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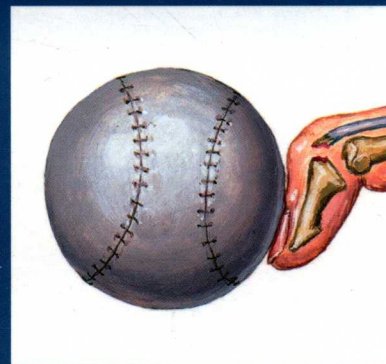
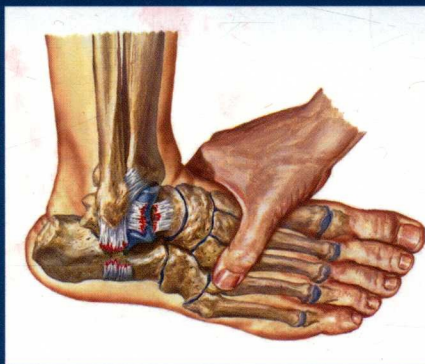
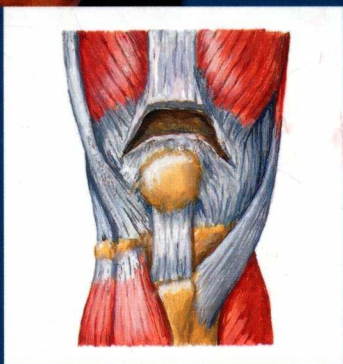
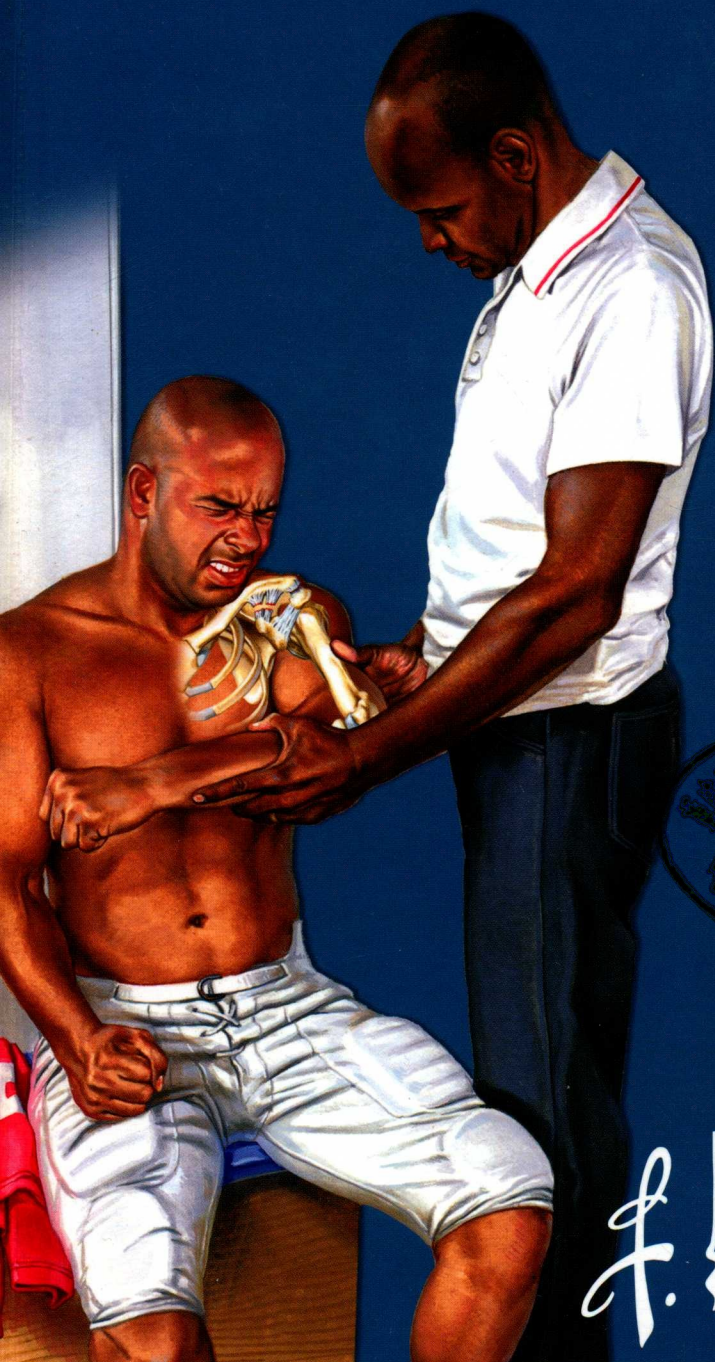
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CHRISTOPHER C. MADDEN  
MARGOT PUTUKIAN  
ERIC C. McCARTY  
CRAIG C. YOUNG

# NETTER'S SPORTS MEDICINE

2nd EDITION

*F. Netter M.D.*

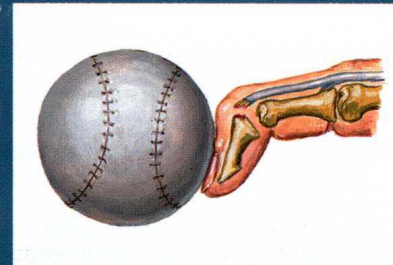
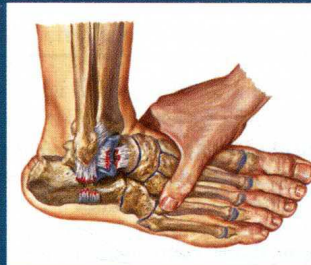
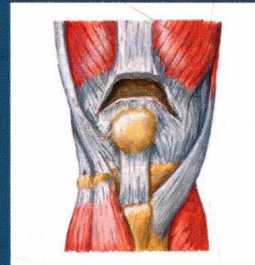
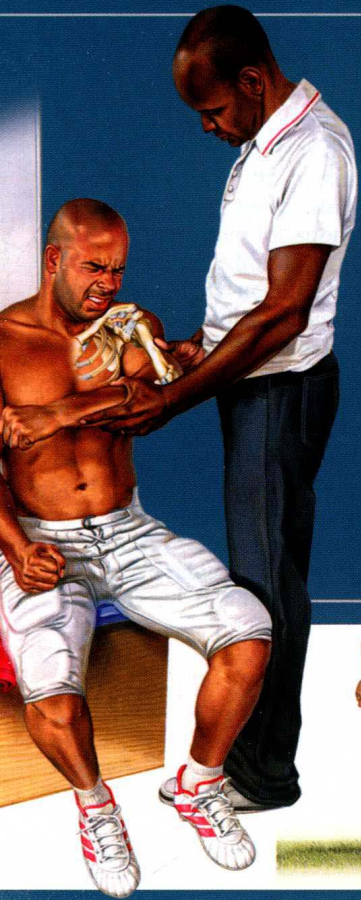


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# NETTER'S SPORTS MEDICINE

2nd EDITION



EDITORS

**Christopher C. Madden, MD, FACSM**

**Margot Putukian, MD, FACSM**

**Eric C. McCarty, MD**

**Craig C. Young, MD**

ILLUSTRATIONS BY

**Frank H. Netter, MD**

CONTRIBUTING ILLUSTRATORS

**Carlos A.G. Machado, MD**

**John A. Craig, MD**

**Kristen Wienandt Marzejon, MS, MFA**

**Tiffany S. DaVanzo, MA, CMI**

**James A. Perkins, MS, MFA**



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1600 John F. Kennedy Blvd.  
Ste 1800  
Philadelphia, PA 19103-2899

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*Senior Content Developmental Specialist:* Marybeth Thiel  
*Publishing Services Manager:* Patricia Tannian  
*Project Manager:* Stephanie Turza  
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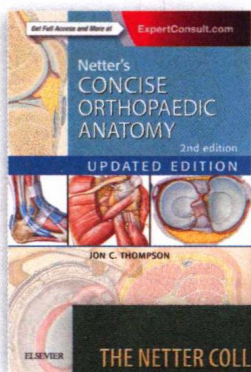
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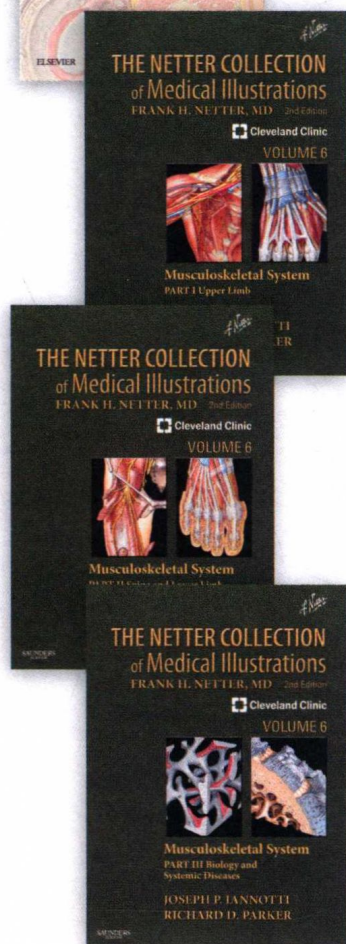
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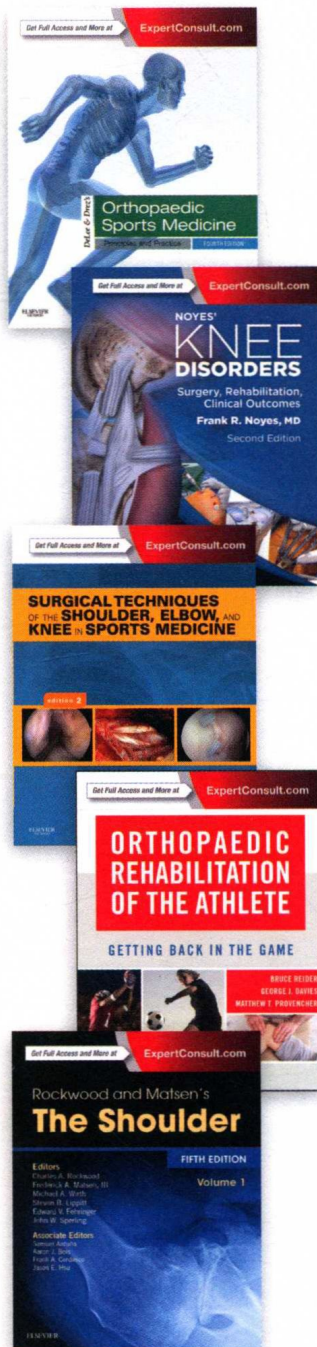
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# DEDICATION

*Netter's Sports Medicine* is dedicated to the *Team Physician's Handbook* and to the many thousands of sports medicine physicians and health professionals who have loyally followed and evolved with its content over three spectacular editions. *Netter's Sports Medicine* evolved from the original efforts embodying the *Team Physician's Handbook* and all that it represented for sports professionals through the years.

The Netter editions bring with them a broader and deeper approach to the comprehensive field of sports medicine. Many new topics, chapters, and authors are combined with cutting-edge Netter and other graphics, displayed in a colorful, user-friendly, easy-access format. *Netter's Sports Medicine* invites a much broader audience of sports medicine professionals and promises to be a premier ready reference and a detailed resource for all sports medicine professionals.

This book is also dedicated with respect and honor to the original creators of the *Team Physician's Handbook*, who we failed to acknowledge in the previous edition: W. Michael Walsh, MD, Morris B. Mellion, MD, and Guy L. Shelton, PT, whose vision and wisdom made this work possible. May their love of sports medicine, conduct in the field, and integrity as human beings set an example for us all to follow.

And, to the most wonderful, loving family I can imagine: Jessica, my beautiful wife, and Sage, my energetic and inquisitive daughter. They are both my best teachers, and they bring me infinite happiness. Also, to my mother, Susan Madden, and my passed father, Spencer Madden, whose love, patience, belief, and guidance presented me with limitless opportunity.

—Christopher C. Madden, MD, FACSM

This book is dedicated to my parents, John and Elissa, who taught me to work hard, enjoy life, and respect other people; to my brother, Peter, and sister, Lisa, as well as their families; and to my husband and best friend, Joe Hindelang, as well as my stepson Joel. I treasure the time and memories we're able to spend together. I have learned so much in my career through my mentors, including my fellowship directors Dave Hough and Doug McKeag, as well as so many colleagues (many of whom are contributors to this book). I feel fortunate that I've had an opportunity to participate in this book with such great contributors and editors.

—Margot Putukian, MD, FACSM

This is dedicated to my parents, Margaret and Jimmie, who instilled in me the thirst for knowledge, and to my teachers who had the patience to give me that knowledge, especially to Drs. Jim Puffer, Bob Dimeff, and John Bergfeld. And finally, and most important, to my beautiful and wonderful wife, Sharon Busey, who has given me the love, support, and time to complete this project—I couldn't have done this without you.

—Craig C. Young, MD

My dedication of this book goes to my best friend and loving wife, Miriam, who is ever supportive, patient, and enduring in her love, especially in an effort such as this book, with the hours it takes and late nights to make it happen. To my dear children, Madeleine, Cleveland, Shannon, and Torrance, who are the light and diversion to the busy life as an academician, surgeon, and team physician. To my parents, Cleve and Jackie, who gave me great inspiration in pursuing excellence. To my many teachers, mentors, coaches, and orthopaedic partners who along the way have taught me so much and continue to live within me. Finally, to my ultimate mentor and the one who gave so much, my savior, Jesus Christ.

—Eric C. McCarty, MD



# EDITORS

## **CHRISTOPHER C. MADDEN, MD, FACSM**

Assistant Clinical Professor  
University of Colorado Health Sciences Center  
Department of Family Medicine  
Aurora, Colorado;  
Sports and Family Medicine Physician  
Private Practice  
Longs Peak Family Practice and Sports Medicine  
Longmont, Colorado;  
Team Physician  
Lyons High School  
Lyons, Colorado

## **MARGOT PUTUKIAN, MD, FACSM**

Director of Athletic Medicine, Head Team Physician, Assistant  
Director of Medical Services  
Princeton University  
Princeton, New Jersey;  
Associate Clinical Professor  
Rutgers Robert Wood Johnson Medical School  
New Brunswick, New Jersey;  
Team Physician, US Men's Lacrosse Team;  
Team Physician, US Soccer;  
Medical Consultant, Major League Soccer;  
Past-President, American Medical Society for Sports Medicine

## **ERIC C. MCCARTY, MD**

Chief  
Sports Medicine and Shoulder Surgery  
Associate Professor  
Department of Orthopaedics  
University of Colorado School of Medicine  
Denver, Colorado;  
Director of Sports Medicine  
Department of Athletics  
University of Colorado  
Boulder, Colorado

## **CRAIG C. YOUNG, MD**

Professor  
Medical Director  
Departments of Sports Medicine, Orthopaedic Surgery, and  
Community and Family Medicine  
Medical College of Wisconsin  
Milwaukee, Wisconsin;  
Team Physician: Milwaukee Ballet, Milwaukee Brewers,  
Milwaukee Bucks;  
Pool Physician: US National Snowboard and Ski Teams, US  
Olympic Committee;  
President 2007–2008 American Medical Society for Sports  
Medicine



# ABOUT THE EDITORS

**Christopher C. Madden, MD, FACSM**, is in private practice on the Front Range of the Rocky Mountains in Colorado. His sports medicine practice is broad, and he has special interests in head injuries, biomechanics, environmental and altitude medicine, backcountry sports, endurance and ultra-endurance medicine, snowboarding injuries, and cycling and mountain biking injuries. Chris edits and writes on a variety of topics in sports publications, ranging from previsit patient education to professional textbooks. He also teaches sports medicine to primary care residents from Rose and the University of Colorado Family Medicine Residency Programs. He is active in the American Medical Society for Sports Medicine, where he is a Past President and member of the Board of Directors, is past Annual Meeting Program Chair, and has served on the Quality Initiatives and Healthcare Transformation Subcommittee, Program Planning Committee, and Public Relations Committees. In 2011, Chris received the AMSSM's highest award, the Founders Award, which is given to "the individual, group or organization who exemplifies the best we can be or do in Sports Medicine." Chris is also a Fellow with the American College of Sports Medicine, where he has served on the Education Committee and has served on and chaired panels at various annual meetings. An avid backcountry enthusiast, Chris loves to mountain bike, trail run, snowboard, ski, hike, mountaineer, rock climb, practice yoga, travel, and spend time with his family.

**Margot Putukian, MD, FACSM**, received her BS degree in Biology from Yale University, where she participated in soccer and lacrosse. She received her MD from Boston University and then did both her internship and residency at the Primary Care Internal Medicine Program at Strong Memorial Hospital in Rochester, New York. She completed her fellowship in sports medicine at Michigan State University. Margot worked as the Director of Primary Care Sports Medicine at Penn State University before starting her current position in January 2004 as the Director of Athletic Medicine and Head Team Physician for Princeton University. Margot also serves as a team physician for U.S. Soccer and the Men's U.S. National Lacrosse Team. Margot is a charter member of the American Medical Society for Sports Medicine (AMSSM), where she served as President from 2004 to 2005, and is currently the President of the AMSSM Foundation. Margot is a medical consultant for Major League Soccer. She currently serves as the Chair for the Clinical Sports Medicine Leadership committee for the American College of Sports Medicine (ACSM) and served previously on the Board of Trustees for ACSM. She served previously on the NCAA Competitive Safeguards and Medical Aspects of Sport Committee and is currently serving as the chair of the Sports Science and Safety Committee for U.S. Lacrosse. She currently serves on the NFL Head, Neck & Spine Committee. Margot has participated in several Team Physician Consensus Statements, NATA Statements, and the Third and Fourth International Consensus Conference on Concussion in Sport in Zurich, Switzerland, as well as the Fifth International Consensus Conference on Concussion in Sport in Berlin, Germany. She has served on the editorial board for *Medicine and Science in Sports and Exercise*, the *Journal of Athletic Training*, *The Physician and Sports Medicine*, and *Athletic Training and Sports Health Care*. She is the proud recipient of the 2007 Dr. David Moyer Team Physician's award presented by the Eastern Athletic Trainer's Association, the 2015 AMSSM Founders Award, and the 2016 ACSM Citation Award.

**Craig C. Young, MD**, is a professor and the Medical Director of Sports Medicine at the Medical College of Wisconsin. He received a BS degree (cum laude) in Biological Sciences from the University of California, Irvine. He is a graduate of the University of California, San Diego School of Medicine. He completed a residency in family medicine at UCLA and a sports medicine fellowship at the Cleveland Clinic Foundation. Dr. Young has served as a team physician for the Milwaukee Brewers since 1994 and for the Milwaukee Bucks since 2016. He has served as a company physician for the Milwaukee Ballet since 1992. He has also served as a physician at the U.S. Olympic Training Center (Chula Vista) and is a physician for the U.S. National Ski and Snowboard Teams. In 2007, he was appointed by the U.S. Olympic Committee as a team physician for the 23rd World Winter University Games in Torino, Italy. Dr. Young is board certified in both family practice and sports medicine. He was the President of the American Society for Sports Medicine (AMSSM) from 2007 to 2008. In 2012, he was the recipient of AMSSM's highest award, the Founders Award, which is given to "the individual, group or organization who exemplifies the best we can be or do in Sports Medicine." His clinical interests include dance medicine, wilderness medicine, female athletes, adolescent athletes, and endurance athletes. His research interests include dance medicine and injury prevention.

**Eric C. McCarty, MD**, is a board-certified and fellowship-trained orthopaedic surgeon with a longtime interest in sports medicine and athletics. He attended college at the University of Colorado, where he excelled and received numerous honors for his exploits in the classroom, as well as on the football field, where he was an All Big-Eight linebacker and also was an Academic All-American. After medical school at the University of Colorado, he completed his training in orthopaedic surgery at Vanderbilt University in Nashville, Tennessee. From there he completed an intensive year of fellowship training in sports medicine and shoulder surgery at the internationally renowned Hospital for Special Surgery in New York City. He subsequently returned to Vanderbilt as a faculty member in the department of orthopaedics. In 2003, Dr. McCarty was recruited from Vanderbilt University to take over the sports medicine and shoulder program and to serve as the head team physician for the University of Colorado and University of Denver athletic programs. His specialized practice involves the care of these collegiate athletes, as well as recreational and highly competitive athletes from the community. In addition to his busy clinical practice, Dr. McCarty is very active in research, teaching, and writing articles in the field of sports medicine and knee and shoulder surgery. He has received grants for his research and frequently gives talks at both the national and international level. Since his playing days, Dr. McCarty continues to maintain a very active lifestyle with his family. He enjoys the activities he grew up with in Colorado, including hiking, cycling, climbing, and skiing. This carries over into his unbridled dedication to returning his patients to their desired activity/sport.



# ABOUT THE ARTISTS

## FRANK H. NETTER, MD

Frank H. Netter was born in 1906 in New York City. He studied art at the Art Student's League and the National Academy of Design before entering medical school at New York University, where he received his MD degree in 1931. During his student years, Dr. Netter's notebook sketches attracted the attention of the medical faculty and other physicians, allowing him to augment his income by illustrating articles and textbooks. He continued illustrating as a sideline after establishing a surgical practice in 1933, but he ultimately opted to give up his practice in favor of a full-time commitment to art. After service in the United States Army during World War II, Dr. Netter began his long collaboration with the CIBA Pharmaceutical Company (now Novartis Pharmaceuticals). This 45-year partnership resulted in the production of the extraordinary collection of medical art so familiar to physicians and other medical professionals worldwide.

In 2005, Elsevier, Inc. purchased the Netter Collection and all publications from Icon Learning Systems. There are now over 50 publications featuring the art of Dr. Netter available through Elsevier, Inc. (in the US: [www.us.elsevierhealth.com/Netter](http://www.us.elsevierhealth.com/Netter) and outside the US: [www.elsevierhealth.com](http://www.elsevierhealth.com)).

Dr. Netter's works are among the finest examples of the use of illustration in the teaching of medical concepts. The 13-book *Netter Collection of Medical Illustrations*, which includes the greater part of the more than 20,000 paintings created by Dr. Netter, became and remains one of the most famous medical works ever published. The *Netter Atlas of Human Anatomy*, first published in 1989, presents the anatomical paintings from the Netter Collection. Now translated into 16 languages, it is the anatomy atlas of choice among medical and health professions students the world over.

The Netter illustrations are appreciated not only for their aesthetic qualities, but, more important, for their intellectual content. As Dr. Netter wrote in 1949, "... clarification of a subject is the aim and goal of illustration. No matter how beautifully painted, how delicately and subtly rendered a subject may be, it is of little value as a *medical illustration* if it does not serve to make clear some medical point." Dr. Netter's planning, conception, point of view, and approach are what inform his paintings and what makes them so intellectually valuable.

Frank H. Netter, MD, physician and artist, died in 1991.

Learn more about the physician-artist whose work has inspired the Netter Reference collection:

<http://www.netterimages.com/artist/netter.htm>.

## CARLOS MACHADO, MD

Carlos Machado was chosen by Novartis to be Dr. Netter's successor. He continues to be the main artist who contributes to the Netter collection of medical illustrations.

Self-taught in medical illustration, cardiologist Carlos Machado has contributed meticulous updates to some of Dr. Netter's original plates and has created many paintings of his own in the style of Netter as an extension of the Netter collection. Dr. Machado's photorealistic expertise and his keen insight into the physician/patient relationship inform his vivid and unforgettable visual style. His dedication to researching each topic and subject he paints places him among the premier medical illustrators at work today.

Learn more about his background and see more of his art at:  
<http://www.netterimages.com/artist/machado.htm>



We are grateful for the opportunity to carry on the widespread popularity of the first edition of *Netter's Sports Medicine*, the history of *Team Physician's Handbook*, and the revered anatomical graphic works of Frank Netter, MD. The second edition continues to embrace a well-organized, colorful, bulleted outline format combined with helpful Netter graphics, tables, figures, pictures, diagnostic imaging, and other medical artwork. The text hosts a national and international author base that represents the best in sports medicine today.

Serving as a team physician is a unique privilege and an awesome challenge. *Netter's Sports Medicine* is written for the multitude of physicians and other health care professionals who are fortunate enough to provide care to a variety of athletes and active individuals in almost any athletic setting imaginable, from pediatric to senior athletics, Little League to professional sports, weekend warrior to Olympic champion, and backcountry mountainside to Super Bowl field.

The book is designed to serve as a comprehensive sports medicine resource and a ready reference in the busy outpatient office, in the training room, on the sideline, and in the long, quiet hours of preparation for sports medicine board certification. Insightful, expert, anecdotal experience fills the void where the most current evidence in sports medicine falls short, and careful considerations of controversies are mindfully presented. The sports medicine

literature has grown exponentially since the first edition of *Netter's Sports Medicine* and its predecessor three editions of the *Team Physician's Handbook*, and many new chapters and chapter sections were added and revised to reflect the evolving depth and breadth of our exciting field. The text is divided into user-friendly sections for quick reference, and each chapter includes a Recommended Readings section limited to the best sources. We have added videos to support learning, and additional information supplementing certain chapters is available online. We welcome many new, respected authors who joined us to produce this book, and we are fortunate to continue our lasting relationship with numerous previous authors, who are leaders in their respective areas of emphasis. We thank all the authors who contributed chapters to previous texts, and whose chapter templates continue to provide a strong foundation to build upon.

Whether you are a primary care physician attempting to manage a common or unique musculoskeletal injury in an efficient ambulatory setting, an orthopaedic surgeon trying to gain insight about a medical or psychological problem foreign to the cast or operating room, an athletic trainer trying to figure out a diagnosis in the training room, or a physical therapist pursuing further in-depth sports medicine knowledge, we sincerely hope you find this reference all it is meant to be and more, and we thank you for opening the cover and sharing with us what we feel is one of the highest quality sports medicine works produced to date. Please enjoy.



# CONTRIBUTORS

**Jeffrey T. Abildgaard, MD**

Orthopaedic Sports Medicine Fellow  
Steadman-Hawkins Clinic of the Carolinas  
Greenville, South Carolina

**Giselle A. Aerni, MD**

Director of Athletic Medicine and Head Team Physician  
Yale University  
New Haven, Connecticut

**Joanne B. "Anne" Allen, MD, FACSM, FAAPMR**

Allen Spine and Sports Medicine P.C. and Emergent Ortho  
Team Physician and Clinical Adjunct Faculty  
University of North Carolina at Wilmington  
Wilmington, North Carolina

**Annunziato Amendola, MD**

Professor and Vice Chair  
Chief  
Division of Sports Medicine  
Department of Orthopaedic Surgery  
Duke University Medical Center  
Durham, North Carolina

**Irfan Asif, MD**

Vice Chair of Academics and Research  
Sports Medicine Fellowship Director  
Associate Professor  
Department of Family Medicine  
Greenville Health System  
University of South Carolina Greenville School of Medicine  
Greenville, South Carolina

**Chad Asplund, MD, MPH, FACSM**

Director  
Sports Medicine  
Georgia Southern University  
Statesboro, Georgia

**Joshua Baker, MD**

National Capital Consortium's Military Sports Medicine  
Fellowship  
Sports Medicine  
Washington, District of Columbia

**Holly J. Benjamin, MD, FAAP, FACSM**

Professor of Pediatrics  
Orthopedic Surgery and Rehabilitation Medicine  
Director of Primary Care Sports Medicine  
University of Chicago  
Chicago, Illinois

**Jacqueline R. Berning, PhD, RD, CSSD**

Professor and Chair  
Department of Health Science  
University of Colorado-Colorado Springs  
Colorado Springs, Colorado

**Anthony Beutler, MD**

Sports Medicine Fellowship Director  
Associate Professor  
Department of Family Medicine  
Uniformed Services University  
Bethesda, Maryland

**O. Josh Bloom, MD**

Carolina Family Practice and Sports Medicine  
Medical Director  
Carolina Sports Concussion Clinic  
Cary, North Carolina;  
Adjunct Instructor  
Department of Family Medicine  
University of North Carolina  
Chapel Hill, North Carolina;  
Clinical Associate  
Department of Family and Community Medicine  
Duke University  
Durham, North Carolina

**Jodi M. Blustin, MD**

Family Medicine Resident Physician  
North Memorial/Broadway Family Medicine  
Minneapolis, Minnesota

**Jonathan T. Bravman, MD**

Assistant Professor  
Director of Sports Medicine Research  
CU Sports Medicine  
Division of Sports Medicine and Shoulder Surgery  
Department of Orthopaedics  
University of Colorado  
Denver, Colorado

**Michael S. Broton, MD**

Assistant Professor  
University of Minnesota  
Minneapolis, Minnesota

**Keith Cameron Burley, MD, CSCS**

Sports Medicine Fellow  
Department of Orthopedics and Sports Medicine;  
Faculty Physician  
Department of Emergency Medicine  
University of Cincinnati  
Cincinnati, Ohio

**Kevin E. Burroughs, MD, ABFP, CAQSM**

Assistant Professor  
Department of Family Medicine  
University of North Carolina at Chapel Hill  
Chapel Hill, North Carolina;  
Director  
Cabarrus Sports Medicine Fellowship  
Director of Sports Medicine  
Cabarrus Family Medicine Residency  
Team Physician  
Catawba College  
JM Robinson High School  
Concord, North Carolina

**Aaron D. Campbell, MD, MHS**

Physician  
Departments of Urgent Care and Sports Medicine  
University of Utah Healthcare  
Park City, Utah



**John C. Carlisle, MD**  
Chief Resident  
Department of Orthopaedic Surgery  
Washington University School of Medicine  
St. Louis, Missouri

**Michael K. Case, MD**  
Physician  
Department of Otolaryngology  
Gundersen Health System  
La Crosse, Wisconsin

**Anthony S. Ceraulo, DO**  
Physician  
Department of Family Medicine  
Wake Forest University Medical Center  
Winston-Salem, North Carolina

**Jorge Chahla, MD**  
Regenerative Sports Medicine Fellow  
Center for Regenerative Sports Medicine  
Steadman Philippon Research Institute  
Vail, Colorado

**Cindy J. Chang, MD**  
Associate Professor  
Departments of Orthopaedics, Primary Care Sports Medicine,  
Family and Community Medicine  
University of California, San Francisco  
San Francisco, California

**Robert F. Chapman, PhD**  
Associate Professor  
Department of Kinesiology  
Indiana University  
Bloomington, Indiana

**Leon Y. Cheng, MD**  
Staff Physician  
Department of Family Medicine  
Palo Alto Medical Foundation  
Sunnyvale, California

**Arthur T. F. Chou, MD**  
Resident Doctor  
National Cheng Kung University  
Tainan, Taiwan

**Stephanie Chu, DO**  
Associate Professor  
Department of Family Medicine  
University of Colorado School of Medicine  
Aurora, Colorado

**Thomas O. Clanton, MD**  
Director  
Foot and Ankle Sports Medicine  
The Steadman Clinic  
Vail, Colorado

**Ryanne Elise Clarke, MSN, FNP-C, APRN**  
Nurse Practitioner  
Priority Health Care  
Gretna, Louisiana

**Daniel C. Cole, PA-C**  
Physician Assistant  
Vermont Orthopaedic Clinic  
Rutland Regional Medical Center  
Rutland, Vermont

**Steven J. Collina, MD**  
Physician  
HealthPlex Sports Medicine  
Crozer-Keystone Health System  
Glen Mills, Pennsylvania

**Daniel Contract, MD**  
Resident Physician  
Department of Physical Medicine and Rehabilitation  
Virginia Commonwealth University School of Medicine  
Richmond, Virginia

**Justin Conway, MD**  
Physician  
Hospital for Special Surgery  
New York, New York

**David B. Coppel, PhD**  
Professor  
Department of Neurological Surgery  
University of Washington  
Seattle, Washington

**David D. Cosca, MD**  
Sports Medicine Consultant and Team Physician  
Student Health and Counseling Center  
University of California, Davis  
Davis, California

**Lauren E. Costello, MD**  
Staff/Team Physician  
Princeton University  
Princeton, New Jersey;  
Assistant Clinical Professor  
Rutgers Robert Wood Johnson Medical School  
New Brunswick, New Jersey

**Charles T. Crellin, MD**  
Physician  
CU Sports Medicine  
University of Colorado  
Denver, Colorado

**Stephen Dailey Jr., MD**  
Director of Sports Medicine  
Intercollegiate Athletics  
Miami University  
Oxford, Ohio;  
Assistant Professor  
Departments of Orthopaedics and Sports Medicine and  
Emergency Medicine  
University of Cincinnati  
Cincinnati, Ohio

**Katherine L. Dec, MD**  
Professor  
Departments of Physical Medicine and Rehabilitation/  
Orthopaedic Surgery  
Virginia Commonwealth University School of Medicine  
Richmond, Virginia;  
Team Physician  
Longwood University  
Farmville, Virginia



**Jesse DeLuca, DO**

Associate Program Director  
NCC/Military Sports Medicine Fellowship  
Fort Belvoir Community Hospital  
Fort Belvoir, Virginia

**William Dexter, MD, FACS**

Director  
Sports Medicine Program  
Department of Family Medicine  
Maine Medical Center  
Portland, Maine;  
Professor  
Department of Family Medicine  
Tufts University School of Medicine  
Boston, Massachusetts

**Robert J. Dimeff, MD**

Professor  
Departments of Orthopedic Surgery, Pediatrics, Family and  
Community Medicine  
UT Southwestern Medical Center  
Dallas, Texas

**Jon Divine, MD**

Professor  
Department of Orthopaedics and Sports Medicine  
Head Team Physician  
University of Cincinnati Athletics  
Past President, American Medical Society for Sports Medicine  
(AMSSM)  
Cincinnati, Ohio

**Sameer Dixit, MD**

Assistant Professor  
Departments of Orthopaedics, Medicine and Physical Medicine  
and Rehabilitation  
Johns Hopkins University School of Medicine  
Baltimore, Maryland

**Timothy R. Draper, DO**

Associate Program Director  
Sports Medicine Fellowship  
Cone Health  
Team Physician  
Guilford College  
Greensboro, North Carolina;  
Clinical Assistant Professor  
Department of Family Medicine  
University of North Carolina  
Chapel Hill, North Carolina

**Jonathan A. Drezner, MD**

Professor  
Department of Family Medicine  
Director, Center for Sports Cardiology  
University of Washington  
Seattle, Washington

**Siatta B. Dunbar, DO**

Physician  
Fairview Health Services  
Sports and Orthopedic Care  
Fairview Ridges Specialty Care Center  
Burnsville, Minnesota

**Kevin Eerkes, MD**

Clinical Associate Professor of Medicine  
Department of Internal Medicine  
NYU School of Medicine  
New York, New York

**Ashraf M. Elbanna, MD**

Orthopaedic Surgeon  
Memorial Healthcare  
Owosso, Michigan

**Todd S. Ellenbecker, DPT, MS, SCS, OCS, CSCS**

Clinic Director  
Physiotherapy Associates  
Scottsdale Sports Clinic;  
Vice President  
Medical Services ATP World Tour  
Scottsdale, Arizona

**Steven Erickson, MD**

Head Team Physician  
Arizona State University  
Program Director  
Primary Care Sports Medicine Fellowship  
ASU/St. Joseph's Hospital and Medical Center  
Phoenix, Arizona

**Nicolai Esala, DO, CAQSM**

Primary Care Sports Medicine Physician  
TRIA Orthopedics  
Maple Grove, Minnesota

**Scott A. Escher, MD**

Physician  
Department of Family Medicine/ Section of Sports Medicine  
Gundersen Health System  
La Crosse, Wisconsin

**Shayne D. Fehr, MD**

Assistant Professor  
Department of Orthopaedic Surgery  
Medical College of Wisconsin  
Milwaukee, Wisconsin

**John E. Femino, MD**

Clinical Associate Professor  
Department of Orthopedics and Rehabilitation  
University of Iowa Hospitals and Clinics  
Iowa City, Iowa

**Karl B. Fields, MD**

Fellowship Director  
Sports Medicine Clinic  
Cone Health System  
Greensboro, North Carolina;  
Professor  
Department of Family Medicine  
University of North Carolina  
Chapel Hill, North Carolina



**R. Robert Franks Jr., DO, FAOASM**

Director Rothman Concussion Institute  
 Rothman Institute  
 Associate Professor  
 Department of Family Medicine  
 Thomas Jefferson University  
 Philadelphia, Pennsylvania;  
 Volunteer Clinical Associate Professor  
 Department of Family Medicine  
 Rowan University School of Osteopathic Medicine  
 Stratford, New Jersey

**Thomas A. Frette, MA, ATC**

Senior Associate Athletic Director  
 University of Nebraska at Omaha  
 Omaha, Nebraska

**Jessie R. Fudge, MD**

Physician  
 Department of Activity, Sports and Exercise Medicine  
 Group Health Cooperative  
 Everett, Washington

**Matthew R. Gammons, MD**

Medical Director  
 Department of Sports Medicine  
 Vermont Orthopaedic Clinic  
 Rutland, Vermont

**David J. Gerlach, MD**

Chief Resident  
 Department of Orthopaedic Surgery  
 Washington University School of Medicine  
 St. Louis, Missouri

**Kyle Goerl, MD**

Associate Director  
 Sports Medicine Fellowship and Family Medicine Residency  
 Via Christi Hospitals  
 Assistant Professor  
 Department of Family and Community Medicine  
 University of Kansas School of Medicine-Wichita  
 Medical Director and Head Team Physician  
 Wichita State University Athletics  
 Wichita, Kansas

**Andrew William Gottschalk, MD**

Director of Primary Care Sports Medicine  
 Ochsner Health System  
 Head Medical Team Physician  
 NBA New Orleans Pelicans  
 New Orleans, Louisiana

**Laura M. Gottschlich, DO**

Director of Sports Medicine  
 All Saints Family Medicine Residency  
 Department of Family and Community Medicine  
 Department of Orthopedics  
 Medical College of Wisconsin  
 Milwaukee, Wisconsin

**Gary A. Green, MD**

Clinical Professor  
 Department of Sports Medicine  
 UCLA School of Medicine  
 Los Angeles, California;  
 Medical Director  
 Major League Baseball  
 New York, New York;  
 Partner  
 Pacific Palisades Medical Group  
 Pacific Palisades, California

**Leslie Greenberg, MD**

Assistant Professor  
 Department of Family and Community Medicine  
 University of Nevada, Reno School of Medicine  
 Reno, Nevada

**Heather L. Grothe, MD**

Primary Care Sports Medicine Fellow  
 Department of Family Medicine  
 University of Colorado  
 Aurora, Colorado

**Ronnie D. Hald, PT, ATC**

Physical Therapist  
 Granby, Colorado

**Mederic M. Hall, MD**

Associate Professor  
 Departments of Orthopedics and Rehabilitation, Radiology, and  
 Family Medicine  
 University of Iowa Sports Medicine  
 Iowa City, Iowa

**Kimberly G. Harmon, MD**

Professor  
 Departments of Family Medicine and Orthopaedics and Sports  
 Medicine  
 University of Washington  
 Seattle, Washington

**George D. Harris, MD**

Chair and Professor  
 Department of Family Medicine;  
 Medical Director  
 Department of Primary Care  
 University Healthcare Physicians  
 West Virginia University-Eastern Division, School of Medicine  
 Martinsburg, West Virginia

**Disa L. Hatfield, PhD**

Associate Professor  
 Department of Kinesiology  
 University of Rhode Island  
 Kingston, Rhode Island

**Munawar Hayat, MD**

Resident Physician  
 University of Texas Southwestern  
 Dallas, Texas



**Bruce Helming, MD, FAAFP**

Clinical Assistant Professor  
 Department of Family and Community Medicine  
 Assistant Head Team Physician  
 Intercollegiate Athletics  
 Physician  
 Campus Health Service  
 University of Arizona  
 Tucson, Arizona

**John C. Hill, DO, FACSM, FAAFP**

Professor  
 Director of Primary Care Sports Medicine Fellowship  
 University of Colorado School of Medicine  
 Denver, Colorado

**Kevin M. Honig, MD**

Orthopaedic Surgeon  
 All-Star Orthopaedics  
 Southlake, Texas

**Eugene Hong, MD, CAQSM, FAAFP**

Associate Dean for Primary Care and Community Health  
 Hamot and Sturgis Endowed Chair and Professor  
 Associate Chief  
 Division of Sports Medicine  
 Department of Family, Community and Preventive Medicine  
 Drexel University College of Medicine  
 Philadelphia, Pennsylvania

**Thomas M. Howard, MD, FACSM**

Physician  
 Flexogenix PC  
 Cary, North Carolina

**Kenneth J. Hunt, MD**

Associate Professor and Chief, Foot and Ankle Surgery  
 Department of Orthopaedic Surgery  
 University of Colorado School of Medicine  
 Aurora, Colorado

**Brian A. Jacobs, MD**

Physician  
 Family Medicine of South Bend  
 Team Physician  
 South Bend Cubs Baseball  
 South Bend, Indiana;  
 Team Physician  
 Men's Rugby and Men's Boxing  
 University of Notre Dame  
 Notre Dame, Indiana

**David J. Jewison, MD, MAT, CAQSM**

Assistant Professor  
 Department of Orthopaedics  
 University of Minnesota  
 Minneapolis, Minnesota

**Bevila John-Daniel, MD**

Board Certified Adult Psychiatrist  
 Counseling and Psych Services, Campus Health  
 University of Arizona  
 Tucson, Arizona

**Robert Johnson, MD**

Professor  
 Department of Family Medicine and Community Health  
 University of Minnesota  
 Director Emeritus  
 University of Minnesota Sports Medicine Fellowship  
 Minneapolis, Minnesota

**Nathaniel S. Jones, MD, CAQ-SM**

Assistant Professor  
 Department of Orthopaedic Surgery and Rehabilitation  
 Health Sciences Campus  
 Loyola University Medical Center  
 Maywood, Illinois

**Susan M. Joy, MD**

Physician  
 Sports Medicine Center  
 Kaiser Permanente  
 Sacramento, California

**Christopher C. Kaeding, MD**

Professor  
 Department of Orthopaedic Surgery  
 Executive Director  
 OSU Sports Medicine Center  
 The Ohio State University  
 Columbus, Ohio

**Abbie L. Kelley, DO**

Sports Medicine Fellow Physician  
 WellSpan Sports Medicine  
 York Hospital  
 York, Pennsylvania

**Morteza Khodaei, MD, MPH**

Associate Professor  
 Department of Family Medicine  
 University of Colorado School of Medicine  
 Denver, Colorado

**Christopher Kim, MD**

Fellow  
 Department of Orthopaedic Sports Medicine  
 Duke University Medical Center  
 Department of Orthopaedic Surgery  
 Durham, North Carolina

**Robert Kiningham, MD**

Associate Professor  
 Department of Family Medicine  
 University of Michigan Health System  
 Ann Arbor, Michigan

**Jessica Knapp, DO**

Director of Sports Medicine  
 Tufts Family Medicine Residency  
 Cambridge Health Alliance  
 Cambridge, Massachusetts;  
 Assistant Professor  
 Tufts University School of Medicine  
 Boston, Massachusetts

**Chitra Kodery, DO**

Primary Care Sports Medicine Fellow  
 Princeton University  
 Princeton, New Jersey;  
 Rutgers Robert Wood Johnson Medical School  
 New Brunswick, New Jersey



**Melissa D. Koenig, MD**

Colorado Permanente Medical Group  
Department of Orthopedics  
Denver, Colorado

**William J. Kraemer, PhD**

Professor  
Department of Human Sciences  
The Ohio State University  
Columbus, Ohio

**Matthew J. Kraeutler, MD**

Professional Research Assistant  
Department of Orthopedics  
University of Colorado School of Medicine  
Aurora, Colorado

**Erica L. Kroncke, MD**

Physician  
Primary Care Sports Medicine  
ThedaCare Orthopedic Care  
Appleton, Wisconsin

**Scott R. Laker, MD**

Associate Professor  
Department of Physical Medicine and Rehabilitation  
University of Colorado School of Medicine  
Denver, Colorado

**Mark E. Lavallee, MD**

Director  
York Sports Medicine Fellowship Program  
WellSpan Sports Medicine  
York Hospital  
York, Pennsylvania;  
Clinical Associate Professor  
Department of Family and Community Medicine  
Pennsylvania State University School of Medicine  
Hershey, Pennsylvania;  
Head Team Physician  
Department of Athletics  
Gettysburg College  
Gettysburg, Pennsylvania;  
Chairman  
Sports Medicine Society  
USA Weightlifting  
Colorado Springs, Colorado

**Lior Laver, MD**

Physician  
Department of Trauma and Orthopaedics  
University Hospital Coventry and Warwickshire (UHCW)  
Coventry, England

**Constance M. Lebrun, MCDM, MPE, CCFP(SEM), Dip. Sport Med**

Professor and Director, Enhanced Skills Residency Programs  
Department of Family Medicine, Faculty of Medicine, and  
Dentistry  
Sport Medicine Physician  
Glen Sather Sports Medicine Clinic  
University of Alberta  
Edmonton, Alberta, Canada

**Alan H. Lee, MD**

Orthopaedic Sports Medicine Fellow  
Stanford University  
Stanford, California

**Benjamin D. Levine, MD**

Professor  
Departments of Internal Medicine and Cardiology  
UT Southwestern Medical Center;  
Director  
Institute for Exercise and Environmental Medicine  
Texas Health Presbyterian Hospital Dallas  
Dallas, Texas

**Thomas S. MacKenzie, DDS**

Program Director  
Department of Oral and Maxillofacial Surgery  
Gundersen Health System  
La Crosse, Wisconsin

**Christopher C. Madden, MD, FACS**

Assistant Clinical Professor  
University of Colorado Health Sciences Center  
Department of Family Medicine  
Aurora, Colorado;  
Sports and Family Medicine Physician  
Private Practice  
Longs Peak Family Practice and Sports Medicine  
Longmont, Colorado;  
Team Physician  
Lyons High School  
Lyons, Colorado

**Steven A. Makovitch, DO**

Sports Medicine Fellow and Clinical Instructor  
Division of Physical Medicine and Rehabilitation  
University Orthopaedic Center  
University of Utah  
Salt Lake City, Utah

**Steven L. Martin**

Physician  
Blue Ridge Surgery Center  
Seneca, South Carolina

**Robert Virgil Masocol, MD**

Clinical Assistant Professor  
Department of Family Medicine  
Greenville Health System  
University of South Carolina Greenville School of Medicine  
Greenville, South Carolina

**Dawn Mattern, MD, FAAP**

Medical Director  
Trinity Sports Medicine  
Minot, North Dakota

**Eric C. McCarty, MD**

Chief  
Sports Medicine and Shoulder Surgery  
Associate Professor  
Department of Orthopaedics  
University of Colorado School of Medicine  
Denver, Colorado;  
Director of Sports Medicine  
Department of Athletics  
University of Colorado  
Boulder, Colorado



**Todd M. McGrath, MD**

Sports Medicine  
Aria 3B Orthopaedic Institute  
Aria Jefferson Health  
Adjunct Assistant Professor  
Department of Emergency Medicine  
Drexel University College of Medicine  
Philadelphia, Pennsylvania

**Adrian McGoldrick, MB, BCh, NUI, MRCP, FFSEM**

Senior Medical Officer  
Irish Turf Club  
Curragh, Ireland

**D. Thompson McGuire, MD**

Orthopaedic Surgeon  
Down East Orthopaedics  
Bangor, Maine

**Omer Mei-Dan, MD**

Associate Professor  
CU Sports Medicine and Performance Center  
University of Colorado School of Medicine  
Boulder, Colorado

**Morris B. Mellion, MD**

Past President  
American Academy of Family Physicians  
Teton Village, Wyoming

**Adele J. Meron, MD**

Resident Physician  
Department of Physical Medicine and Rehabilitation  
University of Colorado School of Medicine  
Denver, Colorado

**Mark D. Miller, MD**

S. Ward Casscells Professor  
Department of Orthopaedics  
The University of Virginia  
Charlottesville, Virginia

**Marc A. Molis, MD, FAAFP**

Sports Medicine  
Unity Point, Urbandale Clinic;  
Medical Director of Sports Medicine  
Unity Point Sports Medicine-Urbandale  
Urbandale, Iowa

**Whitney E. Molis, MD, FAAP**

Allergist  
Pediatric and Adult Allergy  
Des Moines, Iowa

**Aaron Monseau, MD**

Assistant Professor  
Department of Emergency Medicine  
West Virginia University School of Medicine  
Morgantown, West Virginia

**George A. Morris, MD**

Vice President  
Performance Excellence  
CentraCare Health  
St. Cloud, Minnesota

**Kinshasa C. Morton, MD, CAQSM**

Assistant Professor  
Department of Family Medicine and Community Health  
Rutgers University  
New Brunswick, New Jersey

**Rebecca Ann Myers, MD**

Physician  
Longs Peak Family and Sports Medicine  
Longmont, Colorado;  
Associate Clinical Professor  
Department of Family and Sports Medicine  
University of Colorado  
Denver, Colorado;  
Physician  
Associate Clinical Professor  
East Grand Community Clinic and Emergency Center  
Winter Park, Colorado

**Ariel Nassim, DO**

Primary Care Sports Medicine, Fellow  
Division of Sports Medicine  
Department of Family, Community, and Preventative Medicine  
Drexel University College of Medicine  
Philadelphia, Pennsylvania

**Mark W. Niedfeldt, MD**

Associate Clinical Professor  
Departments of Family and Community Medicine and Cell  
Biology, Neurobiology, and Anatomy  
Medical College of Wisconsin  
Milwaukee, Wisconsin

**Francis G. O'Connor, MD, FACS**

Director, Center for Health and Military Performance  
Uniformed Services University of the Health Science  
Bethesda, Maryland

**David E. Olson, MD**

Assistant Professor  
Department of Family Medicine and Community Health  
Associate Medical Director  
Department of Athletics  
University of Minneapolis  
Minneapolis, Minnesota

**Amy Jo F. Overlin, MD**

Sports Medicine Physician  
Hedley Orthopaedics  
IASIS  
Phoenix, Arizona

**Cecilia Pascual-Garrido, MD**

Assistant Professor  
Department of Orthopedics  
University of Colorado School of Medicine  
Aurora, Colorado

**Stephen R. Paul, MD**

Associate Professor  
Department of Family and Community Medicine  
Assistant Team Physician  
Intercollegiate Athletics  
Physician  
Campus Health Service  
University of Arizona  
Tucson, Arizona