
CARE OF THE COMBAT AMPUTEE



The Coat of Arms
1818
Medical Department of the Army

A 1976 etching by Vassil Ekimov of an original color print that appeared in *The Military Surgeon*, Vol XLI, No 2, 1917

This book is dedicated to the men and women of the armed forces who have been injured in their service to the United States, and to the men and women of the Department of Defense, Department of Veterans Affairs, and the civilian sector who have met the challenge to provide these heroes and their families with the highest quality of care, promoting unprecedented functional recovery and full participation in society.

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Editor in Chief

Martha K. Lenhart, MD, PhD

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Assistant Professor of Surgery

F. Edward Hébert School of Medicine

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US Army World Class Athlete Program Paralympic sprinter hopeful Sergeant Jerrod Fields, seen here working out at the US Olympic Training Center in Chula Vista, California, won the 100 meters with a time of 12.15 seconds at the 2009 Endeavor Games in Edmond, Oklahoma, on June 13.

Photograph by Tim Hipps, US Army Family and Morale, Welfare and Recreation Public Affairs.

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Senior Editors

PAUL F. PASQUINA, MD
Colonel, MC, US Army

*Chair, Integrated Department of Orthopaedics and Rehabilitation
Walter Reed Army Medical Center and National Naval Medical Center*

and

RORY A. COOPER, PhD
*Senior Career Scientist
US Department of Veterans Affairs
Distinguished Professor
University of Pittsburgh*

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

*Borden Institute
Walter Reed Army Medical Center
Washington, DC*

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Editorial Staff: Joan Redding
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Contributors

JULIE A. AKE, MD, MSC

Captain, Medical Corps, US Army; Infectious Diseases Fellow, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307; formerly, Chief of Medical Residents, Department of Medicine, Madigan Army Medical Center, Tacoma, Washington

MARK R. BAGG, MD

Chairman, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234

BRIAN BELNAP, DO

Major, Medical Corps, US Army; Medical Director, Amputee Program, Comprehensive Combat and Complex Casualty Care, Naval Medical Center, 34800 Bob Wilson Drive, San Diego, California 92134

KENDRA BETZ, MSPT, ATP

SCI Clinical Specialist, Veterans Health Administration, Prosthetic & Sensory Aids (113), 810 Vermont Avenue, NW, Washington, DC 20006

ANDREE BOUTERIE, MD

Staff Psychiatrist, Psychiatry Consultation Liaison Service, Department of Psychiatry, Department of Psychiatry, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Building 2, Room 6237, Washington, DC 20307

JOHN C. BRADLEY, MD

Colonel, Medical Corps, US Army; Chief, Department of Psychiatry, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Building 2, Room 6237, Washington DC, 20307

FRANK BRASILE, PhD

Professor, University of Nebraska, 6001 Dodge Street, Omaha, Nebraska 68182

STEPHEN P. BURNS, MD

Staff Physician, VA Puget Sound Health Care System, SCI (128), 1660 South Columbian Way, Seattle, Washington 98108; Associate Professor, Department of Rehabilitation Medicine, University of Washington, 1959 NE Pacific, Seattle, Washington 98195

CHARLOTTE CARNEIRO, RN, MS, COHN-S, CIC

Infection Control Nurse Specialist, Department of Infection Control and Epidemiology, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307; formerly, Nurse Manager, Occupational Health, Marriott Wardman Park Hotel, 2660 Woodley Road, NW, Washington, DC

JAMES C. CASEY, MOT, OTR/L

Occupational Therapist, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

BRENDA L. CHAN

Research Analyst, CompTIA, 1815 South Meyers Road, Suite 300, Villa Park, Illinois 60181; Formerly, Research Assistant, Department of Physical Medicine and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

KEVIN K. CHUNG, MD

Major, US Army, Medical Corps; Medical Intensivist, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

VINCENT T. CODISPOTI, MD

Captain, Medical Corps, US Army; Resident Physician, Department of Physical Medicine and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

JENNIFER COLLINGER, BSE

Bioengineer, Department of Physical Medicine and Rehabilitation, University of Pittsburgh, Human Engineering Research Laboratories, 7180 Highland Drive, Building 4, Floor 2, 151R1-H, Pittsburgh, Pennsylvania 15206; formerly, Graduate Student Fellow, Bioengineering, University of Pittsburgh, Pittsburgh, Pennsylvania

JOHN J. COLTELLARO, MS, ATP

Clinical Instructor, Department of Rehabilitation Science and Technology, University of Pittsburgh Center for Assistive Technology, Forbes Tower, Suite 3010, 3600 Forbes Avenue, Pittsburgh, Pennsylvania 15213

DAN CONYERS, CPO

Upper Extremity Specialist, Advanced Arm Dynamics Incorporated, 10195 SW Egret Place, Beaverton, Oregon 97007

RORY A. COOPER, PhD

Senior Career Scientist, US Department of Veterans Affairs, and Distinguished Professor, Department of Rehabilitation Science and Technology, University of Pittsburgh, 5044 Forbes Tower, Pittsburgh, Pennsylvania 15260

ROSEMARIE COOPER, MPT, ATP

Assistant Professor, Department of Rehabilitation Science and Technology, University of Pittsburgh, Center for Assistive Technology, Forbes Tower, Suite 3010, 3600 Forbes Avenue, Pittsburgh, Pennsylvania 15213

MICAELA CORNIS-POP, PhD

Rehabilitation Planning Specialist, VA Central Office, 810 Vermont Avenue, NW, Washington, DC 20420

MICHAEL DEMARCO, DO

Major, Medical Corps, US Army; Director of Electrodiagnostic Medicine, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

PETER A. DESOCIO, DO

Captain, US Army, Medical Corps; Anesthesiologist, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

ERIC DESSAIN, MD

Lieutenant Colonel, Medical Corps, US Army; Physician, Chief, Physical Disability Evaluation Service, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

WILLIAM S. DEWEY, PT, CHT, OCS

Occupational Therapist, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

BRAD DICIANNO, MD

Assistant Professor, Human Engineering and Research Labs, VA Pittsburgh Healthcare System, 7180 Highland Drive, 151R1-H, Building 4, 2nd Floor East, Pittsburgh, Pennsylvania 15260

WILLIAM C. DOUKAS, MD

Colonel (Retired), Medical Corps, US Army; Chairman, Integrated Department of Orthopaedics and Rehabilitation, National Naval Medical Center and Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

JAIME L. DROOK, OTR/L

Occupational Therapist, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

CHRISTOPHER EBNER, MS, OTR/L

Occupational Therapist, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, Center for the Intrepid, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234; formerly, Occupational Therapist, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, Fort Sam Houston, Texas

ALBERT ESQUENAZI, MD

Chair, Physical Medicine and Rehabilitation, Chief Medical Officer, MossRehab/Einstein at Elkins Park, 60 East Township Line Road, Elkins Park, Pennsylvania 19027

STEPHEN A. FAUSTI, PhD

Director, National Center for Rehabilitative Auditory Research, Portland VA Medical Center, 3710 SW US Veterans Hospital Road, Portland, Oregon 97207; Professor, Department of Otolaryngology, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Portland, Oregon 97239

JOHN R. FERGASON, CPO

Chief Prosthetist, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234

JAMES R. FICKE, MD

Colonel, Medical Corps, US Army; Chairman, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234

STEVEN V. FISHER, MD

Chief, Department of Physical Medicine and Rehabilitation, Hennepin County Medical Center, Minneapolis, MN 55415; Associate Professor, Department of Physical Medicine and Rehabilitation, University of Minnesota Medical School

KEVIN F. FITZPATRICK, MD, CPT

Major, Medical Corps, US Army; Psychiatrist, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

JONATHAN A. FORSBERG, MD

Lieutenant Commander, Medical Corps, US Navy; Orthopaedic Surgeon, Department of Orthopaedic Surgery, National Naval Medical Center, 8901 Wisconsin Avenue, Bethesda, Maryland 20889

PAUL FOWLER, DO, JD

Senior Medical Evaluation Board Disability Advisor; Physician-Attorney, Command Group, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

ALLISON FRANKLIN, DO

Captain, Medical Corps, US Army; Director of Inpatient Rehabilitation, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307; formerly, Resident, Department of Physical Medicine and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

LOUIS M. FRENCH, PsyD

Director, TBI Program, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, Military Advanced Training Center, 6900 Georgia Avenue, NW, Washington, DC 20307, and Assistant Professor of Neurology, Uniformed Services University of the Health Sciences, 4301 Jones Bridge Road, Bethesda, Maryland 20814

ROBERT S. GAILEY, PhD, PT

Director, Functional Outcomes Research and Evaluation Laboratory, Miami Veterans Affairs Healthcare System, 1201 NW 16th Street, Miami, Florida 33125, and Associate Professor, Department of Physical Therapy, University of Miami Miller School of Medicine, 5915 Ponce de Leon Boulevard, Plumer Building, Coral Gables, Florida 33146

FREDERICK J. GALLUN, PhD

Research Investigator, National Center for Rehabilitative Auditory Research, Portland VA Medical Center, 3710 SW US Veterans Hospital Road, Portland, Oregon 97207; Assistant Professor, Department of Otolaryngology, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Portland, Oregon 97239

JEFF GAMBEL, MD

Colonel, Medical Corps, US Army; Physician, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

OREN GANZ, MOT, OTR/L

Occupational Therapist, Department of Orthopaedics and Rehabilitation/Occupational Therapy Services, Amputee Section, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

BRANDON J. GOFF, DO

Major, Medical Corps, US Army; Assistant Chief, Amputee Service, Integrated Department of Orthopaedics and Rehabilitation, National Naval Medical Center, 8901 Rockville Pike, Bethesda, Maryland 20889 and Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307; formerly, Director of Inpatient Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

BARRY GOLDSTEIN, MD, PhD

Associate Chief Consultant, Spinal Cord Injury/Disorders Services, Department of Veterans Affairs; VA Puget Sound Health Care System, SCI (128N), 1660 South Columbian Way, Seattle, Washington 98108; Professor, Department of Rehabilitation Medicine, 1959 NE Pacific, Seattle, Washington 98195

ROBERT R. GRANVILLE, MD

Colonel, Medical Corps, US Army; Orthopaedic Surgeon, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234; formerly, Director of Amputee Service, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas

GARTH T. GREENWELL, DO

Captain, Medical Corps, US Army; Staff Physiatrist, Department of Physical Medicine and Rehabilitation Services, MCHK-PT, Tripler Army Medical Center, One Jarrett White Road, Tripler Army Medical Center, Hawaii 96859; formerly, Resident, Department of Physical Medicine, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

GARRETT G. GRINDLE, MS

Research Associate, Department of Rehabilitation Science and Technology, University of Pittsburgh, Human Engineering and Research Labs, 7180 Highland Drive, Building 4, Second Floor East Wing 151R7-H, Pittsburgh, Pennsylvania 15206

KRISTIN GULICK, OTR/L, BS, CHT

Occupational Therapist; formerly, Director of Therapy Services, Advanced Arm Dynamics, 123 West Torrance Boulevard, Suite 203, Redondo Beach, California 90277

MARGARET C. HAMMOND, MD

Chief Consultant, Spinal Cord Injury/Disorders Services, Department of Veterans Affairs; Chief, Spinal Cord Injury Service, VA Puget Sound Health Care System, SCI (128N), 1660 South Columbian Way, Seattle, Washington 98108; Professor, Department of Rehabilitation Medicine, University of Washington, 1959 NE Pacific, Seattle, Washington 98195

PETER D. HARSCH, CP

Chief Prosthetist, C5 Combat Care Center Prosthetics, Navy Medical Center, 34800 Bob Wilson Drive, Building 3, San Diego, California 92134

JOSHUA D. HARTZELL, MD

Captain, Medical Corps, US Army; Infectious Diseases Fellow, Department of Medicine, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307; formerly, Chief of Medical Residents, Department of Medicine, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

ALAN J. HAWK

Collections Manager, Historical Collections, National Museum of Health and Medicine, Armed Forces Institute of Pathology, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20306

ROMAN A. HAYDA, MD

Colonel, Medical Corps, US Army; Chief Orthopaedic Trauma, Residence Program Director, Department of Orthopaedic Surgery, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234

TRAVIS L. HEDMAN, PT

Captain, US Army, Medical Corps; Chief, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

CHRISTINE HEINER, BA

Communications Specialist, Human Engineering Research Laboratories, VA Pittsburgh Healthcare System/University of Pittsburgh, 7180 Highland Drive, 151RI-HD, Building 4, 2nd Floor East, Pittsburgh, Pennsylvania 15206

SANDRA L. HUBBARD WINKLER, PhD

Research Health Scientist, Rehabilitation Outcome Research Center Research Enhancement Award Program, Malcolm Randall VA Medical Center, 1601 SW Archer Road, 151-B, Gainesville, Florida 32608, and Assistant Professor, Department of Occupational Therapy, University of Florida, College of Public Health and Health Professions, PO Box 100164, Gainesville, Florida 32610; formerly, Research Associate, Predoctoral Fellow, Department of Rehabilitation Science and Technology, University of Pittsburgh, 5044 Forbes Tower, Pittsburgh, Pennsylvania

BRADLEY IMPINK, BSE

Predocctoral Fellow, Human Engineering Research Laboratories, VA Pittsburgh Healthcare System, 7180 Highland Drive, 151R1-H, Building 4, 2nd Floor East, Pittsburgh, Pennsylvania 15206; formerly, Graduate Student Researcher, Department of Bioengineering, University of Pittsburgh, Pittsburgh, Pennsylvania

AENEAS JANZE, MD

Captain, Medical Corps, US Army; Resident Physician, Department of Physical Medicine and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

MELISSA JONES, PhD, OTR/L

Lieutenant Colonel (Retired), Medical Specialist Corps, US Army; formerly, Research Coordinator, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

SUSAN KAPP, MED, CPO, LPO

Associate Professor and Director, Prosthetic and Orthotic Program, University of Texas Southwestern Medical Center at Dallas, 5323 Harry Hines Boulevard, Suite V5.400, Dallas, Texas 75390

AMOL KARMARKAR, MS

Research Associate, Human Engineering Research Laboratories, VA Pittsburgh Healthcare System/University of Pittsburgh, 7180 Highland Drive, 151RI-H, Building 4, 2nd Floor East, Pittsburgh, Pennsylvania 15206; formerly, Research Assistant, Department of Rehabilitation Science, State University of New York at Buffalo, Buffalo, New York

JOHN J. KEELING, MD

Commander, Medical Corps, US Navy; Director, Orthopaedic Trauma and Foot and Ankle Division, Department of Orthopaedics, National Military Medical Center, Walter Reed National Military Medical Center, 8901 Rockville Pike, Bethesda, Maryland 20899

NICOLE M. KEESEE, MS

Colonel, US Army; Office of The Surgeon General/Veterans Affairs Central Office Seamless Transition Office, 810 Vermont Avenue, NW, VACO 10D1, Washington, DC 20420

KEVIN K. KING, DO

Major, Medical Corps, US Army; Resident Anesthesiologist, Department of Anesthesiology, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234

ANDY KRIEGER

Director, Department of Sports and Recreation, Paralyzed Veterans of America, 801 18th Street, NW, Washington, DC 20006; formerly, Adapted Athletic Specialist, Wright State University, 3640 Colonel Glenn Highway, Dayton, Ohio

TODD KUIKEN, MD, PhD

Director of Amputee Services, Department of Physical Medicine and Rehabilitation, Rehabilitation Institute of Chicago, Room 1309, 345 East Superior Street, Chicago, Illinois 60611

SCOTT KULLA, MS, OTR

Captain, Medical Specialist Corps, US Army; Chief, Department of Occupational Therapy, HHC 121 Combat Support Hospital, Box 238, APO AP 96205; formerly, Chief, Amputee Services, Department of Occupational Therapy, Center for the Intrepid, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas

WILLIAM LAKE

Colonel (Retired), US Marine Corps; Associate, Department of IT Strategy, Booz Allen Hamilton Incorporated, 4040 North Fairfax Drive, Arlington, Virginia 22203

MacJULIAN LANG, CPO

Clinical Specialist, Advanced Arm Dynamics, 123 West Torrance Boulevard, Suite 203, Redondo Beach, California 90277

NICOLE J. LEHNERZ, OTR/L

Occupational Therapist, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

M. SAMANTHA LEWIS, PhD

Research Investigator, National Center for Rehabilitative Auditory Research, Portland VA Medical Center, 3710 SW US Veterans Hospital Road, Portland, Oregon 97207; Assistant Professor, Department of Otolaryngology, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Portland, Oregon 97239

JAMES W. LITTLE, MD, PhD

Assistant Chief, VA Puget Sound Health Care System, SCI (128), 1660 South Columbian Way, Seattle, Washington 98108; Professor, Department of Rehabilitation Medicine, University of Washington, 1959 NE Pacific, Seattle, Washington 98195

CHRISTOPHER V. MAANI, MD

Major, US Army, Medical Corps; Chief, Anesthesiology, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

JAMES M. MACAULAY

Chief of Vocational Rehabilitation, Department of Physical Medicine and Rehabilitation Services, James A. Haley Veterans' Hospital, 13000 Bruce B. Downs Boulevard, Tampa, Florida 33612; formerly, Vocational Rehabilitation Specialist, James A. Haley Veterans' Hospital, 13000 Bruce B. Downs Boulevard, Tampa, Florida

RANDALL J. MALCHOW, MD

Colonel, Medical Corps, US Army; Chief, Regional Anesthesia and Acute Pain Management, Department of Anesthesia and Operative Services, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234; formerly, Chief of Anesthesia, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas, and Program Director, Anesthesiology, Brooke Army Medical Center-Wilford Hall Medical Center, Fort Sam Houston, Texas

RAUL MARIN, MD

Colonel (Retired), Medical Corps, US Army; Physician, Center for the Intrepid, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234; formerly, Medical Director, GaitLab, Physical Medicine and Rehabilitation Teaching Staff, and Chair, Internal Review Board, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

LUIS J. MARTINEZ, MD

Major, Medical Corps, US Army; Infectious Diseases Fellow, Infectious Diseases Clinic, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

MARIA MAYORGA, MD

Colonel (Retired), Medical Corps, US Army; Physician, Past Chief, Physical Disability Evaluation Service, Walter Reed Army Medical Center; Currently, PhD Candidate, Sweden

CAIBRE McCANN, MD

Physiatrist-in-Chief (Retired), Department of Rehabilitation Medicine, Maine Medical Center, Portland, Maine

THANE D. McCANN, MD

Major, Medical Corps, US Army; Staff Physiatrist, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, Center for the Intrepid, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234; formerly, Resident Physician, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

MICHAEL McCUE, PhD

Associate Professor, Department of Rehabilitation Science and Technology, University of Pittsburgh, 5050 Forbes Tower, Pittsburgh, Pennsylvania 15260

SHANE McNAMEE, MD

Medical Director, Polytrauma, Assistant Professor, Department of Physical Medicine and Rehabilitation, Virginia Commonwealth University, 1201 Broadrock Boulevard, Richmond, Virginia 23249

JOHN MIGUELEZ, CP, FAAOP

President and Senior Clinical Director, Advanced Arm Dynamics, 123 West Torrance Boulevard, Suite 203, Redondo Beach, California 90277

JOSEPH A. MILLER, MS, CP, CPT

Captain, Medical Service Corps, US Army; Chief Prosthetic and Orthotic Service, Integrated Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Building 2, RM3H, Washington, DC 20307, and the National Naval Medical Center, 8901 Rockville Pike, Bethesda, Maryland 20889; formerly, Deputy Chief, Prosthetic and Sensory Aids Service, Department of Veterans Affairs, Central Office, 50 Irving Street, NW, Washington, DC 20422

RUPAL M. MODY, MD

Captain, Medical Corps, US Army; Physician, Department of Infectious Diseases, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

ALFREDO E. MONTALVO, MSN, BSN, APN

Lieutenant Colonel, US Army, Medical Corps; Psychiatric Clinical Nurse Specialist, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

MARIA MOURATIDIS, PsyD

Command Consultant and Subject Matter Expert for Traumatic Brain Injury and Psychological Health, National Naval Medical Center, 8901 Wisconsin Avenue, Bethesda, Maryland 20889

PAULA J. MYERS, PhD

Chief, Audiology Section, Department of Audiology and Speech Pathology, James A. Haley Veterans Hospital, 13000 Bruce B. Downs Boulevard, Tampa, Florida 33612; formerly, Pediatric Audiologist, All Children's Hospital, St. Petersburg, Florida

MARVIN OLESHANSKY, MD

Staff Psychiatrist, Department of Psychiatry, Tripler Army Medical Center, 1 Jarrett Hite Road, Honolulu, Hawaii 96859

PAUL F. PASQUINA, MD

Colonel, Medical Corps, US Army; Chair, Integrated Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center and National Naval Medical Center, Section 3J, 6900 Georgia Avenue, NW, Washington, DC 20307

CINDY E. POORMAN, MS

Rehabilitation Planning Specialist, Department of Veterans Affairs, Denver Veterans Affairs MVA Central Office, US Department of Veterans Affairs, 810 Vermont Avenue, NW, Washington, DC 20420

BENJAMIN K. POTTER, MD

Major, Medical Corps, US Army; Musculoskeletal Oncology Fellow, Department of Orthopaedics and Rehabilitation, University of Miami School of Medicine, (D-27), PO Box 016960, Miami, Florida 33101; formerly, Chief Resident, Integrated Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, Washington, DC

MICHAEL PRAMUKA, PhD

Assistant Professor, Department of Rehabilitation Science and Technology, University of Pittsburgh, 5044 Forbes Tower-Atwood, Pittsburgh, Pennsylvania 15260; formerly, Neuropsychologist, Henry M. Jackson Foundation/San Diego Naval Medical Center, 34800 Bob Wilson Drive, San Diego, California

CHARLES D. QUICK OTR/L

Major, US Army, Medical Corps; Chief, Occupational Therapy Service, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

ROBERT RADO CY, MSC

Chief Executive Officer and President, TRS Incorporated, 3090 Sterling Circle, Studio A, Boulder, Colorado 80301

EVAN M. RENZ, MD

Lieutenant Colonel, US Army, Medical Corps; Director, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

JEFFREY S. REZNICK, PhD

Director, Institute for the Study of Occupation and Health, American Occupational Therapy Foundation, 4720 Montgomery Lane, Bethesda, Maryland 20824

ANDREW RHODES, DO

Captain, Medical Corps, US Army; Physician, Medical Evaluation Board, Physical Disability Evaluation Service, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

REGINALD L. RICHARD, MS, PT

Clinical Research Coordinator, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

ELIZABETH A. RIVERS, OTR, RN

Burn Rehabilitation Specialist (Retired), Burn Center, Regions Hospital, formerly known as St. Paul Ramsey Medical Center, 640 Jackson Street, Saint Paul, Minnesota 55101

MATTHEW SCHERER, PT, MPT, NCS

Captain, Medical Specialist Corps, US Army; Doctoral Student, Department of Rehabilitation Science, University of Maryland at Baltimore, 111 South Greene Street, Baltimore, Maryland 21212; formerly, Amputee Physical Therapy Section Chief, Physical Therapy Service, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

CHARLES R. SCOVILLE, DPT

Colonel (Retired), Medical Service Corps, US Army; Chief, Integrated Amputee Service, Walter Reed Army Medical Center, 6900 Georgia Avenue NW, Washington, DC 20307

JONATHAN SENSINGER, PhD

Assistant Research Professor, Neural Engineering Center for Artificial Limbs, Rehabilitation Institute of Chicago, Room 1309, 345 East Superior Street, Chicago, Illinois 60611

SCOTT B. SHAWEN, MD

Lieutenant Colonel, Medical Corps, US Army; Orthopaedic Surgeon, Integrated Department of Orthopaedics and Rehabilitation, National Naval Medical Center/Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

BETH A. SHIELDS, RD, LD, CNSD, MS

Dietitian, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

JOSEPH A. SHROUT, MD

Lieutenant Colonel (P), Medical Corps, US Army; Orthopaedic Hand Surgeon, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, Building 2, 6900 Georgia Avenue, NW, Washington, DC 20307; formerly, Chief, Department of Surgery and Special Care, Kimbrough Ambulatory Care Center, Fort George Meade, Maryland

BARBARA SIGFORD, MD

National Director, Physical Medicine, and Rehabilitation Service, VA Central Office, 810 Vermont Avenue, NW, Washington, DC 20420

DOUGLAS G. SMITH, MD

Professor of Orthopaedic Surgery, Department of Orthopaedic Surgery, University of Washington, Harborview Medical Center, 325 Ninth Avenue, Seattle, Washington 98104

MELISSA Z. SMITH, MOT, OTR/L

Occupational Therapist, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

LISA M. SMURR, MS, OTR/L, CHT

Major, Medical Specialist Corps, US Army; Assistant Chief of Occupational Therapy, Brooke Army Medical Center and Officer in Charge of Occupational Therapy, Center for the Intrepid, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234; formerly, Chief of Occupational Therapy, Orthopaedic Podiatry, Schofield Barracks Health Clinic, Tripler Army Medical Center, 1 Jarrett White Road, Tripler Army Medical Center, Hawaii

MICHELLE L. SPORNER, MS, CRC

Research Assistant, Human Engineering Research Laboratories, VA Pittsburgh Healthcare System/University of Pittsburgh, 7180 Highland Drive, Building 4, 2nd Floor, 151R1-H, Pittsburgh, Pennsylvania 15206

BARBARA A. SPRINGER, PhD, PT, OCS, SCS

Colonel, Medical Specialist Corps, US Army; Director, Propency Office for Rehabilitation & Reintegration, Office of The Surgeon General, Falls Church, Virginia 22041; formerly, Chief, Integrated Physical Therapy Service, National Naval Medical Center, 8901 Rockville Pike, Bethesda, Maryland, and Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

GRETCHEN STEPHENS, MPA

Polytrauma/TBI Coordinator, VA Central Office, 810 Vermont Avenue, NW, Washington, DC 20420

STEVEN STIENS, MD

Staff Physician, VA Puget Sound Health Care System, SCI (128), 1660 South Columbian Way, Seattle, Washington 98108; Associate Professor, Department of Rehabilitation Medicine, University of Washington, 1959 NE Pacific, Seattle, Washington 98195

JELENA SVIRCEV, MD

Staff Physician, Department of Veterans Affairs, Puget Sound Health Care System, 1660 South Columbian Way, SCI 128, Seattle, Washington 98108; Acting Instructor, Department of Rehabilitation Medicine, University of Washington, 1959 NE Pacific, Seattle, Washington 98195

CHARLES K. THOMPSON, PA-C

Physician Assistant, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

RICHARD F. TROTTA, MD

Colonel, Medical Corps, US Army; Assistant Chief, Infectious Disease Service, Department of Internal Medicine, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

JACK W. TSAO, MD, DPHIL

Commander, Medical Corps, US Navy; Associate Professor, Department of Neurology, Uniformed Services University of the Health Sciences, 4301 Jones Bridge Road, Room A1036, Bethesda, Maryland 20814; Traumatic Brain Injury Consultant, US Navy Bureau of Medicine and Surgery, 2300 E Street, NW, Washington DC

HAROLD J. WAIN, PhD

Chief, Psychiatry Consultation Liaison Service, Department of Psychiatry, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Building 2, Room 6238, Washington, DC, 20307

PAIGE E. WATERMAN, MD

Major, Medical Corps, US Army; Infectious Disease Fellow, Department of Medicine, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307

SHARON R. WEEKS

Research Assistant, Physical Medicine and Rehabilitation, Walter Reed Army Medical Center, 6900 Georgia Avenue NW, Washington, DC 20307

ALICIA F. WHITE, PT, DPT

Physical Therapist, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

JASON M. WILKEN, PhD, PT

Director, Military Performance Laboratory, Department of Orthopaedics and Rehabilitation, Center for the Intrepid, Brooke Army Medical Center, 3851 Roger Brooke Drive, Fort Sam Houston, Texas 78234

JAMES F. WILLIAMS, PA-C, MPAS

Physician Assistant, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

DEBRA J. WILMINGTON, PhD

Research Investigator, National Center for Rehabilitative Auditory Research, Portland VA Medical Center, 3710 SW US Veterans Hospital Road, Portland, Oregon 97207; Assistant Professor, Department of Otolaryngology, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Portland, Oregon 97239

ERIK J. WOLF, PhD

Research Engineer, Department of Physical Medicine and Rehabilitation, Walter Reed Army Medical Center, Building 2A, Room 146, 6900 Georgia Avenue, NW, Washington, DC 20307

ROBERT N. WOOD-MORRIS, MD

Major, Medical Corps, US Army; Infectious Disease Fellow, Department of Infectious Diseases, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC 20307; formerly, Chief of Medicine, Wurzburg Medical Center, Wurzburg, Germany

KATHLEEN YANCOSCK, MS, OTR/L, CHT

Major, Medical Specialist Corps, US Army; Graduate Student, Department of Rehabilitation Science, University of Kentucky, 923 Forest Lake Drive, Lexington, Kentucky 40515; formerly, Chief of Amputee Section of Occupational Therapy Service, Walter Reed Army Medical Center, 6900 Georgia Avenue, NW, Washington, DC

ALAN W. YOUNG, DO

Physiatrist, Burn Rehabilitation Department, US Army Burn Center, US Army Institute of Surgical Research, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, Texas 78234

GEORGE ZITNAY, PhD

Founder and Director, Defense and Veterans Brain Injury Center –Laurel Highlands, 727 Goucher Street, Johnstown, Pennsylvania 15905

Foreword

Our country's Warriors—Soldiers, Sailors, Airmen, and Marines—who are wounded or injured as a consequence of their service deserve the highest quality care available. The leadership of the Department of Defense and of the Army have firmly declared that aside from fighting and winning our current conflict, the comprehensive, state-of-the-art care of our wounded, ill, and injured Warriors is the most important mission of the US Military. Despite more destructive weapons and horrific wounds, the men and women of Military Medicine, as a whole, have continuously adapted to changing requirements and have developed comprehensive rehabilitative methods. This approach, combined with the goal of restoring our wounded service members to the highest possible functional level, is resulting in the optimal reintegration of our wounded Warriors and the best opportunity for return to uniformed service and/or productive civilian life. For example, even as this textbook goes to print, elements of the US Army Medical Command in its Warrior Transition Command are developing tools and processes ("Comprehensive Transition Plans") for tailoring this optimal reintegration for all Soldiers.

Today, service members with amputations receive rapidly progressive rehabilitation. To enhance recovery—and in some respect recapturing lessons learned from rehabilitative care in prior conflicts—three designated military facilities across the continental United States—Walter Reed Army Medical Center in Washington, DC; Brooke Army Medical Center in San Antonio, Texas; and Balboa Naval Medical Center in San Diego, California—maintain multidisciplinary teams of highly trained professionals, each contributing to a decisive continuum of care from the earliest phases of recovery and healing to reintegration into military or civilian life. Comprised of experts from more than a dozen specialties, these teams work together in addressing the rehabilitative, social, family, vocational, and spiritual needs of our service members, while simultaneously incorporating leading-edge technology, innovative research, and collaboration with Department of Veterans Affairs and civilian institutions. Excellent outcomes are being achieved, and the lessons learned from this young, athletic population are providing significant contributions to the healthcare of other service members, as well as civilians with major limb amputations.

More than a decade has elapsed since the previous *Textbook of Military Medicine* specifically addressed rehabilitative aspects of war injuries. It is fitting that knowledge of the evolution and application of our current approach to rehabilitation for the combat amputee—a collaborative and integrated team approach—be recorded in this latest volume of the series. The publication of this textbook, *Care of the Combat Amputee*, will serve as a valuable reference for healthcare practitioners in and out of uniform and will further facilitate establishment of best practices in the multidisciplinary spectrum of amputee care.

Accomplished through collaboration among the armed services, the VA, and the civilian sector with a common goal of achieving preeminent medical treatment, comprehensive training, and cutting-edge research, this volume will serve as a milestone in a long tradition of patient care. The book was completed through the tireless efforts of the authors, guided by the exceptional leadership of Colonel Paul F Pasquina, MD, and Rory A Cooper, PhD; the dedicated staff of the Borden Institute; and the Pittsburgh VA Rehabilitation Research and Development Center team, on behalf of service members, veterans, and their families. It is a tribute to the dedication of the men and women who serve our nation and to those who care for our wounded Warriors.

Lieutenant General Eric B. Schoomaker, MD, PhD
The Surgeon General and
Commanding General, US Army Medical Command

Washington, DC
November 2009

Preface

The Department of Veterans Affairs (VA) succeeded the Veterans Administration in 1989. VA operates the nation's largest integrated healthcare system, providing a broad spectrum of medical, surgical, and rehabilitative care. VA's vocational rehabilitation and employment programs help veterans with service-connected disabilities achieve maximum independence in daily living, and, to the greatest extent feasible, obtain and maintain employment. Additionally, VA manages the largest medical education and health professions training program in the United States, and VA research has earned an international reputation for excellence in areas such as aging, chronic disease, assistive devices, and mental health. Studies conducted within VA help improve medical care not only for veterans but also for the nation at large. Because 7 in 10 VA researchers are also clinicians, VA is uniquely positioned to translate research results into improved patient care. About 60% of VA employees are veterans, and more than 24% of these are disabled. Three hold the Medal of Honor.

Advances in body armor and battlefield medical care have helped to prevent damage to vital organs and stem blood loss, saving lives of service members injured in Iraq and Afghanistan. At the same time, increasing numbers of service members are experiencing traumatic injuries to their extremities that can result in amputation, followed by the fitting of a prosthetic limb and assistive devices. To meet the challenge of providing the best care possible to veterans with limb amputations at this critical time and for the remainder of their lives, VA and DoD have collaborated at unprecedented levels, as well as working with leading clinicians, prosthetists, and bioengineers from academia and industry.

A central theme of VA–DoD collaboration is the team approach to prosthetics care—in particular, engineers working closely with clinicians to ensure that devices are designed to fit the needs of veterans. Colonel Paul F Pasquina, MD, MC, USA, chair of the Integrated Department of Orthopaedics and Rehabilitation of Walter Reed Army Medical Center and National Naval Medical Center, and Rory A Cooper, PhD, director of the VA Rehabilitation Research & Development Center in Pittsburgh, have assembled experts throughout the diverse range of disciplines that work together to care for military and veteran amputees, from battlefield evacuation and surgery through therapy, rehabilitation, and community reintegration, to create this seminal work in the annals of military and VA medicine. Doctors Pasquina and Cooper are to be commended for their dedication to providing the highest quality of care to veterans with disabilities, and for compiling this outstanding record of the programs, processes, medical care, and technological advances that maximize the opportunities for our combat amputees from Iraq and Afghanistan to lead full and productive lives.

The addition of *Care of the Combat Amputee* to the *Textbooks of Military Medicine* series from the Borden Institute, an agency of the US Army Medical Department Center & School, provides comprehensive coverage of current and emerging care of combat amputations. The dedicated personnel working in our nation's military and veterans' organizations are making substantial medical, rehabilitative, technical, administrative, and social advances. We all strive to provide the best available care to those most seriously injured in Iraq and Afghanistan. Injuries can change the life of a service member in an instant, but the rebuilding process can take years. The veterans who have left their limbs on the battlefield have done so in the service of all of us. The resilience and spirit of these men and women serve as an inspiration to us all.

Hon. Michael J. Kussman, MD, Brigadier General, US Army (Retired)
Under Secretary for Health, Veterans Health Administration
US Department of Veterans Affairs

Washington, DC
May 2008

Prologue

“As we express our gratitude, we must never forget that the highest appreciation is not to utter words, but to live by them.”

—John Fitzgerald Kennedy

This book represents the cumulative work of some of the world’s best minds in medical, surgical, and rehabilitative care. Dozens of people gave freely of their time in preparing and editing chapters, adding up to thousands of hours of work over a period of about 4 years. Because of the criticality of the topic and its historical impact, the book was written with close collaboration among authors via both e-mail and the Internet. Because face-to-face communication is also essential, we assembled experts within the core topic areas to lead discussion groups in reviewing materials for each chapter in detail. This 3-day meeting was held in September 2007—the first scientific meeting held at the Center for the Intrepid at Brooke Army Medical Center. Throughout the period of Operation Enduring Freedom and Operation Iraqi Freedom, care of combat amputees has made tremendous progress, accompanied by growing collaboration among clinicians and scientists within the Department of Defense and Department of Veterans Affairs. Many individuals from academia, industry, veterans’ service organizations, and the public at large have made important and lasting contributions.

We have attempted to cover the spectrum of issues involved in combat amputee care while remaining focused on the service member or veteran with major limb amputation. The book is intended to serve as a reference for experienced clinicians; a textbook for students, residents, and fellows; and a source for researchers, as well as a historical document for posterity. This work was completed during a time of war, when despite the arrival of new wounded on a nearly daily basis to military and veteran medical centers, new programs were established, benefits were expanded, and medical care improved at a rapid pace, as has been the case during times of war over the centuries.

Topics covered follow the course of care and community reentry of service members with combat-related major limb amputations, from surgical complications and treatments in theater through follow-up care and even multiple revisions. Acute and outpatient rehabilitation is described, including comorbidities, complications, and outcomes. Therapeutic interventions are detailed, and many breakthroughs in active rehabilitation are noted throughout the textbook. Emerging technologies and the processes of fitting prosthetics are presented to the reader. Opportunities for sports and recreation, a critical aspect of successful rehabilitation and community reintegration, are described. Learning to challenge one’s perception of self and master new abilities is often accomplished through these activities. The complex systems and structures for providing medical care and the benefits earned by wounded and injured service members can be difficult to navigate; we have attempted to summarize and clarify these systems. The entire book is thoroughly referenced to the scientific, clinical, and public-policy literature. If successful, this book will serve as a guide for years to come.

It has taken an entire cadre of professionals to create this volume, and it has been completed with a great sense of commitment and honor. There is no greater calling than to help other people, especially those with debilitating injuries. In addition to the authors and editors, a number of other people were critical to seeing this product to completion: Christine Heiner, Joan Redding and other Borden Institute staff, Colonel Martha Lenhart, Paula Stankovic, Colonel (Retired) Charles Scoville, Troy Turner, Colonel (Retired) Rebecca Hooper, Lieutenant Colonel Rachel Evans, and Amy Donovan made critical contributions to keeping the book on track and of the highest quality. Brad Impink, Jen Collinger, Michelle Sporer, Amol Karmarkar, and Garrett Grindle, all graduate students at the University of Pittsburgh, and Sharon Weeks from Walter Reed Army Medical Center provided invaluable assistance in writing, editing, formatting, and coordinating chapters. Several of our colleagues also assisted with reviewing chapters and checking facts, for which we are grateful. We would like to acknowledge Kendra Betz, Cindy Poorman, Lucille Beck, Barbara Sigford, John Milani, and Billie Randolph for their comments. This book was conceptualized under the leadership of Lieutenant General (Retired) Kevin Kiley, MD, during his tenure as Surgeon General of the Army; it was wholeheartedly and seamlessly supported by his successor, Lieutenant General Eric Schoomaker, MD, PhD.

Brigadier General (Retired) Michael Kussman, MD, the Under Secretary for Veterans Health, provided his unwavering commitment to completion of this project. We are both especially very thankful to our wives and families for their love and support, allowing us to take time away from them to complete this volume and to

care for wounded, injured, and ill veterans and active duty soldiers. We also owe a debt of gratitude to Arnold Fisher and the Intrepid Fallen Heroes Fund, for their private donations in support of the Center for the Intrepid, and to Congressional leaders who secured government funding to build the Military Advanced Training Center.

For us this has been a labor of love, and has afforded us a tremendous opportunity to learn, connect with other professionals, expand upon research efforts, and influence policy and practice. Most importantly, we share deeply in the commitment to improve outcomes for wounded service members and their families. It is with a great sense of satisfaction and humility that we present this volume to present and future generations of healthcare professionals.

Paul F. Pasquina, MD, Colonel, Medical Corps, US Army
Chief, Integrated Department of Orthopaedics and Rehabilitation
Walter Reed Army Medical Center, Washington, DC
National Naval Medical Center, Bethesda, Maryland

Rory A. Cooper, PhD
Director, VA Rehabilitation Research and Development Center, Pittsburgh
Distinguished Professor and FISA Foundation/Paralyzed Veterans of America Chair
University of Pittsburgh

Washington, DC, and Pittsburgh, Pennsylvania
October 2009