



The Children's Hospital of Philadelphia

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The Division of Orthopaedic Surgery at the Children's Hospital of Philadelphia (CHOP) has had another successful year marked with significant growth. We have continued to develop our clinical and research programs, as evident by notable academic and clinical achievements. We are pleased to announce that CHOP was ranked first in pediatric care by both *Parents* magazine and *US News and World Report* in 2013. The Division of Orthopaedics Surgery at CHOP was ranked second in pediatric orthopaedic surgery in the United States.

Clinical Program

Our orthopaedic faculty continues to expand and is currently comprised of twenty-eight total providers, including eighteen specialty-trained pediatric orthopaedic surgeons (thirteen operative and five nonoperative), five pediatricians with sports medicine training, and five transition-to-adult care faculty.

CHOP Orthopaedics is thrilled to announce the addition of two pediatricians with sports medicine training to the division. Dr Naomi Brown (Figure 1A) obtained her medical degree from Tufts University School of Medicine in Boston, MA. She completed her residency at CHOP in 2009 and a fellowship in sports medicine at Boston Children's Hospital. Dr. Brown has served as a co-investigator on a number of clinical studies, including a publication in *Pediatrics* which analyzes the duration of concussion symptoms. Dr. Christian Turner (Figure 1B) joined the Division of Orthopedic Surgery in July 2013 after completing a fellowship in primary care sports medicine here at CHOP. Dr. Turner received his medical training at the State University of New York in Syracuse, NY. He completed his residency at Connecticut Children's Medical Center in Hartford, CT. Dr Turner has served as team physician or assistant team physician for the University of Pennsylvania, West Chester University, two Philadelphia-area high schools, and at training camp for the Philadelphia Eagles. Both Drs. Brown and Turner are members of the American Academy of Pediatrics, the American College of Sports Medicine, and the American Medical Society for Sport Medicine. The division will be welcoming Dr. Brian T. Vernau (Figure 1C) in Fall 2014 after his completion of a sports medicine fellowship at CHOP. Dr. Vernau is also a pediatrician with sports medicine training.

Our department also staffs sixteen nurse practitioners, two registered nurses, five physician assistants, five cast technicians, and two athletic trainers who are able to evaluate, diagnose, and treat the full range of musculoskeletal disorders, as well as an additional staff of 41 office personnel.

This past year also marked the beginning of construction on the Buerger Center for Advanced Pediatric Care. The

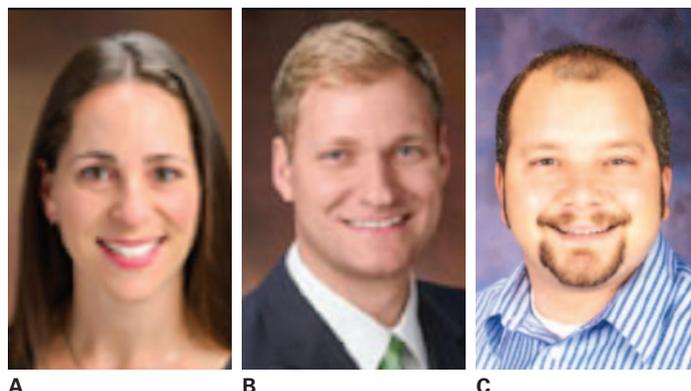


Figure 1. (A-C): From left to right, Drs. Naomi Brown, Christian Turner, and Brian Vernau.

Buerger Center, opening in 2015, will stand "as the nation's most state-of-the-art facility for outpatient medicine" (Figure 2). We are also looking forward to the opening of the newest CHOP Orthopedics facilities in Princeton, NJ, King of Prussia, PA, and Chadds Ford, PA. CHOP has also continued to develop a partnership with Virtua Memorial Hospital. In 2012, Virtua opened a Specialty Care Center where CHOP orthopedic physicians have a large presence. CHOP surgeons began providing fracture care in the emergency department at Virtua in 2013. The partnership with Virtua Memorial has centralized inpatient and outpatient emergency care.



Figure 2. Buerger Center for Advanced Pediatric Care will open its doors in 2015 and will be a state-of-the-art outpatient care facility which will house an orthopedic ambulatory care center.

Teaching

CHOP Orthopaedics currently funds four one-year clinical fellowships, and three one-two year research fellowships. The 2013-2014 clinical fellows are Patrick O'Toole, MD (Figure 3A); Rushyuan J. Lee, MD (Figure 3B); Ronald J. Mistovich, MD (Figure 3C); and Anish Potty, MD (Figure 3D). This year's research fellows are Nariman Abol Oyoun, MD, from Egypt (Figure 4A); Emmanuil Grigoriou, MD, from Greece (Figure 4B), and Muayad Kadhim, MD, from Syria (Figure 4C). Following completion of their clinical fellowships, Dr. O'Toole will be returning to Ireland to accept an academic position in orthopaedic surgery. Dr. Lee will be accepting an academic position at Johns Hopkins Hospital in Baltimore, MD, where he will focus on trauma and sport medicine. Dr. Mistovich is currently looking for an academic position in pediatric orthopaedic surgery in the Midwest with his wife who is a pediatrician. Dr. Potty will be continuing his medical training in Tampa, FL, as a clinical fellow in sports medicine. After completing his research fellowship, Dr. Grigoriou hopes to complete an orthopedic surgery residency program in the United States; Dr. Kadhim plans to complete a clinical or research fellowship in the United States; Dr. Abol Oyoun will be returning to Assiut University in Egypt, where she was an attending orthopedic surgeon.

The Division of Orthopaedic Surgery continues to reach out to the international community of specialists by participating in the Visiting International Scholars Program (VISP), a program designed to provide international orthopaedic surgeons with the opportunity to observe clinical care of pediatric patients in a high volume, academic setting. Over the past year, CHOP Orthopaedic Surgery has had numerous Visiting International Scholars, including Thiago Nogueira Pereira from Brazil, Wei Hsun Wang from Taiwan, Bagaria Vaibhav and Atul Malhotra from India, Jasqui Salomon from Mexico, and Li Lianying and Jacky Hua from China. Some of our Visiting International Scholars have gone on to be accepted as Research or Clinical Fellows here at CHOP or at other institutions in the United States.

Basic Science Research

The past year has been an exciting and productive one for our Basic Research Program, led by Maurizio Pacifici, PhD (Figure 5), with many activities and research initiatives related to a number of skeletal pathologies. Our faculty



Figure 3. (A-D): From left to right, the CHOP Orthopaedic 2012-2013 Clinical Fellows: Drs. Patrick O'Toole, Ronald J. Mistovich, Rushyuan J. Lee, and Anish Potty.

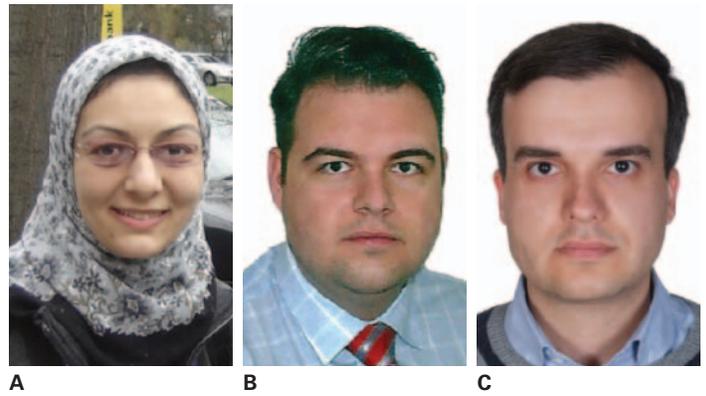


Figure 4. (A-D): From left to right, the CHOP Orthopaedic Research Fellows: Dr. Emmanuil Grigoriou from Greece, Dr. Muayad Kadhim from Syria, and Dr. Nariman Abol Oyoun from Egypt

members and their associates continue to work diligently on the aims of our several current NIH R01 grants and one DOD grant to understand the pathogenic mechanisms of pediatric and adult conditions, including Heterotopic Ossification (HO), Hereditary Multiple Exostoses (HME), and other musculoskeletal pathologies. Work led by one of our faculty members, Dr. Masahiro Iwamoto, and supported by the Muscular Dystrophy Association aims to exploit a new pharmacological pathway to enhance muscle tissue repair after trauma or congenital conditions, such as muscular dystrophies. An equally important area of research led by another faculty member, Dr. Motomi Enomoto-Iwamoto, and supported by a R21 grant from the NIH focuses on tendon and ligament biology and aims to stimulate structural and functional repair in those essential structures when damaged by trauma or overuse. Dr. Enomoto-Iwamoto has recently received a new grant from the Arthritis Foundation to study a cell membrane protein that affects the behavior and function of surface cells in articular cartilage, cells that are essential for the frictionless movement of the joints. The outcome of the work will shed



Figure 5. Group picture of the CHOP Orthopaedic Translational Research team led by Maurizio Pacifici, PhD. Back row from left to right: Eiki Koyama, Cheri Saunders, Rachel Mascareno, Colleen Larmour, Masahiro Iwamoto, Kenta Uchibe, Rebekah Decker, Federica Sgariglia. Front row: Agnese DiRocco, Julianne Huegel, Jiyeon Son, Rebecca Berger, Motomi Enomoto-Iwamoto, Maurizio Pacifici, Leslie Cantley, and Chloe Williams.

new light on the biology of those cells and suggest ways to maintain their function during aging or restore it in chronic conditions including osteoarthritis. In a related development, our faculty member Dr. Eiki Koyama has joined forces with Dr. Hyun-Duck Nah, a faculty member in the CHOP Division of Plastic and Reconstructive Surgery, to understand the development and growth of the temporomandibular joint and identify possible therapeutic means to treat TMJ osteoarthritis, a condition particularly common in women. The data and insights stemming from all the above research lines have generated publications in top peer-reviewed journals.

An exciting biomedical development is that our basic research work on HO has allowed further progress toward a possible clinical trial to treat children affected by Fibrodysplasia Ossificans Progressiva (FOP), a congenital and very severe form of HO. Papers we published in 2010 and 2011 showed for the first time that synthetic agonist ligands for nuclear retinoic acid receptors are very potent inhibitors of HO/FOP in experimental animal models of the disease. In the past year or so, the Canadian-based pharmaceutical company Clementia has been working closely with us and with our colleagues at the Penn FOP Foundation, Drs. Fred Kaplan, Bob Pignolo, and Eileen Shore, to organize and implement a Phase 2 trial for FOP in the very near future using such pharmacological treatment.

Our clinical division remains a major national and international center of diagnosis, care, and surgical treatment for children affected by HME. As indicated above, our Basic Research Program continues to be actively engaged in understanding the pathogenesis of HME, using animal models and cells in vitro. Thus, to extend these basic research efforts toward translational medicine outcomes, we have recently recruited a senior investigator, Dr. Paul Billings, to create new cell-based bioassays to screen chemical libraries and identify drugs able to correct a specific polysaccharide deficiency that causes HME. If identified, such pharmacological treatment could be used in combination with surgical interventions to provide a more effective and comprehensive therapy for HME patients in the future.

Genetic Research

CHOP Orthopaedics is also working in collaboration with the Center for Applied Genomics (CAG), led by Dr. Struan Grant, to compile a registry of DNA and RNA samples obtained from patients and families with a variety of orthopaedic conditions, including targeting families with multiple individuals affected with adolescent idiopathic scoliosis (AIS), osteochondritis dissecans (OCD) of the knee, and multiple hereditary exostoses (MHE). In 2011, CAG and Orthopaedics won the Scoliosis Research Society (SRS) Russell Hibbs Award for Best Basic Science Paper in 2011 for their study entitled, "A Genome Wide Association Study Identifies IL17RC as an Adolescent Idiopathic Scoliosis Locus." Our most recent efforts involve an analysis of whole exome sequencing on familial blood samples which will further elucidate the influence of genetics on the development of AIS. Our current finding presents the potential opportunity for diagnostic applications and for

novel therapeutic intervention for AIS by providing novel entry points in known scoliosis biological pathways.

Biomechanical Research

Our division welcomes Saba Pasha, PhD (Figure 6), to the research team. Dr. Pasha is a post-doctoral researcher with an interest in 3D analysis of skeletal deformities using the EOS imaging system, gait analysis, and clinical evaluation of medical devices in the pediatric population. CHOP expanded its diagnostic toolkit in 2013 with the addition of the EOS imaging system, which uses low doses of radiation to provide high quality 3D images. This enables accurate diagnosis and more informed treatment decisions.

Clinical Research

The CHOP Orthopaedic Surgery Division is currently conducting 101 IRB approved clinical research projects. This includes a number of randomized clinical trials and multicenter studies. Investigators within the division have been awarded funding from both internal and external sources to conduct these studies. In the past two years, the division has published over 110 articles in major orthopaedic journals, including (but not limited to) *JBJS*, *SPINE*, *JPO* and *CORR*.

Our pediatric orthopaedic faculty continues to present research studies at orthopaedic conferences around the world, including the American Academy of Orthopaedic Surgeons (AAOS), the Pediatric Orthopaedic Society of North America (POSNA), the European Pediatric Orthopaedic Society (EPOS), the Scoliosis Research Society (SRS), the American Orthopaedic Society for Sports Medicine (AOSSM), the International Meeting on Advanced Spine Techniques (IMAST), the Societe Internationale de Chirurgie Orthopedique et de Traumatologie (International Society of Orthopaedic Surgery and Traumatology, SICOT) and many more.

In 2009, our department initiated an annual Benjamin Fox Scholarship Award for current medical students who are interested in conducting a year of clinical research within orthopaedics. In June, our department awarded Christine Goodbody, (Figure 7A) an upcoming fourth year medical student at the Perelman School of Medicine at the University of Pennsylvania and Afamefuna Nduaguba, (Figure 7B) a fourth year medical student at Harvard University with this scholarship. While at CHOP, Christine has concentrated her research on complications of supracondylar humerus and lesser trochanter avulsion fractures, effect and outcomes of BMI on scoliosis presentation, and treatment of tibial shaft fractures. Afamefuna has focused his research on developmental hip dysplasia (DDH) management, septic arthritis of the knee, effects of BMI on ACL ruptures and chondral injuries, and the accessibility of surgical services in developing counties.



Figure 6. Saba Pasha, PhD, is completing postdoctoral research at CHOP.

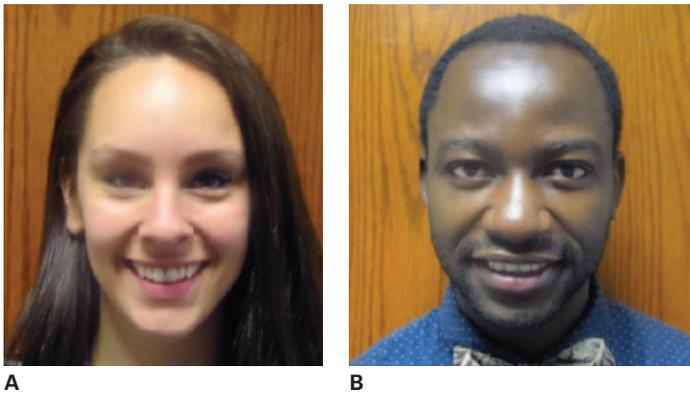


Figure 7. 2013-2014 Benjamin Fox Research Fellows Christine Goodbody (A) and Afamefuna Nduaguba (B). Christine and Afamefuna are upcoming fourth year medical students who have taken a year to do clinical research in pediatric orthopaedic surgery at CHOP.

Recognitions and Achievements

Our Attendings have assumed several leadership roles within the pediatric orthopaedic community over the past year.

Robert Campbell, MD, has continued to expand and develop the Center for Thoracic Insufficiency at CHOP. Dr. Campbell was nominated by the American Academy of Orthopaedic Surgeons for representation on the Center for Devices and Radiological Health (CDRH) Medical Advisory Committees' Orthopaedic and Rehabilitation Devices Panel. Dr. Campbell has been recognized in the past by the Food and Drug Administration (FDA) for his work on the VEPTR.

Denis S. Drummond, MD, CHOP Orthopaedics Chief Emeritus, has continued to serve as the Co-Director of the CHOP Orthopaedic Fellowship Program. Dr. Drummond was the Director of Clinical Research until 2012 and remains an active member of the research program in CHOP Orthopaedics.

Keith Baldwin, MD, MSPT, MPH, is the current director of clinical research in the Division of Orthopedic Surgery at CHOP. Dr. Baldwin is also the Health Policy Chair of the Orthopedic Rehabilitation Association and an Associate Editor for Rehabilitation for the *Journal of Bone and Joint Surgery (JBJS)*.

Jack Flynn, MD, is currently the President of the Pediatric Orthopaedic Society of North America (POSNA) and will host the 30th Annual Meeting of POSNA in Hollywood, CA, in April. Dr. Flynn and Dr. Stu Weinstein just released the 7th edition of *Lovell and Winter's Pediatric Orthopaedics*, considered to be the authoritative text in the field. Dr. Flynn led CHOP's effort in the landmark NIH BrAIST trial, which conclusively proved the efficacy of bracing as a treatment for scoliosis. He co-chaired the International Pediatric Orthopaedic Symposium (IPOS) and began his service as Chair of the American Academy of Orthopaedic Surgeons CME Courses Committee. He continues his service on the Board of Directors of the Children's Spine Study Group and is active in the Harms Study Group, a multi-center collaboration of researchers studying care improvements for pediatric spine deformity surgery.

Theodore J. Ganley, MD, is the Sports Medicine Director at CHOP, supporting the clinical, research and outreach

initiatives which continue to grow, including the new planned sports medicine center in King of Prussia and Chadds Ford. In 2013, Dr. Ganley collaborated on the creation of the new Penn/CHOP Orthopedic Sports Medicine Fellowship with Dr. Brian Sennett as well as departmental chairmen, Drs. Scott Levin and John Dormans. He was the Director of the AAOS/ POSNA sponsored course entitled, "Cutting Edge Techniques in Pediatric Orthopedic Surgery" at the AAOS orthopedic learning center. He was selected as moderator or instructor at instructional course lectures for the following annual meetings: the AAOS, AAP, AOSSM, POSNA, and IPOS. He was an advisory board member for the International Pediatric Orthopedic Symposium and ran the sports medicine section of the Surgical Simulation Lab. He co-founded the Research in OCD of the Knee (ROCK) group and is on the board which developed the Pediatric Research in Sports Medicine (PRISM) group. Dr. Ganley has been selected as a visiting professor and invited lecturer this year at Harvard Boston Children's Hospital, Case Western Reserve University, Union Memorial Hospital, and the Mexican Society of Pediatric Orthopedics in Villahermosa.

B. David Horn, MD, was the Pediatric Chair of the Pediatric Orthopaedic Scored and Recorded Self-Assessment Examination, which was published by the American Academy of Orthopaedic Surgeons (AAOS) in 2013.

John Todd Lawrence, MD, PhD, received the OmeGa Core Competency Grant in 2012. This funding has supported the creation of a fracture reduction model (patent pending) as a means to educate and improve resident performance in fracture reduction and casting techniques. Dr. Lawrence, along with Dr. David Horn and Dr. Richard Davidson, was a visiting professor in Austria at the Open Medical Institute. He presented four lectures on the topic of sports medicine.

Christina Master, MD, in conjunction with the Mind Matter: Improving Pediatric Concussion Management Program at CHOP, has written and lectured extensively on the topic of concussions in children and adolescents. In November 2013, Dr. Master participated in a Congressional Panel at the House of Representatives regarding concussion in athletics. She is also a co-investigator on a number of grants which fund research relating to concussion treatment.

Wudbhav Sankar, MD, is the Director of the Young Adult Hip Preservation Program at CHOP and has played a key role in the development of a comprehensive hip database. Dr. Sankar was the Program Chair of the POSNA at the 2014 Annual Meeting. He is also the section editor of the spine section of *Operative Techniques in Orthopedics Surgery*, 2nd Edition. Along with his professional achievements this year, Dr. Sankar and his wife welcomed their second child, Kamran, on March 12, 2013.

David Spiegel, MD, was awarded the 2013 Humanitarian Award from the Pediatric Orthopaedic Society of North America (POSNA) for his "outstanding service to the underserved children of the world with musculoskeletal disorders." He was also accepted into the American Academy of Orthopedic Surgery (AAOS) Achievement Award Program. Dr. Spiegel continues his work with the World Health Organization, traveling to Port of Spain, Trinidad and Tobago,

and Geneva, Switzerland, in the past year. He is currently on the board of Orthopaedics Overseas, the Ponseti International Association, and Miracle Feet.

Lawrence Wells, MD is the section editor for the orthopaedic section of *Nelson's Textbook of Pediatrics*, 20th Edition, which will be published in 2015. Dr. Wells is the Program Chair for the Philadelphia Orthopaedic Society in 2013-2014 and is a member of the executive committee for the section on orthopaedics for the American Academy of Pediatrics. He was also appointed to the Physicians Leadership Academy of the University of Pennsylvania.

John P. Dormans, MD, FACS, Chief of Orthopaedic Surgery at CHOP, was elected into the Presidential Line of the Scoliosis Research Society (SRS) and will host the SRS 50th Anniversary meeting as President in Minneapolis, MN, in 2015. Dr. Dormans recently completed his term as Chairman of Société Internationale de Chirurgie Orthopédique et de Traumatologie (SICOT) USA. He is currently the Secretary General of the SICOT Foundation. Dr. Dormans is the President Elect of the World Orthopaedic Concern (WOC) and will serve as President for the 2014-2017 term. He also completed his term as President of POSNA in 2010.