Penn Medicine

PENN PHYSICAL MEDICINE and REHABILITATION UPDATE

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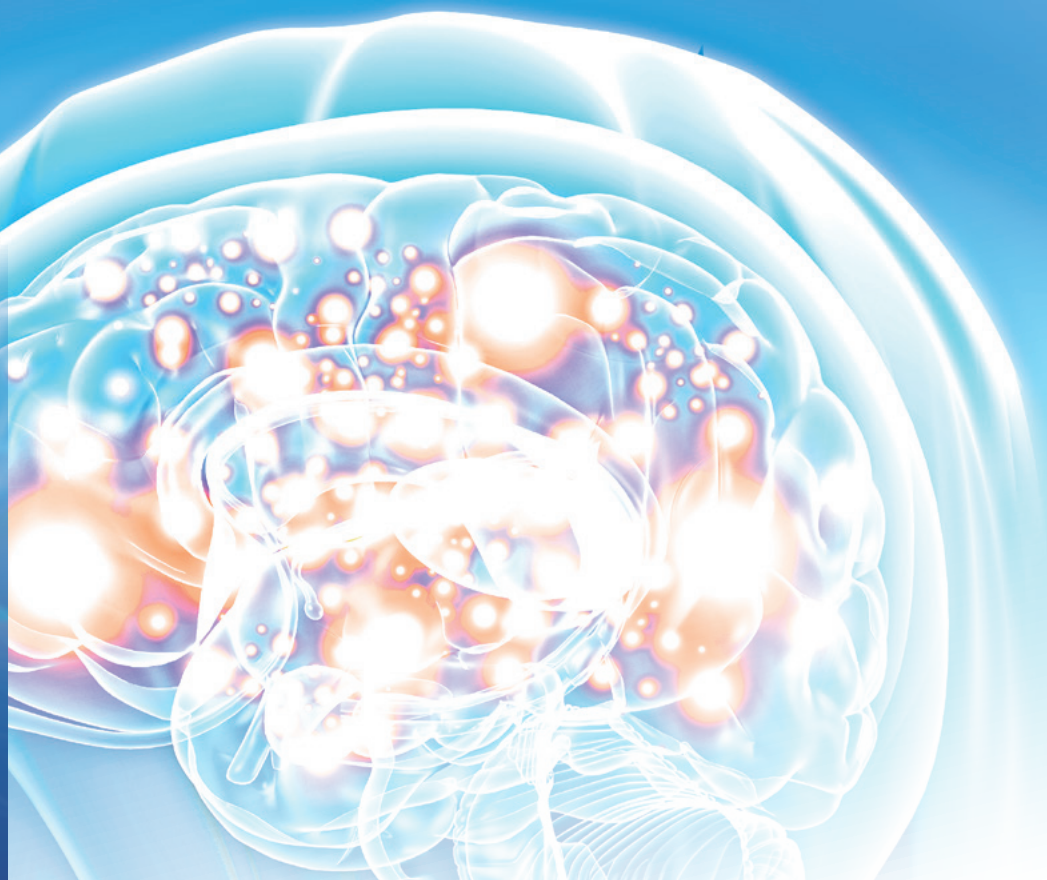

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New Robotics Laboratory

Enabling Advances in Brain Plasticity and Motor Function

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A MESSAGE FROM THE CHAIR

Dear Colleagues,

It gives me great pleasure to update you on the many exciting things happening in the Department of Physical Medicine and Rehabilitation (PM&R) at Penn Medicine. This is the inaugural edition of the Penn Physical Medicine and Rehabilitation Update. We are fortunate to be part of a great university and health system, and in such a fertile environment, we are thriving, building our research, expanding our educational programs, and growing our clinical services.

The Penn Rehabilitation Robotics Research and Development Laboratory at the University of Pennsylvania School of Medicine, led by its director Dr. Michelle J. Johnson, is pioneering new rehabilitation strategies using state-of-the art robots. The Lab's mission and focus is to use rehabilitation robotics and neuroscience to investigate brain plasticity and motor function after nontraumatic brain injuries. By exploring the underlying cause of limb impairment following neural disease, injury or accident, the Lab seeks to develop cost-effective methods of functional recovery with the goal of promoting independent living and empowering patients with disabilities through an improved quality of life.

It is with both joy and a sense of loss that we pay tribute to Margaret Stineman, MD, as she retires from Penn after an illustrious career. I met her at a meeting once many years ago after she delivered a talk. I thought to myself—extraordinary. Her science was stellar, her presentation captivating, and her personality charming. Dr. Stineman is retiring following a thirty-year career at Penn Medicine. An accomplished leader in her field, Dr. Stineman has made countless contributions to our department as well as to the field of PM&R through her tireless dedication to research and innovation. Published well over 100 times, Dr. Stineman amassed numerous honors and awards over the course of her remarkable career. We wish her the greatest success on the next stage of her life's journey.

We are fortunate to have generous people who have contributed to our department over the years with lasting impact. One individual, Mr. Michael J. Dunbar generously contributed recently in honor of his father, William Dunbar, MD. The role of philanthropic support has long been established to advance academic discoveries and further our department's mission. For this reason, we are pleased and honored to receive this generous donation from Mr. Dunbar and the Dunbar family. Their endowment will now fund two annual awards: a $5,000 cash award for a resident in the Department of Physical Medicine and Rehabilitation who "has best advanced the theory and practice of physical medicine and rehabilitation" and a $5,000 cash award for professional or non-professional staff who have assisted in helping patients to achieve a greater quality of life.

As the oldest department of its kind in the country, we are in the middle of an inspiring and impressive evolution. Our rehabilitation unit is fully integrated within Penn Medicine under an electronic health record. Capitalizing on the advances made in healthcare reform and innovative technological solutions, this platform has advanced care for our patients and enhanced communication across hospitals.

We continue to be a rapidly growing, fully integrated department that supports the Penn Medicine health system on many levels. We provide advanced musculoskeletal care at the new Penn Musculoskeletal Center. Our inpatient and consult services address the rehabilitation needs of patients with complex medical, neurological, and musculoskeletal disorders. We are dedicated to building an excellent research program to advance the science and practice of rehabilitation medicine. Our outstanding educational programs include an accredited residency-training program and fellowship program.

As we move forward and engage the many contemporary healthcare changes, we will maintain a sharp focus on science and teaching.

—Timothy R. Dillingham, MD, MS

The William J. Erdman II, Professor and Chair
Department of Physical Medicine and Rehabilitation
The University of Pennsylvania

PIONEERING
REHABILITATION RESEARCH IN ROBOTICS

The Penn Rehabilitation Robotics Research & Development Lab combines robotics and neuroscience to investigate brain plasticity and motor function after non-traumatic brain injuries such as stroke, cerebral palsy, spinal cord injuries, amputation and neurological disorders. By examining the underlying causes of motor and cognitive dysfunction, the Lab is pioneering new ways to improve the recovery process by utilizing sophisticated robotics systems to provide effective neurorehabilitation.

The Lab officially opened on August 1, 2013 under the leadership of Michelle J. Johnson, PhD, Assistant Professor of Physical Medicine and Rehabilitation at the University of Pennsylvania. The Lab's mission is to combine robotics, rehabilitation and neuroscience to translate research findings into the development of affordable, assistive and therapeutic robots that are able to provide effective neurorehabilitation on both a national and global level.

Research Initiatives

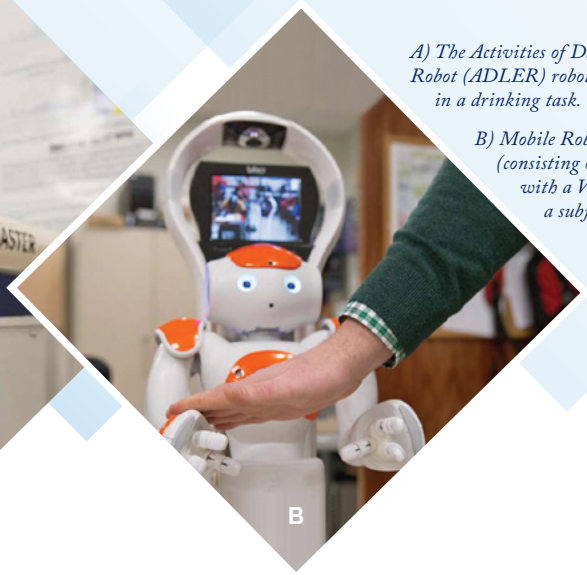
This innovative research focuses on several initiatives, most notably addressing the need for affordable therapeutic robots to balance the limitations that currently exist in the rehabilitation industry, where rehab patients well exceed the number of human therapists available. Research is centered on developing robotic systems that are capable of providing neurorehabilitation while safely interacting with patients in real-world rehab environments. The goal of this therapy is to improve patients' quality of life and performance of daily living activities in supervised (hospital) or under-supervised (at-home) settings.

The Lab is organized into three research areas: neurorehabilitation, global health, and mobile/humanoid therapeutic assistance. All research areas in the lab are focused on the development of therapy robot systems to understand the barriers of neurological impairment, functional recovery for activities of daily living (ADLs), and community-based participation after neurological injury and utilize technology to overcome these barriers.

Neurorehabilitation

The neurorehabilitation research area investigates the underlying causes of impairment and, based on findings, applies techniques using the robots to expedite the recovery process. The Neurorehabilitation research area focuses both on the development and use of "hands on" robots to support and move the upper limbs in functional activities and on understanding the causes of impairment and how to best apply these systems to provide effective rehabilitation.

Neurorehabilitation techniques focus predominantly on stroke, cerebral palsy and physical rehabilitation in general. Patients find their way to the Lab mainly through physician referral. Many are stroke survivors at different levels of function. Factors such as the type of rehabilitation they're trying to achieve, the study we're performing and the system we want them to interact with determine their path through the Lab. Researchers examine the interaction between the robot and the patient, including the ways in which this interaction changes the patient's brain, also called neuroplasticity, to improve physical functioning. Neuroplasticity refers to the brain's ability to reorganize itself after injury or



A) The Activities of Daily Living Exercise Robot (ADLER) robot assists a researcher in a drinking task.

B) Mobile Robot Therapist Flo (consisting of a NAO robot with a Vgo robot) instructs a subject

disease by forming new neural connections. These new connections are stimulated through activity such as various neurehabilitation techniques.

Applying neurorehabilitation techniques using the robots is relatively simple.

For example, the Activities of Daily Living Exercise Robot (ADLER) used mostly in the stroke training setting, trains the patient in consistent and repeated practice of daily living tasks such as drinking. A patient places his/her hand into the cradle attached to the robot's arm and lifts a cup to drink. The robot records the mechanics of these actions, allowing it to guide the patient through rehabilitation based on these motions. These repetitive motions stimulate the neurons in the brain to form new connections and the patient eventually re-learns the activity. The Bi-ADLER robot is similar, except that it allows patients to perform tasks that require unilateral or bilateral coordinated reaching and grasping.

Flo is a Bi-ADLER humanoid robot that treats patients who are recovering from strokes, especially those with upper body disabilities. This robot is primarily used in inpatient facilities such as hospitals and nursing homes.

Global Health

The global health research area designs and develops affordable therapy robots such as TheraDrive with accessible, low-cost technologies that have the potential for national and global applications. These systems use standard parts and readily available commercial products along with innovative custom parts to reduce cost and complexity and maximize usability in poorer and under-supervised environments. The Lab is currently developing these systems for countries with low-to-medium socioeconomic levels. Penn has established a partnership with a university in Latin America and is also seeking similar opportunities in Africa through the Botswana U-Penn Partnership.

Mobile/Humanoid Therapeutic Assistance

Mobile/humanoid therapeutic assistance refers to the development and use of mobile robots to aid in the recovery process of patients requiring neurorehabilitation. The goal of this research area is to provide low-cost, effective rehabilitation techniques within both inpatient and outpatient rehab environments using these robot systems.

One of our humanoid robots is Baxter. In a current study, Baxter is being trained to be able to move as a therapist would for stroke survivor treatment. The research phases for this study include learning (the robot learns the movements of a therapist), demonstration (the robot mimics these learned movements), and teaching (the robot is then capable of providing the desired therapy). The study is currently in the the learning phase. The team has implemented an algorithm to capture the kinematic movement of the therapist using Microsoft Kinect and is working to create a re-targeting algorithm to map this movement data to the robot. Once this retargeting is complete, the study will progress to the demonstration phase, enabling the robot to mimic the movement, and finally into the teaching phase when the robot will be able to safely interact with a patient to provide therapy.

With the goal of creating a robot ideal for telerehab, telemonitoring, and teleconsulting, the team has created Flo, a Mobile Therapy Robot Prototype which consists of the humanoid robot NAO and the telepresence robot Vgo. Flo was designed to provide remote and in-person "hands off" therapy for adults and children with upper arm/hand disabilities due to non-traumatic brain injury.

Affiliations and Collaborations

The Lab is affiliated with the General Robotics, Automation, Sensing and Perception (GRASP) Laboratory at the University of Pennsylvania. GRASP integrates computer science, electrical engineering and mechanical engineering in a collaborative research environment to provide new concepts that will further enhance the burgeoning robotics industry. GRASP is a $10 million research center that has made technological innovations such as building autonomous vehicles, developing self-configuring humanoid robots and making robots swarm. The Lab is also strongly affiliated with the Center for Neuroengineering and Therapeutics (CNT) in the Perelman School of Medicine.

- **The Lab is always looking to forge relationships with other healthcare professionals with similar goals and interests for our projects,** and we are open to collaborating with those interested in recruiting patients to the Lab. In addition to engineers, we are also looking to bring in medical students and residents who are interested in rehabilitative robotics, and we work with occupational and physical therapists who participate in various projects.

In addition, The Lab is seeking to strengthen its affiliation with other centers that are deploying research studies in robotic neurorehabilitation such as the Children's Hospital of Philadelphia's neuro-rehabilitation center, which will allow our studies to branch out into the pediatric population.

The Lab Team

The Lab's director, Dr. Michelle J. Johnson, spearheaded the opening of the lab in the summer of 2013. Well recognized for her work pioneering new rehabilitation strategies combining neuroscience and robotics, Dr. Johnson's current research focuses on understanding upper extremity dysfunction and recovery after brain injury.

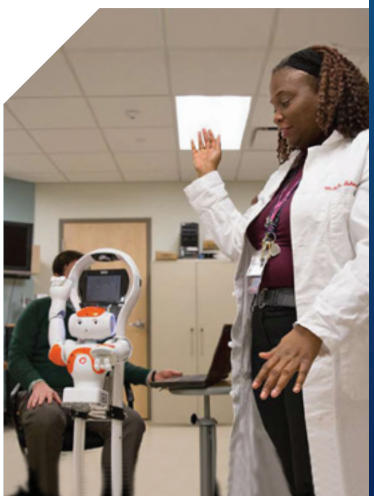
In the summer of 2014, the Lab had about 15 undergraduate students working on various projects, including several National Science Foundation (NSF) grant winners. One of our summer interns was a high school student, who was selected by The Franklin Institute's STEM Scholars Program.

In addition to running the lab, Dr. Johnson is Assistant Professor of Physical Medicine and Rehabilitation at the University of Pennsylvania and she holds a secondary appointment as an Assistant Professor in Bioengineering. She completed her PhD in Mechanical Engineering from Stanford University, with an emphasis in mechatronics, robotics, and design. She completed her post-doctoral NSF-NATO fellowship at the Advanced Robotics Technology and Systems Laboratory at the Scuola Superiore Sant'Anna in Italy. Dr. Johnson is also a member of the Mechanical Engineering and Applied Mechanics graduate group.

Along with a lab manager and research coordinator, Dr. Johnson oversees a diverse team of undergraduate, graduate and doctoral students from the University of Pennsylvania and other top-ranked programs from around the country. The majority of graduate students are candidates for an M.S. in Robotics at the University of Pennsylvania with undergraduate degrees in biomedical, mechanical, or electrical engineering, although several of these students have computer science backgrounds. Other universities represented at the Lab include Cooper Union, Drexel University, NYU, Oklahoma State University, Stanford University, Washington University in St. Louis and several top foreign institutions.

The Lab's doctoral students are trained in theory and practice and are also mentored to become leaders in research and education. The graduates of the interdisciplinary Master's in Robotics program are uniquely equipped to face research and development challenges of the rapidly growing robotics industry.

- Learn more at **pennrehabrobotics.org.**



Mobile Therapy Robot Prototype, Flo directs Dr Johnson to lift arm and follow her.

Margaret Grace Stineman, MD

RETIRES AFTER **30 YEARS OF SERVICE**

This Fall, a familiar smile and laugh will be notably missing from the halls of Penn Medicine.

Margaret G. Stineman, MD has announced her retirement following an illustrious career spanning three decades. Dr. Stineman came to Penn Medicine in 1984 as a resident then was appointed as an assistant professor in the Department of Physical Medicine and Rehabilitation in 1989. She now retires as a tenured Professor Emeritus in Physical Medicine and Rehabilitation. She held a secondary appointment as professor of Epidemiology in the Department of Biostatistics and Epidemiology at Penn. Additionally, Dr. Stineman contributed to the department and Penn in so many ways. Her science was stellar and personality charming. She inspired all those around her and especially those with whom she collaborated. Serving as the Vice Chair and Director of Research for the Department of Physical Medicine and Rehabilitation, she trained students, residents and fellows and enhanced our academic missions.

"May I have the strength to see what I need to see, to know what I need to know, so that I can care for you in the best possible way."

— Margaret G. Stineman, MD

Dr. Stineman's career in medicine and research is truly remarkable for its breadth and depth. The foundation for her work has been an expanded biopsycho-ecological model that views interactions between the person and the environment as contributing to illness and disability. It is this ecological framework that has inspired her conviction that medical interventions should move beyond the person to include the environment in which he or she lives.

Dr. Stineman received uninterrupted NIH funding beginning in 1990 for a broad range of projects applying quantitative and qualitative methods to examine the rehabilitation of patients with disabilities related to neurological and other disorders. She and her colleagues developed a patient classification approach that forms the basis for Medicare's national payment system for inpatient rehabilitation, established staging systems for addressing patients' mobility and abilities to care for themselves, and established a clinical and research procedure for addressing the effects of disabilities on quality of life.

Having received awards and honors too numerous to mention in full, some highlights of Dr. Stineman's distinguished and remarkable career include: well over 100 peer-reviewed scientific publications; 1st Stroke Achievement Award for Psychosocial and Medical Caregiving for Professional, Clinical and Academic Accomplishments and Explorations; the Elizabeth and Sidney Licht Award for Excellence in Scientific Writing from the American Congress of Rehabilitation Medicine; and becoming the first Carolyn L. Braddon EdD Research Award recipient from the Association of Academic Physiatrists.

Additionally, Dr. Stineman was an inaugural recipient of the Fellow of the American Congress of Rehabilitation Medicine distinction in 2002, earned the Samuel Martin Health Sciences Evaluation Sciences Research Award, the Distinguished Academician Award from the Association of Academic Physiatrists, and the Gold Key Award from the American Congress of Rehabilitation Medicine. Dr. Stineman was elected to the Institute of Medicine of the National Academies in 2011 and the Association of American Physicians in 2011.

We rejoice with Dr. Stineman in celebrating this incredible milestone. Her influence, passion, and dedication to her colleagues, patients and scientific community has left an impact both professionally and personally. Her life and accomplishments are inspiring and reflect her indomitable spirit. She truly embodies her middle name "Grace", showing grace, kindness, and humility while excelling in her profession, achieving national and international prominence. Margaret has touched so many of our lives and we are all better for having the privilege of knowing and working with her.

We thank her for her invaluable contributions and wish her the very best in her retirement and future endeavors. ◆

Michael J. Dunbar Gift

SUPPORTS CONTINUED EXEMPLARY CARE

Michael Joseph Dunbar (May 10, 1946 - April 21, 2014) made a generous provision in his estate for the Department of Physical Medicine and Rehabilitation at Penn Medicine to memorialize his father and the legacy their family left behind.

Above: William Dunbar, MD, father of Michael J. Dunbar

Michael's father, the late William Dunbar, MD, practiced medicine at the Hospital of the University of Pennsylvania (HUP) for many years and served as Chair of the Department of Physical Medicine and Rehabilitation at Penn Medicine. A proud native of Philadelphia and a University of Pennsylvania graduate, Dr. Dunbar earned his undergraduate degree in 1935 and his medical doctorate in 1939. During World War II, he served his country in the Navy Medical Corps.

A well-loved and respected physician, Dr. Dunbar became a pioneer and trailblazer in the emerging field of rehabilitation medicine. In 1947, Dr. Dunbar was instrumental in bringing better health care to the city by spearheading the opening of the first rehabilitation center, the first cardiac evaluation center and the first comprehensive hospital unit in Philadelphia.

Dr. Dunbar's son Michael also proudly worked at HUP, and after spending 42 years in loyal service, he retired from the mailroom. The only son of Dr. and Mrs. Dunbar, Michael left the majority of his estate to create the Dr. William Dunbar Awards in Physical Medicine and Rehabilitation to reward those individuals who help continue the work and delivery of medicine his father so loved. This generous gift provides an annual cash award of $5,000 and recognizes one resident and one supporting staff member for performing in ways that uphold Dr. Dunbar's ideals. These individuals are recognized as those who have helped patients achieve a greater quality of life and who have worked to advance the theory and practice of physical medicine and rehabilitation.

Penn Medicine finds estate gifts to be particularly meaningful. We are honored that Mr. Dunbar found us worthy, to leave his entire estate to Penn, to establish this award. This act, coupled with Mr. Dunbar's more than four decades of service to HUP as a member of its staff, makes such a gift even more special.

Mr. Dunbar's foresight is far-reaching. By creating this generous award, he has secured his father's legacy in the institution where Dr. Dunbar brought so much innovation and change. Because the William Dunbar Award is an endowed fund, it is perpetual. Only a portion of the endowment's interest is used each year as Mr. Dunbar outlined in his bequest. This ensures the future growth of the fund so that it may provide long-lasting support for the Department. ◆

YOUR SUPPORT MATTERS!

- **These progressive and exciting developments are made possible through philanthropy and individuals who understand and champion our goals. We welcome gifts of all sizes and are pleased to discuss all forms of giving preferences with any prospective donor seeking to support our significant strides toward inventive research and health care technologies.**

To learn more about bequests or to request customized language, please contact Christine S. Ewan, JD, Executive Director of Planned Giving at (215) 898-9486. Christine may also be reached by email at cewan@upenn.edu or by regular mail at:

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RECENT **PUBLICATIONS**

- **Prosthesis Use and Satisfaction Among Persons With Dysvascular Lower Limb Amputations Across Postacute Care Discharge Settings.**
  Roth EV, Pezzin LE, McGinley EL, Dillingham TR. PM R. 2014 Jun 19. pii: S19341482(14)00297-4 doi:10.1016/j.pmrj.2014.05.024. [Epub ahead of print]

- **Epidemiology of limb loss.**
  Varma P, Stineman MG, Dillingham TR. Phys Med Rehabil Clin N Am. 2014 Feb;25(1):1-8. doi: 10.1016/j.pmr.2013.09.001. Review.

- **Effect of postacute rehabilitation setting on mental and emotional health among persons with dysvascular amputations.**
  Pezzin LE, Padalik SE, Dillingham TR. PM R. 2013 Jul;5(7):583-90. doi: 10.1016/j.pmrj.2013.01.009. Epub 2013 Mar 13.

- **High-resolution median nerve sonographic measurements: correlations with median nerveconduction studies in healthy adults.**
  Marciniak C, Caldera F, Welty L, Lai J, Lento P, Feldman E, Sered H, Sayeed Y, Plastaras C. J Ultrasound Med. 2013 Dec;32(12):2091-8. doi: 10.7863/ultra.32.12.2091.

- **Diagnosing adductor muscle avulsion at the symphysis pubis with ultrasound.**
  Chen DJ, Caldera FE, Kim W. Am J Phys Med Rehabil. 2014 Apr;93(4):346-8. doi: 10.1097/PHM.0000000000000000.

- **Restoring ADL function after wrist surgery in children with cerebral palsy: a novel Bilateral robot system design.**
  Holley D, Theriault A, Kamara S, Anewenter V, Hughes D, Johnson MJ. IEEE Int Conf Rehabil Robot. 2013 Jun;2013:6650463. doi: 10.1109/ICORR.2013.6650463.

- **Remote vibrotactile noise improves light touch sensation in stroke survivors' fingertips via stochastic resonance.**
  Enders LR, Hur P, Johnson MJ, Seo NJ. J Neuroeng Rehabil. 2013 Oct 11;10:105. doi: 10.1186/1743-0003-10-105.

- **Factors associated with pain reduction after transforaminal epidural steroid injection for lumbosacral radicular pain.**
  McCormick Z, Cushman D, Casey E, Garvan C, Kennedy DJ, Plastaras C. Arch Phys Med Rehabil. 2014 Dec;95(12):2350-6. doi: 10.1016/j.apmr.2014.07.404. Epub 2014 Aug 7.

- **Adverse events associated with fluoroscopically guided zygapophyseal joint injections.**
  Plastaras C, McCormick Z, Macron D, Garvan C, Joshi A, Chimes G, Smeal W, Rittenberg J. Pain Physician. 2014 Jul-Aug;17(4):297-304.

- **Trainee involvement in transforaminal epidural steroid injections associated with increased incidence of vasovagal reactions.**
  Schneider B, Kennedy DJ, Casey E, Smuck M, Conrad B, Plastaras C. PM R. 2014 Oct;6(10):914-9. doi: 10.1016/j.pmrj.2014.04.003. Epub 2014 Apr 20.

- **Fluoroscopy procedure and equipment changes to reduce staff radiation exposure in the interventional spine suite.**
  Plastaras C, Appasamy M, Sayeed Y, McLaughlin C, Charles J, Joshi A, Macron D, Pukenas B. Pain Physician. 2013 Nov-Dec;16(6):E731-8.

- **Should antiplatelet medications be held before cervical epidural injections?**
  Furman MB, Plastaras CT, Popescu A, Tekmyster G, Davidoff S, Kennedy DJ. PM R. 2014 May;6(5):442-50. doi: 10.1016/j.pmrj.2014.04.012.

- **Present and potential use of spinal cord stimulation to control chronic pain.**
  Song JJ, Popescu A, Bell RL. Pain Physician. 2014 May-Jun;17(3):235-46.

- **A randomized study of lubiprostone for opioid-induced constipation in patients with chronic noncancer pain.**
  Cryer B, Katz S, Vallejo R, Popescu A, Ueno R. Pain Med. 2014 Nov;15(11):1825-34. doi: 10.1111/pme.12437. Epub 2014 Apr 9.

- **The effect of protein and calorie intake on prealbumin, complications, length of stay, and function in the acute rehabilitation inpatient with stroke.**
  Pellicane AJ, Millis SR, Barker KD, Temme KE, Sayyad A, Oswald MC, Roth EJ. NeuroRehabilitation. 2013;33(3):367-76. doi: 10.3233/NRE-130966.

- **Recognition and rehabilitation of the female athlete triad/tetrad: a multidisciplinary approach.**
  Temme KE, Hoch AZ. Curr Sports Med Rep. 2013 May-Jun;12(3):190-9. doi: 10.1249/JSR.0b013e318296190b.

- **Hemiplegic shoulder pain: an approach to diagnosis and management.**
  Vasudevan JM, Browne BJ. Phys Med Rehabil Clin N Am. 2014 May;25(2):411-37. doi: 10.1016/j.pmr.2014.01.010. Epub 2014 Mar 14.