AIRBORNE HAZARDS RELATED TO DEPLOYMENT

I can think of no higher responsibility than ensuring that the men and women who have served our nation in uniform are treated with the care and respect that they have earned.

Eric K. Shinseki
General (Retired), US Army
Secretary of Veterans Affairs

AIRBORNE HAZARDS RELATED TO DEPLOYMENT

Edited by

COLEEN P. BAIRD, MD, MPH
Program Manager
Environmental Medicine Program
US Army Public Health Command

and

DEANNA K. HARKINS, MD, MPH
Occupational Medicine Physician
Environmental Medicine Program
US Army Public Health Command

Borden Institute
US Army Medical Department Center and School
Fort Sam Houston, Texas

Office of The Surgeon General
United States Army
Falls Church, Virginia

2015

A Specialty Volume of the

TEXTBOOKS OF MILITARY MEDICINE

Published by the
Borden Institute
US Army Medical Department Center and School
Fort Sam Houston, Texas

Office of The Surgeon General
Department of the Army, United States of America

Editor in Chief
Daniel E. Banks, MD, MS, MACP
Lieutenant Colonel, Medical Corps, US Army
Director, Borden Institute

Timothy K. Jones, DDS
Colonel (Retired), Dental Corps, US Army
Assistant Director, Borden Institute

Burn pits have operated in the theater of war during Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn.

Photograph: Courtesy of the US Army Public Health Command (Aberdeen Proving Ground, Maryland).

EDITORIAL STAFF

Borden Institute
Daniel E. Banks, MD, MS, MACP
LTC, MC, US Army
Director and Editor in Chief

Vivian Mason
Volume Editor

Douglas Wise
Layout Editor

This volume was prepared for military medical educational use. The focus of the information is to foster discussion that may form the basis of doctrine and policy. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

Dosage Selection:

The authors and publisher have made every effort to ensure the accuracy of dosages cited herein. However, it is the responsibility of every practitioner to consult appropriate information sources to ascertain correct dosages for each clinical situation, especially for new or unfamiliar drugs and procedures. The authors, editors, publisher, and the Department of Defense cannot be held responsible for any errors found in this book.

Use of Trade or Brand Names:

Use of trade or brand names in this publication is for illustrative purposes only and does not imply endorsement by the Department of Defense.

Neutral Language:

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

CERTAIN PARTS OF THIS PUBLICATION PERTAIN TO COPYRIGHT RESTRICTIONS.
ALL RIGHTS RESERVED.

NO COPYRIGHTED PARTS OF THIS PUBLICATION MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL (INCLUDING PHOTOCOPY, RECORDING, OR ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM), WITHOUT PERMISSION IN WRITING FROM THE PUBLISHER OR COPYRIGHT OWNER.

Published by the Office of The Surgeon General
Borden Institute
Fort Sam Houston, TX 78234-6100

Library of Congress Cataloging-in-Publication Data

Airborne hazards related to deployment / edited by Coleen P. Baird and Deanna K. Harkins.
p. ; cm. -- (Textbooks of military medicine)
Includes bibliographical references and index.
I. Baird, Coleen P., editor. II. Harkins, Deanna K., editor. III. Borden Institute (U.S.), issuing body. IV. United States. Department of the Army. Office of the Surgeon General, issuing body. V. Series: Textbooks of military medicine.
[DNLM: 1. Air Pollutants, Occupational--adverse effects. 2. Lung Diseases. 3. Military Personnel. 4. Respiratory Function Tests. 5. Veterans. WA 450]
RC776.R38
616.2'4--dc23
2015009018

PRINTED IN THE UNITED STATES OF AMERICA

22, 21, 20, 19, 18, 17, 16, 15 5 4 3 2 1

Contents

Contributors xi

Additional Acknowledgments xiv

Foreword by The Surgeon General xv

Preface xvii

Prologue xix

Introduction xxiii

Section I: Airborne Exposures and Characterization 1

1 Overview of Airborne Hazards in Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn 3
Paul Ciminera, Coleen P. Baird, William Eschenbacher, and Deanna K. Harkins

2 Background of Deployment-Related Airborne Exposures of Interest and Use of Exposure Data in Environmental Epidemiology Studies 15
Jeffrey S. Kirkpatrick and Coleen P. Baird

3 Deployment to Al Anbar: A Seabee Battalion Surgeon's Perspective 27
Richard T. Meehan

4 Pulmonary Response to Airborne Hazards: Interpreting Cases of Suspected Deployment-Related Lung Disease 33
Tee L. Guidotti

5 Future Improvement to Individual Exposure Characterization for Deployed Military Personnel 47
Veronique Hauschild and Jessica Sharkey

Section II: Population Surveillance 59

6 Epidemiology of Airborne Hazards in the Deployed Environment 61
Joseph H. Abraham, Leslie L. Clark, and Aaron I. Schneiderman

7 **Discussion Summary:** Defining Health Outcomes in Epidemiological Investigations of Populations Deployed in Support of Operation Iraqi Freedom and Operation Enduring Freedom 73
Joseph H. Abraham

8 Pulmonary Function Testing—Spirometry Testing for Population Surveillance 89
William Eschenbacher

9 **Discussion Summary:** Recommendation for Surveillance Spirometry in Military Personnel 95
Michael J. Morris, William Eschenbacher, and Charles E. McCannon

10 Spirometry Monitoring and Prevention Using Spirola Software 103
Eva Hnizdo and Cara Halldin

Section III: Follow-up Medical Care of Service Members and Veterans 119

11 **Discussion Summary:** Basic Diagnosis and Workup of Symptomatic Individuals 121
Michael J. Morris, Corina Negrescu, David G. Bell, and Carole N. Tinklepaugh

12 Allergic Airway Disease and Deployment to the Middle East 131
Jennifer Mbuthia, Anthony M. Szema, and Jonathan Li

13 Follow-up Medical Care of Service Members and Veterans—Cardiopulmonary Exercise Testing 139
William Eschenbacher

14 Value of Lung Biopsy in Workup of Symptomatic Individuals 145
Robert Miller

15 The Problems With Constrictive Bronchiolitis: Histopathological and Radiological Perspectives 153
Michael R. Lewin-Smith, Michael J. Morris, Jeffrey R. Galvin, Russell A. Harley, and Teri J. Franks

16 Military Personnel With Postdeployment Dyspnea: Chronic Lung Disease and the Role of Surgical Lung Biopsy 163
Michael J. Morris and Daniel E. Banks

17 Evaluating the Effects of Airborne Hazards: A Clinical Perspective From the War Related Illness and Injury Study Center 175
Michael J. Falvo, Ronald F. Teichman, and Drew A. Helmer

18 Experience With Emerging Lung Diseases From the National Institute for Occupational Safety and Health 183
Kathleen Kreiss

19 Follow-up Medical Care of Service Members and Veterans: Case Reports—Usual and Unusual 201
Michael R. Lewin-Smith, Russell A. Harley, Jeffrey R. Galvin, and Teri J. Franks

20 Veterans Affairs Symposium: Case Reports 209
Michael J. Morris

21 Denver Veterans Affairs Medical Center Experience With Postdeployment Dyspnea Case Reports 213
Carolyn H. Welsh and York E. Miller

22 **Discussion Summary:** Methodological Considerations to Design a Pulmonary Case Series and a National, Broad-based Registry for Veterans of Operation Iraqi Freedom and Operation Enduring Freedom 219
Kelley Ann Brix and Stella E. Hines

Section IV: Health Communication and Outreach **229**

23 Risk Communication: An Essential Element of Effective Care 231
Connie Raab, Deanna K. Harkins, Michelle Kennedy Prisco, and Bethney A. Davidson

24 Community-based Participatory Research: An Overview for Application in Department of Defense/Veterans Affairs Research 239
Erin N. Haynes

25 Toxic-Embedded Fragments Registry: Lessons Learned 245
Joanna M. Gaitens and Melissa A. McDiarmid

26 Lessons Learned From Self-Selected Registries (Agent Orange) 253
Wendi J. Dick

Section V: Research Initiatives **259**

27 Research Studies: Overview and Future Directions 261
David A. Jackson

28 Considerations Regarding Biomonitoring 271
Camilla A. Mauzy, Lisa M. Kirk Brown, Coleen P. Baird, and Carole N. Tinklepaugh

29 **Discussion Summary:** Exposure Characterization—Questionnaires and Other Tools 283
Joel C. Gaydos and Kathleen Kreiss

30 Review of Epidemiological Analyses of Respiratory Health Outcomes After Military Deployment to Burn Pit Locations With Respect to Feasibility and Design Issues Highlighted by the Institute of Medicine 291
Jessica Sharkey, Coleen P. Baird, Angelia Eick-Cost, Leslie L. Clark, Zheng Hu, Sharon Ludwig, and Joseph H. Abraham

31 Update on Key Studies: The Millennium Cohort Study, the STAMPEDE Study, the Million Veteran Program, and the National Health Study for a New Generation of US Veterans 305
Nancy F. Crum-Cianflone, Michael J. Morris, Darrel W. Dodson, Lisa L. Zacher, and Ronald M. Przygodzki

32 National Health Study for a New Generation of US Veterans 317
Aaron I. Schneiderman

33 **Discussion Summary:** Work Group E—Strategic Research Planning 321
David A. Jackson and Michael R. Peterson

Appendix A: A Self-Reporting Tool to Collect Individual Data for Respiratory Health Effects and Military Airborne Exposures 331
Veronique Hauschild and Jessica Sharkey

Appendix B: Respiratory Health and Exposure Questionnaire 339
Veronique Hauschild and Jessica Sharkey

Appendix C: Proposed Evaluation of Patients With Normal Spirometry 355

Appendix D: Airborne Hazards Joint Action Plan 357

Appendix E: Frequently Asked Questions About Military Exposure Guidelines 387

Appendix F: Executive Summary: Screening Health Risk Assessment, Burn Pit Exposures, Balad Air Base, Iraq 395

Appendix G: Executive Summary, Addendum 2: Screening Health Risk Assessment, Burn Pit Exposures, Balad Air Base, Iraq 401

Abbreviations and Acronyms 407

Index 411

Contributors

PAUL CIMINERA, MD, MPH
Co-Organizer, Joint DoD/VA Airborne Hazards Symposium
Director, Veterans Health Administration, Office of Public Health, Post-9/11 Era Environmental Health Program, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

WILLIAM ESCHENBACHER, MD
Co-Organizer, Joint DoD/VA Airborne Hazards Symposium
Pulmonologist, Veterans Health Administration, Pulmonary/Critical Care, Cincinnati VA Medical Center, 3200 Vine Street, Cincinnati, Ohio 45220; Professor of Medicine, Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, University of Cincinnati College of Medicine, 231 Albert Sabin Way, Cincinnati, Ohio 45229

JOSEPH H. ABRAHAM, SCD
Epidemiologist, Environmental Medicine Program, Occupational and Environmental Medicine Portfolio, Army Institute of Public Health, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

COLEEN P. BAIRD, MD, MPH
Program Manager, Environmental Medicine Program, Occupational and Environmental Medicine Portfolio, Army Institute of Public Health, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

DANIEL E. BANKS, MD
Lieutenant Colonel, Medical Corps, US Army; Professor, Department of Medicine, Uniformed Services University for the Health Sciences, 4301 Jones Bridge Road, Bethesda, Maryland 20814; Director and Editor in Chief, Borden Institute, 2478 Stanley Road, Fort Sam Houston, Texas 78234; Staff Physician, Department of Medicine, Brooke Army Medical Center, 3551 Roger Brooke Drive, Fort Sam Houston, Texas 78234

DAVID G. BELL, MD
Lieutenant Colonel, Medical Corps, US Army; Program Director, Pulmonary/Critical Care, San Antonio Military Medical Center, 3551 Roger Brooke Drive, Fort Sam Houston, Texas 78234

KELLEY ANN BRIX, MD, MPH
Deputy Director for the Defense Medical Research and Development Program, Office of the Assistant Secretary of Defense for Health Affairs, Force Health Protection and Readiness Defense Health Headquarters, 7700 Arlington Boulevard, Suite 5101, Falls Church, Virginia 22042-5101

PAUL CIMINERA, MD, MPH
Director, Veterans Health Administration, Office of Public Health, Post-9/11 Era Environmental Health Program, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

LESLIE L. CLARK, PHD
Senior Epidemiologist, General Dynamics Information Technology, Division of Epidemiology and Analysis, Armed Forces Health Surveillance Center, 11800 Tech Road, Suite 220, Silver Spring, Maryland 20904

NANCY F. CRUM-CIANFLONE, MD, MPH
Department Head, Deployment Health Research Department, Naval Health Research Center, 140 Sylvester Road, San Diego, California 92106-3521

BETHNEY A. DAVIDSON, BS
Health Risk Communication Specialist, Army Institute of Public Health, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

WENDI J. DICK, MD, MSPH, MCRP
Senior Advisor to the Afghanistan Assistant Minister of Defense for Health Affairs, Office of the Command Surgeon, NATO Training Mission-Afghanistan, International Security Assistance Force, Kabul, Afghanistan; Former Director, Environmental Health Program, Pre-9/11 Era, Post-Deployment Health, Office of Public Health, Veterans Health Administration, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

DARREL W. DODSON, MD
Colonel, Medical Corps, US Army; Chief, Department of Medicine, Pulmonary/Critical Care Medicine, William Beaumont Army Medical Center, Fort Bliss, 5005 North Piedras Street, El Paso, Texas 79920

ANGELIA EICK-COST, PhD, SCM
Senior Epidemiologist, Henry M. Jackson Foundation for the Advancement of Military Medicine, Division of Epidemiology and Analysis, Armed Forces Health Surveillance Center, 11800 Tech Road, Suite 220, Silver Spring, Maryland 20904

WILLIAM ESCHENBACHER, MD
Pulmonologist, Veterans Health Administration, Pulmonary/Critical Care, Cincinnati VA Medical Center, 3200 Vine Street, Cincinnati, Ohio 45220; Professor of Medicine, Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, University of Cincinnati College of Medicine, 231 Albert Sabin Way, Cincinnati, Ohio 45229

MICHAEL J. FALVO, PhD
Research Physiologist, War Related Illness and Injury Study Center, Veterans Affairs New Jersey Health Care System, 385 Tremont Avenue, East Orange, New Jersey 07018; Assistant Professor, Rutgers University–New Jersey Medical School, 185 South Orange Avenue, Newark, New Jersey 07103

TERI J. FRANKS, MD
Senior Pulmonary and Mediastinal Pathologist, The Joint Pathology Center, Joint Task Force National Capital Region Medical, 606 Stephen Sitter Avenue, Silver Spring, Maryland 20910-1290

JOANNA M. GAITENS, PhD, MSN/MPH, RN
Research Nurse Associate, Baltimore Veterans Affairs Medical Center, 10 North Greene Street, Baltimore, Maryland 21201; Assistant Professor, Department of Medicine, Occupational Health Program, University of Maryland School of Medicine, 11 South Paca Street, Suite 200, Baltimore, Maryland 21201

JEFFREY R. GALVIN, MD
Professor, Departments of Diagnostic Radiology, Thoracic Imaging, and Internal Medicine, Pulmonary/Critical Care Medicine, University of Maryland School of Medicine, 685 West Baltimore Street, Baltimore, Maryland 21201

JOEL C. GAYDOS, MD, MPH
Colonel (Retired), Medical Corps, US Army; Science Advisor, Armed Forces Health Surveillance Center, 11800 Tech Road, Suite 220, Silver Spring, Maryland 20904

TEE L. GUIDOTTI, MD, MPH, DABT
Vice President for Health/Safety/Environment & Sustainability, Medical Advisory Services, PO Box 7479, Gaithersburg, Maryland 20898; Diplomate, American Board of Toxicology, PO Box 97786, Raleigh, North Carolina 27624

CARA HALLDIN, PhD
Epidemiologist, Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, 1095 Willowdale Road, Morgantown, West Virginia 26505-2888

DEANNA K. HARKINS, MD, MPH
Occupational Medicine Physician, Environmental Medicine Program, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

RUSSELL A. HARLEY, MD
Senior Pulmonary and Mediastinal Pathologist, The Joint Pathology Center, Joint Task Force National Capital Region Medical, 606 Stephen Sitter Avenue, Silver Spring, Maryland 20910-1290

VERONIQUE HAUSCHILD, MPH
Environmental Scientist, Injury Prevention Program, Epidemiology and Disease Surveillance Portfolio, Army Institute of Public Health, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

ERIN N. HAYNES, DrPH, MS
Assistant Professor, Department of Environmental Health, Division of Epidemiology and Biostatistics, University of Cincinnati College of Medicine, 3223 Eden Avenue, Cincinnati, Ohio 45267-0056

DREW A. HELMER, MD, MS
Director, War Related Illness and Injury Study Center, Veterans Affairs New Jersey Health Care System, 385 Tremont Avenue, East Orange, New Jersey 07018; Associate Professor, Rutgers University–New Jersey Medical School, 185 South Orange Avenue, Newark, New Jersey 07103

STELLA E. HINES, MD, MSPH
Assistant Professor, University of Maryland School of Medicine, Department of Medicine Occupational Health Program and Division of Pulmonary & Critical Care Medicine, Baltimore Veterans Affairs Medical Center, 11 South Paca Street, Suite 200, Baltimore, Maryland 21201

EVA HNIZDO, PhD
Epidemiologist, Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, 1095 Willowdale Road, Morgantown, West Virginia 26505-2888

ZHENG HU, MS
Biostatistician, Henry M. Jackson Foundation for the Advancement of Military Medicine, Division of Epidemiology and Analysis, Armed Forces Health Surveillance Center, 11800 Tech Road, Suite 220, Silver Spring, Maryland 20904

DAVID A. JACKSON, PhD
Director, Pulmonary Health Program, US Army Center for Environmental Health Research, 568 Doughten Drive, Fort Detrick, Maryland 21702-5010

MICHELLE KENNEDY PRISCO, MSN
Nurse Practitioner, Washington DC Veterans Administration Medical Center, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

LISA M. KIRK BROWN, DrPH
Adjunct Professor, Uniformed Services University of the Health Sciences, 4301 Jones Bridge Road, Bethesda, Maryland 20814

JEFFREY S. KIRKPATRICK, MS
Portfolio Director, Health Risk Management Portfolio, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

KATHLEEN KREISS, MD
Field Studies Branch Chief, Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Mailstop H-2800, 1095 Willowdale Road, Morgantown, West Virginia 26505

MICHAEL R. LEWIN-SMITH, MB, BS
Senior Environmental Pathologist, The Joint Pathology Center, Joint Task Force National Capital Region Medical, 606 Stephen Sitter Avenue, Silver Spring, Maryland 20910-1290

JONATHAN LI, BS
Postbaccalaureate premedical student, Stony Brook University, 101 Nicolls Road, Stony Brook, New York 11794

SHARON LUDWIG, MD, MPH, MA
Captain, US Public Health Service/US Coast Guard; Director, Division of Epidemiology and Analysis, Armed Forces Health Surveillance Center, 11800 Tech Road, Suite 220, Silver Spring, Maryland 20904

CAMILLA A. MAUZY, PhD
Biomarker/Biomonitor Development Project Director, Aerospace Toxicology Program, Molecular Bioeffects Branch (RHDJ), 711th Human Performance Wing, Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio 45433

JENNIFER MBUTHIA, MD
Lieutenant Colonel, Medical Corps, US Army; Office of The Army Surgeon General, Defense Health Headquarters, 7700 Arlington Boulevard, Falls Church, Virginia 22042; Assistant Professor of Pediatrics, Uniformed Services University of the Health Sciences, 4301 Jones Bridge Road, Bethesda, Maryland 20814

CHARLES E. McCANNON, MD, MBA, MPH
Staff Physician, Environmental Medicine Program, Occupational and Environmental Medicine, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

MELISSA A. McDIARMID, MD, MPH
Medical Director, Baltimore Veterans Affairs Medical Center, 10 North Greene Street, Baltimore, Maryland 21201; Professor of Medicine and Epidemiology & Public Health, and Director, Division of Occupational and Environmental Medicine, University of Maryland School of Medicine, 11 South Paca Street, Suite 200, Baltimore, Maryland 21201

RICHARD T. MEEHAN, MD
Captain (Retired), US Navy; Professor of Medicine, Department of Medicine and Rheumatology Division and Co-Director, National Jewish Health Deployment-Related Lung Disease Center, National Jewish Health, 1400 Jackson Street, Denver, Colorado 80206

ROBERT MILLER, MD
Associate Professor of Medicine, Vanderbilt University School of Medicine, Division of Allergy, Pulmonary, and Critical Care Medicine, 6134 Medical Center East, Nashville, Tennessee 37232-8288

YORK E. MILLER, MD
Thomas L. Petty Chair of Lung Research Professor, Department of Medicine, Division of Pulmonary Sciences and Critical Care Medicine, University of Colorado School of Medicine, Anschutz Medical Campus, 12700 East 19th Avenue, Aurora, Colorado 80045; Staff Physician and Chest Clinic Director, Denver Veterans Affairs Medical Center, Eastern Colorado Health Care System, 1055 Clermont Street, Denver, Colorado 80220

MICHAEL J. MORRIS, MD
Colonel (Retired), Medical Corps, US Army; Department of Defense Chair, Staff Physician, Pulmonary/Critical Care Medicine and Assistant Program Director, Internal Medicine Residency, San Antonio Military Medical Center, 3551 Roger Brooke Drive, Fort Sam Houston, Texas 78234

CORINA NEGRESCU, MD, MPH
Veterans Administration Chair and Medical Director, Veterans Benefits Administration, Contract Exams, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

MICHAEL R. PETERSON, DVM, MPH, DrPH
Chief Consultant, Post-Deployment Health, Office of Public Health, Veterans Health Administration, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

RONALD M. PRZYGODZKI, MD
Acting Director, Biomedical Laboratory Research & Development, Office of Research and Development, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

CONNIE RAAB, BA
Director, Public Health Communications, Office of Public Health, Veterans Health Administration, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

AARON I. SCHNEIDERMAN, PhD, MPH, RN
Deputy Director, Epidemiology Program, Post-Deployment Health Group (10P3A), Office of Public Health, Veterans Health Administration, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

JESSICA SHARKEY, MPH
Epidemiologist, Environmental Medicine Program, Occupational and Environmental Medicine Portfolio, Army Institute of Public Health, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

ANTHONY M. SZEMA, MD
Assistant Professor of Medicine and Surgery, Stony Brook University School of Medicine, 101 Nicolls Road, Stony Brook, New York 11794; Chief, Allergy Section, Northport Veterans Affairs Medical Center, 79 Middleville Road, Northport, New York 11768

RONALD F. TEICHMAN, MD, MPH
Occupational and Environmental Medicine Specialist, War Related Illness and Injury Study Center, Veterans Affairs New Jersey Health Care System, 385 Tremont Avenue, East Orange, New Jersey 07018; Teichman Occupational Health Associates, 4 Forest Drive, West Orange, New Jersey 07052

CAROLE N. TINKLEPAUGH, MD, MBA
Occupational Medicine Physician, Environmental Medicine Program, US Army Public Health Command, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

CAROLYN H. WELSH, MD
Professor, Department of Medicine, Division of Pulmonary Sciences and Critical Care Medicine, University of Colorado Denver School of Medicine, Anschutz Medical Campus, 12700 East 19th Avenue, Aurora, Colorado 80045; Staff Physician and Sleep Program Director, Denver Veterans Affairs Medical Center, Eastern Colorado Health Care System, 1055 Clermont Street, Denver, Colorado 80220

LISA L. ZACHER, MD
Colonel (Retired), Medical Corps, US Army; Chief, Department of Medicine, Orlando Veterans Administration Medical Center, 5201 Raymond Street, Orlando, Florida 32803

Additional Acknowledgments

COLONEL WILLIAM RICE
Director
Occupational and Environmental Medicine Portfolio
US Army Public Health Command

US ARMY PUBLIC HEALTH COMMAND PUBLICATIONS MANAGEMENT DIVISION
Val Buchanan
Jeannette England
John Eppinger
Audrey Gibson
Rachel Mitchell
Jessica Owens
Anne Quirin
Jody Rush
Joyce Woods

ADMINISTRATION

Patricia A. Gibbs
Tri-Service Vision Program Office Automation Technician
Occupational Medicine Program
US Army Public Health Command

Dinna J. Louissaint
Health Systems Specialist
Occupational and Environmental Medicine Portfolio
US Army Public Health Command

Foreword

I am pleased to present this volume, titled *Airborne Hazards Related to Deployment*, published by the Army Medical Department's Borden Institute. The Borden Institute, part of the Army Medical Department Center and School, is the primary outlet for scholarly and peer-reviewed publications describing observations made and science conducted by the healthcare providers who take care of our Nation's service members and veterans. The Borden Institute's publications do not necessarily represent Army doctrine or the opinion of the Department of Defense or the Army; nevertheless, they represent the best work of our providers as they seek to inform future policy and decision-making.

You are holding a unique book, one that demonstrates the commitment of the Army and the Nation to its soldiers. It was a decade in the making, following several special studies, the involvement of external subject matter experts, the development of strong interagency cooperation between the Department of Defense and the Department of Veterans Affairs, and the direct input of academic medical centers. Inside, the reader will find medical doctors and scientists reaching conclusions that are at odds with each other. This book puts these contradicting learned opinions under one cover, for it is important that readers absorb these writings and come to their own conclusions. Science itself exists on the border between what is known and what is not known, so we are constantly rewriting our medical library of knowledge, while recognizing there is no permanent certainty in science's conclusions. In spite of these difficulties, we are all seeking to understand and to intervene on the side of our soldier patients.

This book represents the state of the science in relation to postdeployment airborne hazards and illnesses. And what a Herculean effort! This work contains 33 chapters with 88 named authors. Although I thank the many authors for showcasing their work, the editors and editorial staff at the US Army Public Health Command—along with their counterparts at the Borden Institute—deserve special praise for their meticulous efforts to ensure the synchronization of many disparate parts into one harmonious whole. I am proud of the whole team!

Patricia D. Horoho
Lieutenant General, US Army
The Surgeon General and
Commanding General
US Army Medical Command

Washington, DC
October 2014

Preface

I join my US Department of Defense (DoD) colleague, Dr Karen Guice, in recognizing the pursuit of scientific truths as a fundamental obligation for US Veterans Affairs (VA) and military medical professionals. The substantial efforts of those who have contributed to this book are a clear signal of our combined commitment to this mission.

> The VA asked the Institute of Medicine (IOM) to determine the health consequences of exposure to open burn pits in Iraq and Afghanistan. The IOM report[1] released in October 2011 was comprehensive and provided useful guidance for both the VA and DoD. The IOM endorsed our concern that open burn pits are just one source of potentially harmful exposures. The IOM report stated that, "the pollutants of greatest concern at Joint Base Balad (JBB) may be the mixture of chemicals from regional background and local sources—other than the burn pit—that contribute to high particulate matter . . . ."[1] These airborne exposures may lead to health consequences, especially in those with high exposures or special susceptibility. Particulate matter, which is ubiquitous in southwest Asia and Afghanistan, must be studied in the context of all potentially hazardous exposures.

The Airborne Hazards Symposium held in August 2012 provided an opportunity to discuss what *we know*, what *we need to know*, and what *can be done* to study and improve care for veterans and service members who might have suffered adverse health effects related to exposure to airborne hazards, including burn pit smoke and other pollutants.

We understand that service members and veterans are concerned about what may be causing their illnesses and that these illnesses may affect their future well-being. The VA and DoD are working to provide service members and veterans with the best possible care. For example:

- We are providing healthcare for deployment-related issues at no cost for at least 5 years after deployment. This allows the VA to provide care for veterans while we work to determine individual service connection for their health condition.
- We are providing consistent and seamless care between the DoD and VA by using the same screening and assessment guidelines associated with postdeployment respiratory disease.
- We are continuing to make use of existing studies, such as the 150,000-person Millennium Cohort Study led by the DoD and the 30,000-person National Health Study of a New Generation of US Veterans. These studies enable us to identify adverse health effects associated with deployment, including respiratory disease, and follow them over time.
- We are collaborating through our VA/DoD Deployment Health Working Group so that we can more easily share information, discuss the latest findings, and implement them quickly to serve our veterans.
- We are developing a proposal for a long-term prospective study. The VA's Office of Public Health, working with the VA's Office of Research and Development, is developing a proposal for long-term studies to examine the health effects of deployment to Iraq and Afghanistan and health outcomes among veterans of all eras.
- We developed an Airborne Hazards Joint Action Plan to respond to recommendations from the IOM and as directed by VA and DoD leadership. We are also implementing an Airborne Hazards and Open Burn Pit Registry as required by Public Law 112-260 enacted in January 2013.

The VA strives to care for veterans as a whole and is implementing Patient Aligned Care Teams (PACT) to maximize their total health. At the symposium, we brought together for the first time experts who could offer invaluable insight and expertise to address the environmental health concerns of veterans. Academicians, clinicians, and scientists from the civilian sector—along with representatives of veterans service organizations and veterans—shared their perspectives, experience, and expertise. This book captures those perspectives and scientific views and provides an unprecedented opportunity to make a difference in the lives of our veterans. This knowledge will be translated to better care for veterans through the VA's PACT and environmental health programs, thus ensuring that the combined commitment of the VA and DoD to scientifically understand the health effects of deployment translates to improved health for those who we serve—our service members and veterans.

Reference

1. Institute of Medicine of the National Academies. *Long-Term Health Consequences of Exposure to Burn Pits in Iraq and Afghanistan*. Washington, DC: National Academies Press; 2011: 1–9, 31–44, 117–129.

Madhulika Agarwal, MD, MPH
Deputy Under Secretary for Health for Policy and Services
Veterans Health Administration
US Department of Veterans Affairs

Washington, DC
June 2014

Prologue

The Sergeant Thomas Joseph Sullivan Center

The Sergeant Thomas Joseph Sullivan Center is named for a Marine Corps Sergeant who served in Iraq in 2004 and who suffered from severe postdeployment illnesses of the lung, heart, and musculoskeletal and gastrointestinal systems. Sergeant Sullivan's deployment health records indicate that he had been exposed to desert dust and smoke from burning refuse and chemical plants in theater. Sergeant Sullivan died in 2009 of complications related to postdeployment illness. His family founded The Sergeant Thomas Joseph Sullivan Center in his memory to improve postdeployment health outcomes through awareness, research, and connection, especially for those with complicated illness.

According to one analysis, 20% to 35% of military service members who served in our post-9/11 wars have been exposed to environmental hazards.[1] This potentially translates to as many as 800,000 personnel. The 2012 Joint Department of Defense/Department of Veterans Affairs Airborne Hazards Symposium, on which this book is based, highlighted that airborne hazards—especially dust and smoke (or particulate matter) inhalation—are deployment health risks with potentially serious long-term health consequences. It is important that available information about airborne hazards in the Middle East theater be conveyed to healthcare providers and patients (veterans and others) so that these risk factors may inform clinical practice and patient self-management while scientific research efforts proceed.

Ongoing research on the long-term health impacts of theater airborne hazards, especially dust and smoke inhalation, may yield explanations for respiratory, cardiovascular, immunological, neurological, and other mysterious illnesses that have plagued veterans since the 1991 Persian Gulf War. Research into the role that airborne exposures may play in causing such health problems is essential (as is rapid distribution of findings), even those that are as of yet inconclusive, to educate service members, veterans, and private and public sector healthcare providers.

Such research should be conducted in an open and transparent manner, with input sought from government and non-government centers of medical and scientific excellence and from veterans themselves. Information about ongoing research and lines of investigation, as well as data and findings, must be distributed to the broader medical and scientific communities through government-funded educational initiatives.

Beneath the data, theories, and findings are individuals and families searching for answers; and, in some cases, they are struggling for their lives. The Sergeant Thomas Joseph Sullivan Center stands firm in its support of robust research on the diagnosis, treatment, and prevention of postdeployment illness, including research on airborne hazards and other deployment exposures (environmental, metal, chemical, biological, etc) and the expeditious dissemination of theories and findings to those providing and receiving postdeployment healthcare. The guiding principle for this position is a belief that greater access to information about deployment health risks by providers and patients will improve the overall quality of care and facilitate better health outcomes for veterans and service members with complicated postdeployment illness.

Reference

1. Teichman R. Health hazards of exposures during deployment to war. *J Occup Environ Med.* 2012;54:655–658.

The Sergeant Thomas Joseph Sullivan Center
Washington, DC

Burnpits 360° Advocacy Group

After more than 20 years of military service, including deployment to southwest Asia, a US Army captain was medically retired earlier this year. His life had changed significantly following his redeployment to the United States. He experienced more than 100 medical visits, including encounters with various healthcare providers, numerous visits to emergency rooms, and multiple medical examinations. Also, he experienced first-hand the frustration felt by many who have found it necessary to explain their postdeployment health concerns repeatedly in an effort to obtain diagnosis and treatment. Additional challenges faced by these warfighters include the effects of time spent away from family members and time lost from civilian jobs and other pursuits. In the end, this soldier had to give up not one, but two careers that he loved.

This veteran's story is but one example. He speaks for many warfighters in expressing how extremely vital it is for the medical community of physicians and specialists to become aware of deployment-related health hazards, such as those examined in this book. **Medical education and research should be an uppermost priority for the Department of Defense and the Department of Veterans Affairs.** The medical community, governmental medical agencies, and others who care for warfighters need to work as a team. Cohesive action must be taken to establish protocols and clinics, and to continue to build and develop relevant websites and national registries to their maximum benefit. Veterans, active duty personnel, Department of the Army/Department of Defense civilians, and contractors should be made aware of potential postdeployment medical issues and should be kept up to date on the treatment options available.

We at Burnpits 360° ask that those who use this book join us in helping the community of warfighters achieve a better quality of life. May we work together to better understand and treat all who have been exposed to deployment-related airborne hazards.

Burnpits 360°
Robstown, Texas

Adrian Atizado/Disabled American Veterans

On behalf of Disabled American Veterans, we thank all of the book's contributors for the work that they have done and will continue to do to improve the health and well-being of veterans and service members. It is our hope that the information contained herein will be useful in improving the quality of life of the men and women who were exposed to hazards while serving in the military.

There is a well-documented history not only of toxic and hazardous exposures in the military, but also of the struggle to understand their effects on troops, and the battle to care for veterans, families, and dependents.

The association between deployment-related hazards and their specific resulting conditions often remains unresolved for both the veteran and the medical and research communities. Discussion about deployment-related hazards follows a well-worn path from World War II veterans concerned about ionizing radiation to today's generation of veterans concerned about exposures to airborne and other hazards.

One of the many lessons the Disabled American Veterans has learned from past experience with airborne hazard exposures is that **useful** information regarding their presence within military operating areas must be collected by the Department of Defense, transmitted, and acted on by the Department of Veterans Affairs as early as possible. For example, registries such as the Burn Pit Registry (described in this book), if designed and implemented effectively, can serve as tools for active outreach to concerned veterans and their families. Such registries offer a pathway into the Department of Veterans Affairs healthcare system—a system that is continually learning to provide better care for hazard-exposed veterans.

It is a privilege to be included in the prologue of this important and timely publication. We hope that the valuable information it provides will greatly assist the medical and research communities in their continuing efforts on behalf of our nation's veterans, service members, and their families.

Adrian Atizado
Assistant National Legislative Director
Disabled American Veterans
Cold Spring, Kentucky

Warren Goldstein/The American Legion

The American Legion has long been at the forefront of environmental exposures that have adversely affected our nation's service members and veterans during the Vietnam War, the Gulf War, Operation Iraqi Freedom, and Operation Enduring Freedom.

Agent Orange

After Vietnam, the American Legion announced its sponsorship of an independent study on the effects of exposure to Agent Orange on Vietnam War veterans. Congress received the results of the "American Legion–Columbia University Study of Vietnam-era Veterans" in 1989, which later led to the recognition of Agent Orange benefits. We applauded Secretary Shinseki's decision in 2010 to expand Agent Orange presumptives for veterans who served in Vietnam who currently have leukemia, Parkinson's disease, and hairy cell carcinoma.

Resolution Recommendations

- The American Legion continues to advocate for veterans currently afflicted by dioxins found in herbicides.
- The American Legion vigorously supports liberalization of the rules relating to the evaluation of studies involving exposure to dioxin, and we will continue to closely monitor the development of all ongoing research on the long-term effects of Agent Orange exposure.
- More recently, The American Legion has passed resolutions at national conventions relating to Agent Orange exposure sites within US Air Force C-123K Transport Aircraft and with Blue Water Navy Vietnam veterans.

Gulf War I and Gulf War II Illnesses

After the first Gulf War, The American Legion developed a Persian Gulf War Task Force and hired national staff to evaluate the undiagnosed environmental illnesses affecting these veterans. We have continued to work with the Department of Veterans Affairs through participation in advisory committees and development of several resolutions.

Resolution Recommendations

- It has been determined that thousands of Gulf War veterans will suffer from chronic, unexplained physical symptoms. Many service members who have served in the southwest Asia theater since the 1991 Gulf War, including those serving in Operation Iraqi Freedom, have also been exhibiting chronic, unexplained physical symptoms. The American Legion will present a resolution that extends the presumptive period for service connection for Gulf War veterans with undiagnosed illness.
- There has recently been some progress in research on the long-term health effects of many of the Gulf War veterans who were potentially exposed to environmental hazards during the war, but numerous health concerns experienced by these veterans are still not well understood. Additional research into the long-term health effects of exposures is needed.
- The American Legion recommends that the Department of Veterans Affairs not select a particular date for these undiagnosed symptoms to manifest. Currently, the date for presumptive conditions to manifest is December 3, 2016.

Although we still face ongoing challenges from environmental exposures today, The American Legion has also closely followed environmental exposures with the newest generations of veterans in Iraq and Afghanistan. Most of the focus has been on burn pits both abroad and stateside, but more environmental hazards exist—thus, The American Legion's passing of its resolution on environmental exposures.

The American Legion recommends that the Department of Defense provide a full listing of all environmental toxins. The American Legion believes in treating the veteran first, funding the necessary research, and ensuring that our nation's veterans are not subject to environmental exposures in the future. The American Legion will continue to publicly support and keep abreast of the ongoing Department of Defense and Department of Veterans Affairs research related to environmental hazards and exposures due to deployment. Examples of current research that is being closely monitored are from the War Related Illness and Injury Study Center, which is currently studying the effects of deployment as it relates to cardiopulmonary function and the medically unexplained autonomic functions of Gulf War veterans.

We applaud both the Department of Defense and the Department of Veterans Affairs's work with research and policy, and for supporting the environmental health needs of our nation's veterans. We look forward to sharing our resolutions and concerns with the proper offices and working together to improve health outcomes and treatment.

Warren Goldstein
Senior Field Service Representative
The American Legion
Indianapolis, Indiana

Introduction

One of our most fundamental obligations as military medical professionals is to follow the scientific facts, wherever they may lead, regarding the health status and health risks of the men and women who serve our country. This book honors that obligation. In the following chapters, we provide the scientific community and the public with the current state of our collective scientific knowledge about the long-term health consequences of exposure to airborne hazards in a deployed military environment. For several years, federal, academic, and private sector experts have explored one of the more complex scientific issues facing deployed service members: understanding the health risks from airborne particulates, including burn pit smoke in our deployments to Iraq and Afghanistan.

In October 2011, the Institute of Medicine (IOM), a prestigious and independent medical organization, released its report, *Long-Term Health Consequences of Exposure to Burn Pits in Iraq and Afghanistan*,[1] which examined the relationship of burn pit emissions and other possible airborne exposures to the health of the deployed force. Using measurements of airborne particulate matter, metals, volatile organic compounds, polycyclic aromatic hydrocarbons, dioxins, and furans, the IOM assessed possible exposures to burn pit emissions at Joint Base Balad, in Iraq, and possible health effects associated with those exposures.

Joint Base Balad had arguably the largest burn pit in the entire Iraq/Afghanistan theater. Still, most pollutants detected at Joint Base Balad were found at concentrations below those typical of urban areas outside of the United States and below US health-based reference values considered to be protective of the general population. Nonetheless, background levels of airborne particulate matter (PM) were measured well above US air pollution standards. The IOM noted increased respiratory and cardiovascular morbidity and mortality detected in many studies of other populations exposed to elevated PM levels. The IOM attributed the high PM levels at Joint Base Balad mostly to local and regional sources other than the burn pit emissions, and concluded that if any long-term health risks were associated with deployment to Iraq or Afghanistan, they most likely would be associated with high concentrations of airborne particulates rather than burn pit emissions. Information on health effects resulting from exposures to combinations of substances emitted from the burn pits was unavailable. In the end, the IOM's findings were inconclusive. More study is needed.

In response to the various challenges highlighted in the IOM report, the US Department of Defense (DoD) and the US Department of Veterans Affairs (VA) undertook a series of collaborative steps:

- We drafted an interagency Airborne Hazards Joint Action Plan to map out our objectives for the future. We will continue to address comprehensively the concerns about health effects of burn pit emissions and airborne particulates in theater, and enhance the follow-up medical care for all of our deployed populations at risk from possible airborne hazards.
- We asked the Defense Health Board, comprised of independent subject matter experts, to assess clinical protocols used in diagnosing symptomatic individuals who may have respiratory conditions related to deployment; determine how to establish clinical respiratory function baselines in future deployments; and recommend the types of registries we should consider establishing for tracking individuals with pulmonary symptoms or disease. We asked the Defense Health Board to help guide our research agenda by recommending future research for the DoD to address deployment-related pulmonary disease.

- We hosted the first-ever Joint DoD/VA Airborne Hazards Symposium in August 2012. It convened to help us better understand the possible health effects associated with a variety of inhalational exposures experienced by our military service members and veterans who deployed to Iraq and Afghanistan.

Airborne Hazards Related to Deployment captures the scientific information presented at that symposium. The chapters in this volume provide important background information, the past and present efforts in research and epidemiology, the clinical challenges, and the outreach and research initiatives for the future. I am confident that the scientific community will find them useful and informative.

The issues presented and discussed at this symposium are of great importance to many—our military community, veterans, deploying civilians, family members, contractors, the media, and our elected officials. All are interested in clarifying the long-term health consequences of military deployments, including the exposures to airborne substances in the current conflicts.

Over the last 10 years, the military public health community has overseen and achieved a remarkable outcome—the lowest disease and nonbattle injury rate ever recorded in warfare, despite our presence in some of the most inhospitable places on earth. Notwithstanding that success, our work is far from done. We will continue our efforts to reduce possible health effects of deployments that may not be detected until long after the deployment is over.

I thank everyone who took part in this symposium, whether as an invited speaker or as a participant in the discussions. We have a deep public, moral, and personal obligation to ensure that those who protect this nation are, in turn, protected. I am proud of the contributions of so many experts to advance the knowledge we have in support of these obligations and in support of the broader global health community.

Reference

1. Institute of Medicine of the National Academies. *Long-Term Health Consequences of Exposure to Burn Pits in Iraq and Afghanistan*. Washington, DC: National Academies Press; 2011: 1–9, 31–44, 117–129.

Karen S. Guice, MD, MPP
Principal Deputy
Office of the Assistant Secretary of Defense
Washington, DC