

**Advanced Platform Technology Center (APTC)
Louis Stokes Cleveland VA Medical Center (LSCVAMC)**



A VA Research Center

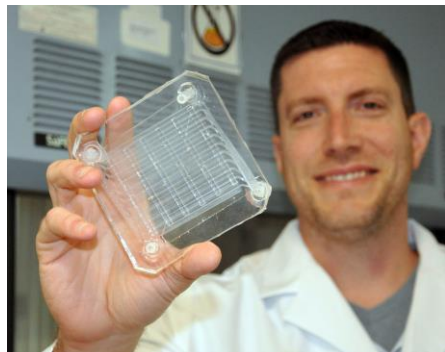
<http://www.aptccenter.research.va.gov>

**ANNUAL REPORT
For Activities during the period: October 1, 2017 – September 30, 2018**

NARRATIVE SUMMARY

KEY IMPACTS

1. Microfluidic artificial lung research progresses and VA Secretary takes notice



VA Researchers are building a 3D-printed, wearable, microfluidic artificial lung that will be compatible with living tissue and is capable of short- and long-term respiratory support. The system is designed to reduce suffering and improve quality of life for Veterans with end stage lung disease who currently have no other treatment option. An article on the progress of the lung was featured in VA Research Currents in August and has been covered by numerous media outlets that have been shared to Facebook over 500 times, along with a news story viewed over 2,200

times on Facebook. This project was also mentioned by VA Secretary Robert Wilkie during his statement before the Senate Veterans Affairs Committee. Core Investigator Joseph Potkay, PhD, is the lead scientist behind this technology. Dr. Potkay received a National Institutes of Health (NIH) R21 grant earlier this year to develop a control system for the lung, and a NIH R01 titled *Human-Scale Microfluidic Artificial Lung* will be awarded in 2019. *Photo credit: Brian Hayes*

2. VA interdepartmental collaboration and APTC pilot funding enables US patent approval



Companionship and social isolation influence not only the quality of life among older people, but impact physical and mental health and subsequent use of health services. These issues are particularly important to aging and increasingly isolated Veterans in rural areas. Development of a wearable, bio-social sensor system to measure social data in older persons was funded by the APTC's pilot program and patented in May (US 9,968,296 B2). The system is designed to assess biological, behavioral, social, and physical environmental data, as well as examine their interactive roles and relative importance. This was a collaboration

between Associate Investigator Kiju Lee, PhD, and LSCVAMC's Innette Sarduy, Associate Director, Patient Care/Nurse Executive; Patria Gerardo, MD and Elizabeth Noelker, Medical Director and Chief Nurse (respectively), VA Community Living Center. Dr. Lee plans to explore NIH programs that suit further exploration of this technology and user studies.

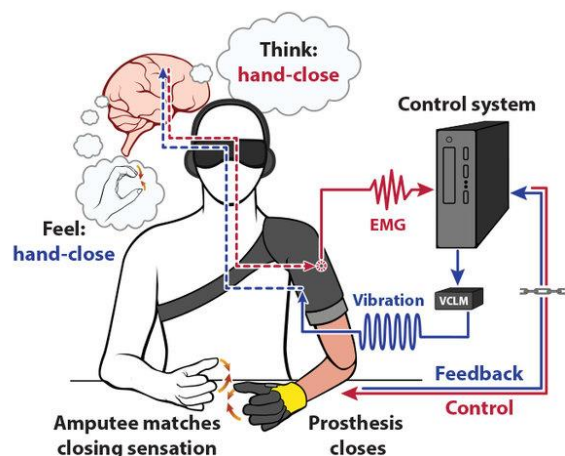
3. VA wound healing research featured on the cover of *Journal of Clinical Investigation*

The March cover of The Journal of Clinical Investigation (JCI) featured an article titled *Factor XII and uPAR Upregulate Neutrophil Functions to Influence Wound Healing*. This article describes a novel signaling pathway in neutrophils that involves coagulation Factor XII and its receptor uPAR, and their effect on neutrophil priming and sterile inflammation. These findings identify the FXII/uPAR axis as a driver of neutrophil-mediated inflammation, highlighting a potential target for inflammatory disease and inhibiting wound healing. Excessive or persistent neutrophil activity at wound sites contributes to the development of chronic, nonhealing wounds. This study found the



FXII/uPAR/pAkt2 axis in neutrophils, which promotes cell activation and leads to impaired wound healing. Wound preventative measures are a critical need for Veterans, specifically the large population of spinal cord injury patients and wheelchair users. Associate Investigators, Evi Stavrou, MD and Umut Gurkan, PhD, along with international and national collaborators, authored the breakthrough article that has been viewed almost 8,300 times on JCI and Pubmed Central. *Image credit: Erika Woodrum*

4. New method to restore natural sensation in patients with prosthetic arms

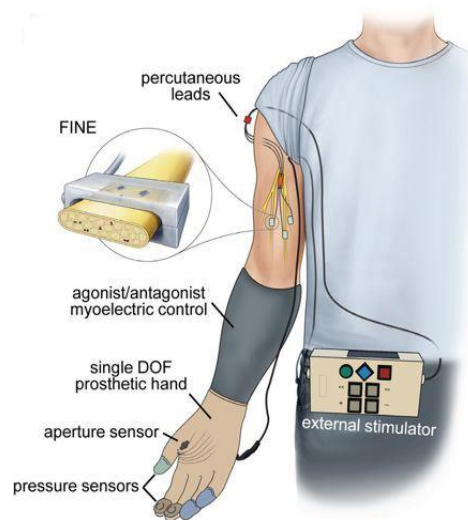


Science Translational Medicine (STM) published an article detailing a successfully engineered sense of complex hand movement in subjects with upper limb amputations. The team vibrated their reinnervated skin and muscles to elicit the illusion of movement. The vibrations, essentially, “turned on” specific neural pathways and allowed subjects to feel as if their fingers and hands were moving and that they were an integrated part of their own body, improving spatial awareness and fine motor control without having to visually monitor the prostheses. This breakthrough may enhance the ability of Veterans with limb loss to

control advanced upper limb prostheses, enable independence in activities of daily living, and improve quality of life. The article, titled *Illusory Movement Perception Improves Motor Control for Prosthetic Hands*, has been highlighted in 57 popular press articles and viewed over 19,000 times on the STM website. The research team, led by Core Investigator Paul Marasco, PhD, is exploring ways to expand these techniques to lower limb amputees or those with conditions that inhibit movement sensation such as stroke. They are also working to package the system into a prosthesis for longer-term, daily applications. *Image credit: Paul Marasco*

5. Home-use of a neurally-connected sensory prosthesis

In the first known study of how amputees use advanced sensory-enabled prostheses outside the laboratory, subjects reported a greater sense of psychosocial well-being and used a sensory-enabled hand more regularly and for longer periods of time compared to traditional prostheses. This breakthrough home-use trial, published in *Scientific Reports* and titled *Home Use of a Neural-connected Sensory Prosthesis Provides the Functional and Psychosocial Experience of Having a Hand Again*, asserts that sensory feedback achieved by directly interfacing to the peripheral sensory nerves, fundamentally changed how upper limb amputees perceived and interacted with their prosthesis, “transforming it from a sporadically used tool into a readily and frequently used ‘hand.’” This project, currently funded by DARPA and a VA RR&D Merit Review, is led by Core Investigator Dustin Tyler, PhD, has also been covered extensively by



several national media outlets (e.g., Eurasia Review, Science Daily, and Technology Networks).
Image credit: Cleveland FES Center

6. Insights and advancements from a stimulation-driven cycling competition



An article published in the Journal of NeuroEngineering and Rehabilitation (JNER), titled *Setting the Pace: Insights and Advancements Gained While Preparing for an FES Bike Race*, details the challenges of adapting and combining research and commercial technologies, as well as the human component, of competing in an international competition for stimulation-driven cycling after paraplegia. The article has close to 1,000 views

on the JNER's website and was included in an article collection in the journal called *Advances and challenges in the user evaluation and application of robotic assistive technologies: Insights from the first Cybathlon*. Lessons learned and articulated in the publication are now the basis for developing a new service line for disabled Veterans to take advantage of the health benefits of this unique exercise and recreational modality. The APTC's "Team Cleveland", led by Executive Director Ronald Triolo, PhD, won the gold medal in the bike race at the 2016 Cybathlon and are planning to compete in the 2020 competition.

KEY SERVICES

1. APTC participates in the first RR&D Roadshow at PVA

APTC personnel participated in the first Rehabilitation R&D Service Roadshow at the Paralyzed Veterans of America (PVA) Healthcare Summit + Expo in Dallas, TX. The annual PVA Summit provides the state of the art research, and emerging science, for individuals with spinal cord injury/disease, MS, and ALS. Core Investigator Kath Bogie, D.Phil and biomedical engineer Joseph Lerchbacker demonstrated the technology for preventing deep tissue injury (i.e., pressure sores) and promoting skin and tissue health that they are developing. The PVA Summit provided an opportunity to speak with the multidisciplinary attendees and showcase Health Monitoring & Maintenance technologies, including the modular seat cushion with *SquishINS*, the Smart Modular Adaptive Electrotherapy Delivery System (*SmartMAEDS*) electroceutical bandage, and Footplate Pressure and Positioning Sensor System (FoPPS). Summit attendees completed feedback surveys and there was outreach to some of the exhibitors.

2. Core Investigator co-chairs inaugural Gordon Research Conference

The inaugural Gordon Research Conference (GRC) on Neuroelectronic Interfaces challenged the international field to turn back to the drawing board of basic materials research armed with emerging fundamental neurosciences knowledge to bring together a multi-disciplinary team of leading experts in cellular neuroscience, brain pathology, neuro-technology, and materials science in order to discuss and eventually solve or discard the obstacles to a chronically useful and reliable neural interface. This biennial event surpassed the expectation of Co-Chair and APTC Core Investigator Jeff Capadona, PhD, as well as the GRC organization itself. The participation goal was exceeded by 80%, attendees were from 6 continents (50% domestic), and the large number of sponsors provided the opportunity for 2 networking events per day, a group

trip to NASA, and full registration for all speakers, discussion leaders, graduate students, and post-docs, as well as assistant professors presenting a poster.

3. APTC engages LSCVAMC in workshop for nonprofit *RePlay for Kids*

Twenty-seven investigators and staff from the APTC and LSCVAMC volunteered at a workshop held by *RePlay for Kids*, a nonprofit organization for the repair of therapeutic toys and assistive technologies for children with disabilities. At the workshop, volunteers were shown how to adapt mainstream, battery-powered toys with external switches so that children with physical and developmental disabilities could enjoy them. There are plans to make this an annual event and involve disabled Veterans. APTC Executive Director Ronald Triolo, PhD has been on the Board of Directors for *RePlay* since May 2001, and was elected Board Chair in 2018.

4. APTC participates in outreach and education activities in the community

The *Mean Green STEM Machine* is a program designed to expose Cleveland students in grades 2-7 to a variety of Science, Technology, Engineering and Math (STEM) topics, build awareness of career opportunities in STEM, and introduce them to diverse STEM practitioners. The program is operated in partnership with the Cleveland Public Library and collaborates with the Gelfand STEM Center at CWRU and an array of partners from the greater northeastern Ohio scientific community. APTC Biomedical Engineer Breanne Christie serves as one of three program coordinators who organize 16 sessions a year (with 20 students per session).

5. New appointments and invitations for APTC Investigators

Core Investigator, Kath Bogie, PhD, was invited to join Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) Standards Committee on Wheelchair and Related Seating (WRS) (ISO/TC 173/SC 1/WG 11 Wheelchair seating standards development) working group on Heat and Water Vapor Transfer. The invitation noted that a new ISO standard had been in draft format for some time, but was stalled due to issues with the equipment. Dr. Bogie's work in an article titled *Development of a Sitting MicroEnvironment Simulator for Wheelchair Cushion Assessment*, published in the Journal of Tissue Viability, has been recognized as leading to possible solutions to advance this standard.

Core Investigator, Margot Damaser, PhD, has been appointed to the Field Advisory Committee (FAC) of the Office of Research Oversight (ORO) as the representative for VA Institutional Animal Care and Use Committees (IACUC). Dr. Damaser has been chair of the IACUC at LSCVAMC for over 10 years, and her experience and dedication to research and animal welfare were instrumental to this appointment.

Affiliate Investigator, Musa Audu, PhD, was invited to serve as a member of the NIH Biomedical Computing and Health Informatics (BCHI) Study Section. Members are selected based on their demonstrated competence and achievement in their scientific discipline as evidenced by the quality of research accomplishments, publications in scientific journals, and other significant scientific activities, achievements and honors.

6. Core Investigators contribute to journals and conferences in varying roles

APTC Core Investigators contribute their time and expertise as editors (5) and on editorial boards (11) for 13 journals, and to 11 conferences as co-chair (1), organizing committees (4), abstract reviewers (3), session chairs (3), program committee (3), and on conference editorial board (1).

7. Core Investigators serve on VA Grant and Career Award Review Panels

Drs. Bogie, Capadona, Marasco, Shire, and Triolo contribute their time and expertise to review applications for VA RR&D Merit Review, Career Development Award, SPiRE, and Research Career Scientist funding mechanisms. Drs. Bogie, Damaser, Marasco, Triolo, and Tyler served as grant reviewers for NIH, DoD, and other international and local organizations.

8. Summer Internship Program yields productive outcomes for interns and mentors

The APTC Summer Internship Program was renamed in 2018 after Prof. Wen H. Ko, a prolific APTC Investigator who passed away last December. In 2018, we received 25 applications and accepted 5 undergraduate students into the labs of Drs. Allison Hess-Dunning, Steve Majerus, Matthew Schiefer, Andrew Shoffstall, and Dustin Tyler. Dr. Schiefer led the program by coordinating opportunities and activities for the interns. They attended regular Neural Engineering Center Seminars and SOURCE Tuesday Lunch & Learn Sessions at CWRU, and had the opportunity to present posters and attend conferences. All interns have continued working with the APTC. One is a co-author on a manuscript published in *Micromachines* by Core Investigators Andrew Shoffstall, PhD and Jeffrey Capadona, PhD, and two will be presenting their research at the upcoming *Biomedical Engineering Society* conference and the *IEEE Signal Processing in Medicine and Biology Symposium*.

9. New equipment acquisition expands research capabilities for LSCVAMC researchers

A VA Shared Equipment Evaluation Program (ShEEP) grant in the amount of \$402,187 was used to acquire a high-resolution, micron-scale computed tomography (microCT) system capable of generating 3D images of internal structures. The microCT scanner will integrate with the PerkinElmer IVIS Lumina XR 2D spectral scanner that is already available as a shared resource, allowing our researchers to acquire co-registered molecular optical signals with anatomical microCT data. The investigators who have immediate need for the microCT are conducting research in a broad range of medical areas that are important to our Veteran population, including neurology, obesity, sleep apnea, Alzheimer's disease, osteoporosis, osteopenia, urinary incontinence, and implanted medical devices. The ShEEP grant was awarded to Core Investigator Matthew Schiefer, PhD.

Summary

The APTC continues to advance the state of rehabilitation technology, fulfill our mission, and improve the lives of Veterans and the general population through important discoveries, contributions to community outreach, and cutting-edge intellectual property that lead to active industry conversations and licensing opportunities. This past year, the APTC made important advancements in their projects, increased mentoring capabilities, and received international recognition through research projects and conference chairing, demonstrating that core research programs of the APTC are impactful and vital to Veterans, other federal agencies, and the general public. Of great pride to the APTC is the success and development of our young investigators and interns who further our mission in new areas. As we enter FY19, APTC will continue to pursue innovative and translational work in the clinical application areas of **Prosthetics/Orthotics, Health Monitoring & Maintenance, Neural Interfaces**, as well as developing and disseminating new **Enabling Technologies**. Our investigators, staff, and trainees continue to extend the capabilities of VA researchers and health care professionals at the local, regional, and national level.