San Antonio and the surrounding communities for the past 17 years. He is also President of TIMEO2 Healing Concepts, LLC, in San Antonio, Texas, through which he provides consulting and education services in wound care and hyperbaric medicine both nationally and internationally. His degrees include MBBS from M. S. University, India, and MD in Internal Medicine from St. Luke's Roosevelt Hospital, Columbia University, New York. He is board certified in internal medicine, board certified in undersea and hyperbaric medicine, certified in wound management, and certified in hyperbaric medicine. He is the past chair of American College of Clinical Wound Specialists, past president of American Association of Physicians of Indian Origin, past chair of American Medical Association, International Medical Graduates Section, 2016 President of the Bexar County Medical Society, and 2017 President of American College of Hyperbaric Medicine. He is an adjunct professor in the Department of Family and Community Medicine at the University of Texas Health Science Center and an associate professor at the Osteopathic School of Medicine for the University of Incarnate Word in San Antonio, Texas.

He has been the recipient of the Entrepreneur of the Year Award by the Alamo Asia Chamber of Commerce (2016); the Paul James Sheffield Education Award for Lifetime Dedication to Education in the Field of Undersea and Hyperbaric Medicine (2014); Jefferson C. Davis Memorial Award for Excellence in Clinical Hyperbaric Medicine (2007 and 2011); Carolyn Sue Award (2009); Young Scientist/Medical Doctor Award (2008); and Community Service and Leadership Award by Alamo Asian American Chamber of Commerce (2008).

Dr. Jayesh Shah has 20 years of experience in wound care and hyperbaric medicine practice and 14 years of experience

as program director for continuing medical education courses. As Medical Director of the Wound Care Centers, Dr. Shah has helped these centers from startup through their growth up to their maximum potential. Since 2010, he has served as the Medical Director for the Northeast Baptist Wound Healing Center, which recently became accredited by the UHMS within its first four years of inception. He is also the co-medical director for the Mission Trail Baptist Wound Healing Center since 2014.

He is the co-editor of the first and second editions of *Wound Care Certification Study Guide* and created *WoundDoctor App*, a comprehensive wound care resource tool for physicians, nurses, and physical therapists for iPhone, Android, and iPad. He has authored over 40 chapters on various wound topics in 4 books in addition to 30+ scientific articles in wound care and hyperbaric medicine. As an assistant editor of the *Journal of ACCWS*, he regularly writes a column on certification exam in wound care.



PAUL J. SHEFFIELD PhD, CAsP, CHT-ADMIN, FAsMA, FUHM

Dr. Paul Sheffield is President, International ATMO, Inc. of San Antonio, Texas, which provides wound care and hyperbaric medicine management, consulting, and education services. His degrees include BS (Chemistry) from University of Florida, and MS & PhD (Physiology) from University of Southern California. He is a certified aerospace physiologist and certified hyperbaric technologist.

Dr. Sheffield began his career as a US Air Force aerospace physiologist, with primary responsibilities in aircrew training, research, and hyperbaric medicine. He was on the original team that established the USAF Hyperbaric Center at Brooks Air Force Base, Texas in 1974 where he was one of the originators of the use of tissue oximetry for wound assessment and patient selection for hyperbaric oxygen therapy. He completed his Air Force career as Chief of Aerospace Physiology at the Office of the Air Force Surgeon General in Washington, DC and retired in the grade of colonel after 30 years of military service. He joined International ATMO as Director of Research and Education and eventually became president in 2000.

For over 50 years, Dr. Sheffield has been educating physicians, nurses, and technologists in aerospace physiology, undersea and hyperbaric medicine, and wound care. He authored over 145 publications, including 12 book chapters and edited several books, including *Proceedings of the XIV International Congress on Hyperbaric Medicine* (Best Publishing Company), first and second editions of *Wound Care Practice* (Best Publishing Company), and first and second editions of *Wound Care Certification Study Guide* (Best Publishing Company).

The Gulf Coast Chapter of the Undersea and Hyperbaric Medical Society (UHMS) honored him in 2009 by creating the Paul James Sheffield Education Award, which is presented annually to an individual who made significant contributions to science and education in undersea and hyperbaric medicine.



CAROLINE E. FIFE MD, FAAFP, CWS, FUHM

Dr. Fife completed a family medicine residency at the University of Texas, Southwestern in Dallas followed by a two-year fellowship in undersea and hyperbaric medicine at Duke University. Until 2013 she was a professor of medicine at the University of Texas Health Science Center, Houston, where she initiated the Memorial Hermann Center for Wound Healing and Hyperbaric Medicine and the Lymphedema Center. She is now a professor of geriatrics at Baylor College of Medicine in Houston and the medical director of the CHI St. Luke's Wound Care Clinic in The Woodlands, Texas.

She is also the chief medical officer of Intellicure, Inc., a health information technology company, and the executive director of the U.S. Wound Registry, a nonprofit organization recognized by CMS as a qualified clinical data registry. The USWR develops quality measures and helps wound care and hyperbaric practitioners meet the requirements of Medicare's Quality Payment Program.

She has been a certified wound specialist since 1998. Past and present board activities include the Alliance of Wound Care Stakeholders (current co-chair), the American Academy of Wound Management, the Association for the Advancement of Wound Care and the American Professional Wound Care Association. She is a past president of the Undersea and Hyperbaric Medical Society.

Dr. Fife is co-editor of the books *Wound Care Practice*, *Women and Pressure: Diving and Flying*, and both editions of *Wound Care Certification Study Guide*, all published by Best Publishing Company. She is the author of more than 100 peer-reviewed articles and book chapters and is a popular speaker. Her research contributions include altitude decompression studies enabling the construction of the International Space Station by decreasing the time needed for oxygen prebreathe as part of a NASA lead research consortium; the development of real time lymphatic imaging with Dr. Eva Sevicik using near infrared technology; and more recently, the use of real-world data for comparative effectiveness studies to understand what works best for patients with chronic wounds and ulcers.

CONTRIBUTORS LIST

A

J. Javier Soldevilla Agreda, RN, MsG, BAsc, PhD

B

Dimitri Beeckman, RN, PhD

Samih Bittar, MD

Robyn Bjork, MPPT, CWS, CLT-LANA, CLWT

C

Apirag Chuangsuwanich, MD

Kevin K. Chung, MD

Cherison Cuffy, DPM, CWS

E

Joey K. Ead, MS

Dirk Elston, MD

F

Regina M. Fearmonti, MD

John J. Feldmeier, DO, FACRO, FUHM

Caroline E. Fife, MD, FAAFP, CWS, FUHM

John Fish, MD

Elizabeth Friedrich, MPH, RDN, CSG, LDN,
FAND

G

Aimee D. Garcia, MD, CWS, FACCWS

Julio Garcia, RN, MD, AAPWCA

Helen B. Gelly, MD, FUHM, FCCWS

Daniel J. Gibson, PhD

Timothy M. Graham, DPM

Stephen D. Guthrie, MD, PhD

Barbara R. Guthrie, MD

H

Heather Hettrick, PT, PhD, CWS, CLT-LANA,
CLWT

JoonPio (JP) Hong, MD, PhD, MMM

J

David A. Johnson, MD, FAAFP, CWSP

Kelly Johnson-Arbor, MD, FACEP, FUHM,
FACMT

L

Javier La Fontaine, DPM, MS

Lawrence Lavery, DPM, MPH

Iestyn Marc Lewis, BS, MB, FACEM, DHM

Fedor Lurie, MD, PhD

N

Harikrishna K. R. Nair, MD, FMSWCP

O

Supaporn Opananon, MD, FRCST, FICS, FACS

P

Arun Prasad, MD

R

Christina Ramsey, RN, MSN, GNP-BC, LNCC,
CWS

Julie A. Rizzo, MD

Margie Rodriguez, RN, MSN, WCC

Matthew P. Rowan, PhD

Dianne Rudolph, DNP, GNP-BC, CWOCN

S

Tarun Sahni, MD
Pamela Scarborough, PT, DPT, MS, CDE, CWS,
CEEAA
Gregory S. Schultz, PhD
Thomas E. Serena, MD, FACS, FACHM,
MAPWCA
Jayesh B. Shah, MD, UHM(ABPM), CWSP,
FAPWCA, FCCWS, FUHM, FACP, FACHM
Herbert B. Slade, MD, FAAAAI
Jamie M. Slade, MD
Robert J. Snyder, DPM, MSc, CWS
Hyunsuk (Peter) Suh, MD, PhD
Mellick T. Sykes MD, FACS

T

Abhishek Tiwari, MD
Boulos Toursarkissian, MD, RPVI, FACS
Terry Treadwell, MD, FACS

V

Suzanne Van Asten, MD

W

Dot Weir, RN, CWON, CWS
Michael White, MD, MMM
Jaime Wise, MD, CWSP
Kevin Y. Woo, RN, PhD, FAPWCA

Z

Pedram Zendehtrouh, MD, PhD, FACS

ACKNOWLEDGMENTS

I am sincerely thankful to the co-editors of this book, Dr. Paul Sheffield and Dr. Caroline Fife, for supporting and encouraging my idea of creating the companion textbook to accompany *Wound Care Certification Study Guide*. I greatly admire their friendship, mentorship and guidance in making this project successful.

I am greatly thankful to all authors who have shared their knowledge, experience, expertise, and valuable time by contributing the chapters in this book.

Finally, a special thanks to Lorraine Fico White, publishing editor, and the entire staff of Best Publishing Company, for patiently and diligently editing, formatting, and presenting the material in an organized manner for the readers.

Jayesh B. Shah, MD
Editor

DEDICATION

To my loving and supportive wife, Neha, for her understanding and patience with my hectic schedule.

To my two beautiful children, Prachi and Aj, for giving me the space to write and edit this book, and for giving me the emotional support to persevere through a challenging year.

To my mother, Jaivanti, for keeping me spiritually uplifted.

To my late father, Bipinchandra, for inspiring me to be a physician. His spirit is with me every day.

To my wonderful team of wound care staff and colleagues at Northeast Baptist Wound Healing Center and Mission Trail Baptist Wound Healing Center in San Antonio, for helping me care for chronic wounds.

And finally, to my patients and their caregivers, for their trust in me.

Jayesh B. Shah, MD
Editor