



► The Portland Aerial Tram connects OHSU's Marquam Hill and South Waterfront campuses.



From the directors

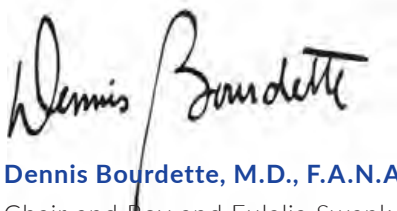
Dear colleagues and friends,

Oregon's geographic beauty and pioneering spirit attract some of the most creative and innovative people to our state. Whether we're revolutionizing running shoes, computer chips or deep brain stimulation, Oregonians are true trailblazers.

As our state's only academic health center, this spirit infuses everything we do at OHSU to promote our missions of healing, teaching and discovery. With a strong tradition of teamwork, diversity and interdisciplinary care, we believe OHSU is a unique place for the neurosciences. A commitment to care excellence and the health of all Oregonians is at the core of all we do.

We are honored to share with you some annual highlights of the promising innovations that are transforming how we provide care to people affected by nervous system disease.

Sincerely,



Dennis Bourdette, M.D., F.A.N.A., F.A.A.N.

Chair and Roy and Eulalia Swank
Research Professor, neurology



Nathan R. Selden, M.D., Ph.D., F.A.C.S., F.A.A.P.

Chair and Mario and Edith Campagna
Chair, neurological surgery

Carrying the torch

OHSU, based in Portland, attracts more than 1 million patient visits a year. We operate the top-ranked adult and children's hospitals in Oregon, and in fiscal 2018, we secured \$462 million in competitive research funding. As a public corporation, we provide outreach services that improve the health of communities and vulnerable residents across the state.

OHSU highlights



Education

OHSU helps educate over 5,500 students and trainees each year.



Research

OHSU award dollars:
\$462 million

**National Institutes of Health
funding ranking:** 28th

**Amount of funding focused on
clinical trials:** over \$80 million
in fiscal year 2018

Invention disclosures: 151

OHSU ranks No. 52 on the
Reuters 100: The World's Most
Innovative Universities 2018 list.

OHSU placed in the
top 20 of *Nature's Index*
2017 Innovation ranking, which
measures the quality and quantity
of research by institutions and
universities worldwide.



Community service

OHSU provides more than 200
community health programs in rural
and urban areas across Oregon.
In fiscal year 2017, the value
of OHSU's contributions to the
community totaled \$437 million.



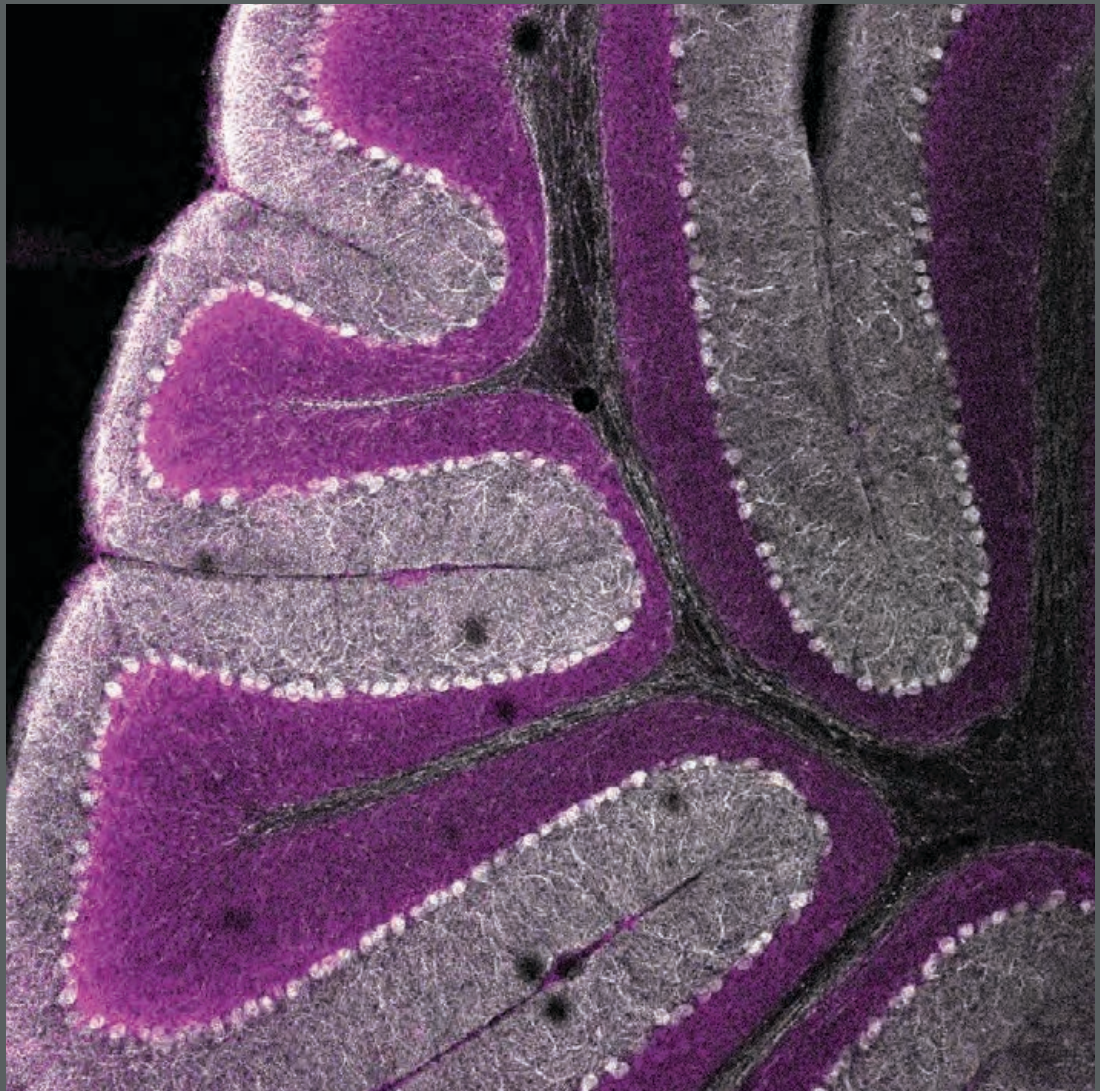
Facilities and employees

Employees: 16,478

OHSU occupies more than 7.9
million square feet of space on
approximately 400 acres.

The OHSU Brain Institute is a national leader in neuroscience patient care, research and education. We utilize the power of world-class advanced imaging facilities to treat the most complicated medical and surgical problems of the human nervous system. Our teams leverage telemedicine to extend highly subspecialized neurological care programs to patients across our region and nation in a wide variety of areas.

► Purkinje cells are marked in white against the nuclei of all other cells in the cerebellum, highlighted in magenta. Image by OHSU neuroscience graduate student Kathleen Beeson.



OHSU Brain Institute facts, figures and highlights

Neuroscience patient care

221 neuroscience diagnoses

40,153 patients for neuroscience in FY18

18 telemedicine locations for neuroscience in FY18

Neuroscience clinicians

157 neuroscience clinicians in FY18

Research and education

Over 300 neuroscience researchers

20 departments, centers and institutes conducting neuroscience research

\$136 million in neuroscience research funding in FY18

176 residents, fellows and graduate students for neuroscience in FY18

Neurosciences accolades, accreditations and recognitions

2018 Get With The Guidelines–Stroke – Gold Plus

Center of Excellence, National Parkinson Foundation

First Joint-Commission-Designated Comprehensive Stroke Center in Oregon

Level 4 Comprehensive Epilepsy Center

One of 32 NIH Alzheimer's Disease Centers in the country

ALS Center of Excellence

Race to Erase MS, Center Without Walls

Nationally recognized OHSU Brain Awareness lecture series

Advancing epilepsy surgery

Recent and dramatic advances in surgical technology represent a seismic shift in the ability to treat epilepsy arising from multiple areas deep in the brain. OHSU and Doernbecher Children's Hospital are on the front line of delivering these world-class techniques to adults and children.

The recent acquisition of a ROSA (Robotic Stereotactic Assistance) robot completes a triad of powerful new technologies used in the surgical treatment of epilepsy.

- First, OHSU neurosurgeons use the new ROSA robot to place multiple monitoring electrodes deep into brain areas most susceptible to seizure generation (stereotactic electroencephalography, or SEEG).
- Second, after confirming a seizure focus, neurosurgeons remove or inactivate this area in an advanced imaging operating room, using a 3-Tesla intraoperative MRI scanner to optimize the results of surgery and promote safety.
- Third, many of these treatments can now be performed using a minimally invasive laser probe (less than 2 millimeters in diameter), avoiding open brain surgery altogether. In some cases, surgeons combine these three technologies, using ROSA

to precisely guide diagnostic electrodes that will identify the seizure focus, then guiding the laser probe to the final target and, finally, observing the laser treatment

“These advances are bringing dramatic new hope to people who were previously ineligible for a chance at surgical cure of their epilepsy. These powerful, minimally invasive therapies were unthinkable only a few years ago.”

Nathan R. Selden, M.D.,
Ph.D., F.A.C.S., F.A.A.P.



◀ The planning workstation for the ROSA robot allows placement and simulation of virtual electrodes before surgical placement.

delivery in the iMRI scanner in real time, providing exquisite control of the anatomical location, size and shape of the ablative lesion. All of these steps occur without the surgeons ever leaving the sterility and safety of a fully equipped neurosurgical operating room.

Because of these advances, OHSU and Doernbecher neurologists and neurosurgeons can now evaluate many epilepsy patients for potentially curative therapy who were previously ineligible, including those who may have more than one focus, or in whom traditional techniques cannot sufficiently localize the problem.

Statewide firsts now include pediatric patients

In 2018, Nathan Selden, M.D., Ph.D., F.A.C.S., F.A.A.P., performed the first pediatric stereotactic laser amygdalohippocampotomy using magnetic resonance-guided laser interstitial thermal therapy in the state.

“We can now treat a patient who would have once had two open craniotomies with a series of tiny punch incisions and minimally invasive access for both diagnosis and curative therapy, often in a single, very short hospital stay,” he said. “Most importantly, even though these approaches are minimally invasive, they offer more widespread access to the relevant brain anatomy, and thus the promise of even higher cure rates for patients suffering from severe and medically refractory epilepsy.”

The patient’s recuperation is phenomenal compared to open procedures, Selden noted. He’s witnessed his pediatric patients waking up in the recovery room just minutes after stereotactic or therapeutic procedures, asking for a Popsicle or their gaming device as if they had not undergone surgery.

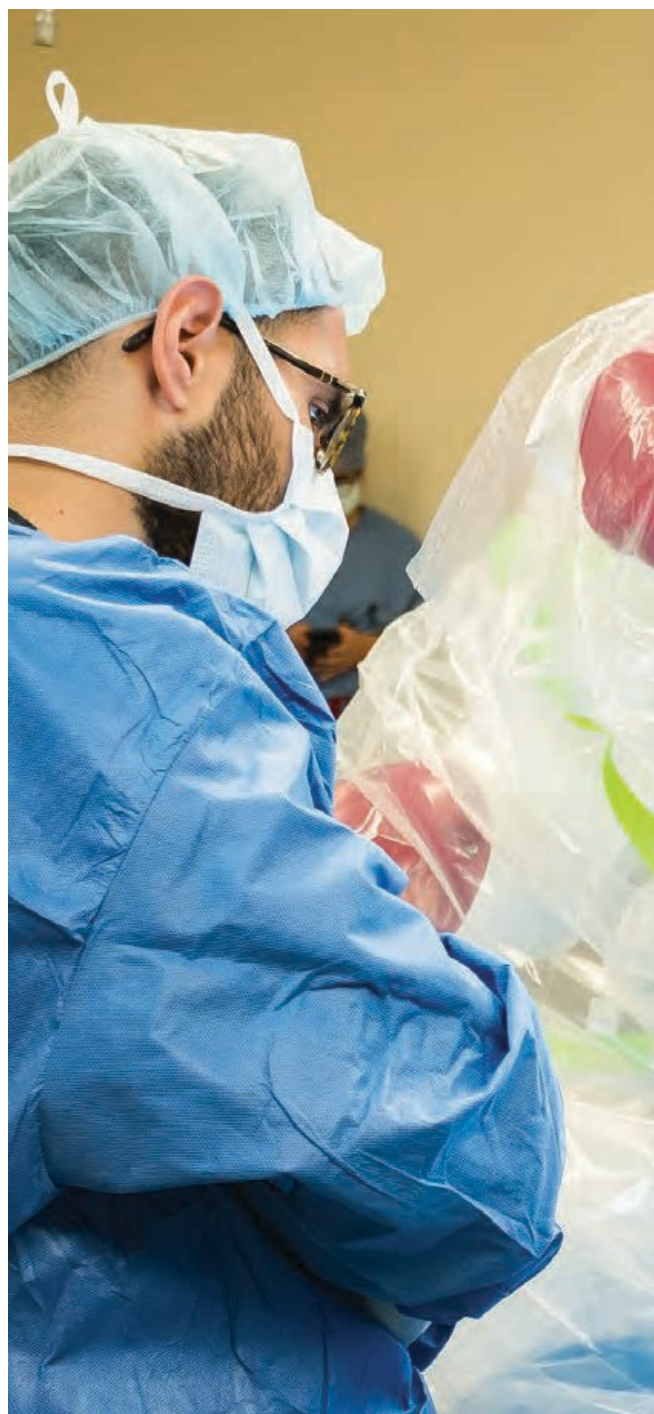
By utilizing this combination of sophisticated tools, epilepsy surgery is less burdensome for adults and children.

Next tech: ROSA robot

In June 2018, OHSU began using a ROSA (Robotic Stereotactic Assistance) robot for all stereotactic electroencephalography diagnostic epilepsy surgery in adults and children. The robot can navigate accurate GPS-like imagery of the brain according to precise calculations needed to place each of up to 20 fine electrode wires in perfect position to map a seizure focus. ROSA's robotic arm also avoids the limited angles imposed by older, frame-based technology on placing electrodes. Using the robot halves electrode operative time and allows for efficient and precise placement.

"We can target all areas of the brain without open brain surgery," Ahmed M.T. Raslan, M.D., said. "We can also remove the wires at the patient's bedside. These tools greatly enhance our ability to find answers for epilepsy while increasing patient safety and comfort."

Though the most common indication for the ROSA robot is epilepsy, OHSU is also using it for deep brain stimulation.





◀ Ahmed M.T. Raslan, M.D., center, is the first surgeon in Oregon to perform brain surgery with a robotic assist. "When we added the robot, we were able to seamlessly integrate it into the process. Based on our current experience, this is a big win. In every case, we've improved safety, accuracy and operative time. The precision is superior to previous methods."

Big breakthroughs from high-end microscopy

The accelerating technology in microscopy is taking basic research to new levels, and OHSU is an epicenter for these powerful investigative tools. With the degree of instrumentation sophistication, OHSU has also developed staff with expertise in operating and maintaining the microscopes to guide investigators in achieving the results they desire, becoming a national and regional resource not only for technology but for knowledge.

► Michael Chapman, Ph.D., professor of biochemistry and molecular biology in the OHSU School of Medicine, looks inside a cryo-EM microscope. Four of these powerful scopes will be installed on the OHSU campus, creating the Pacific Northwest Center for Cryo-EM.



Cryo-EM technique is revolutionizing structural biology

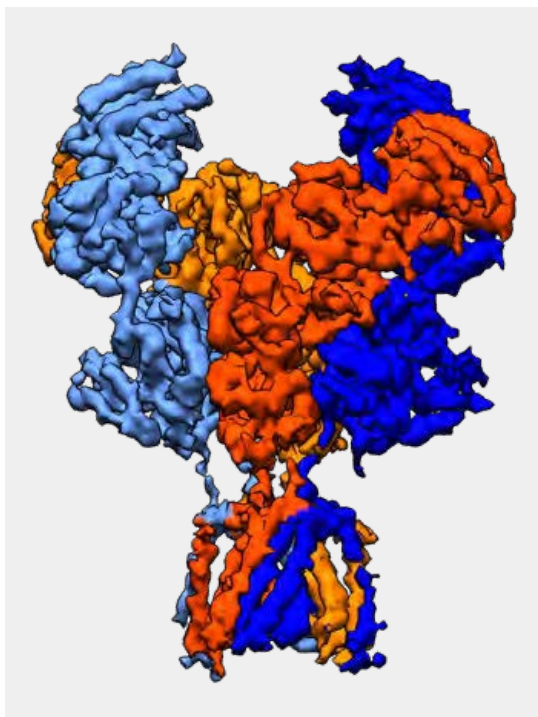
In 2018, the National Institutes of Health selected OHSU as one of three national cryo-EM centers to provide scientists across the nation with access to state-of-the-art technology and training, from sample preparation to microscope data collection and computational analysis.

The new Pacific Northwest Center for Cryo-EM added four powerful microscopes to OHSU's campus, staffed by scientists from OHSU and the Pacific Northwest National Laboratory. This powerful technology allows scientists to see molecules in breathtaking detail.

Eric Gouaux, Ph.D., and investigator with the Howard Hughes Medical Institute and a senior scientist in the OHSU Vollum Institute, is one of three designated principal investigators. He is internationally known for his work to improve basic understanding of the molecular structure and function of proteins that regulate communication between neurons in the brain, including the receptor involved in memory and learning, and the targets of therapeutic agents for Alzheimer's and Parkinson's diseases, as well as for schizophrenia and depression. Many of his previous breakthroughs involved the use of X-ray crystallography, but he is now a convert to cryo-EM because of the technology's unique ability to see the organization of large networks of molecules in fine detail.

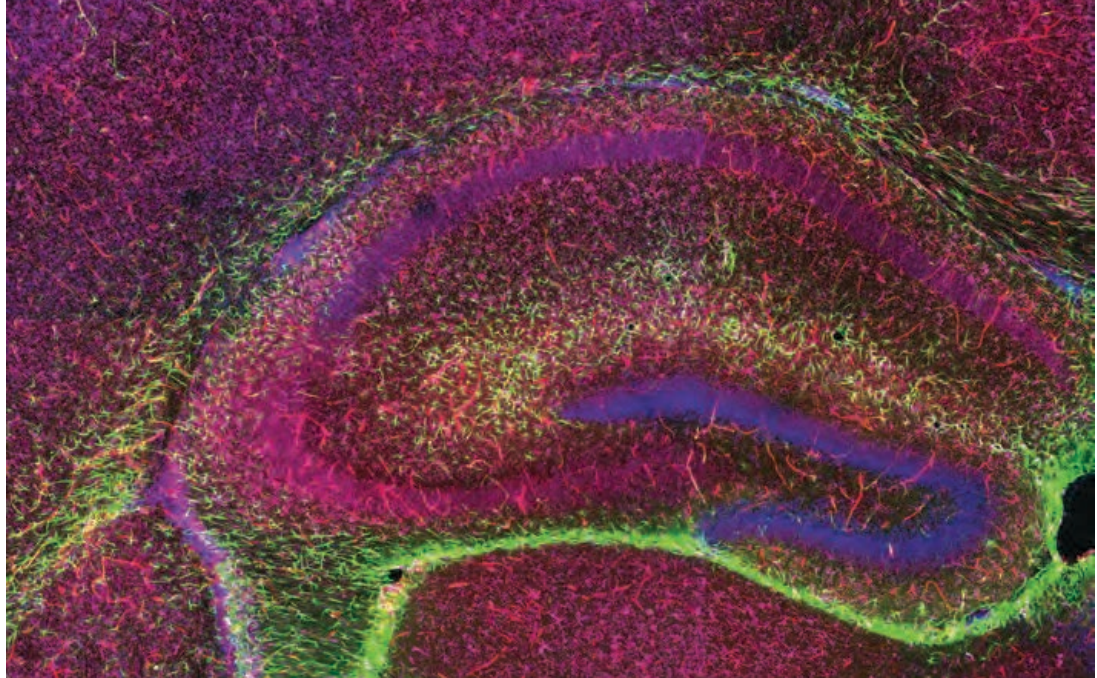
"There's been this enormous revolution. It's analogous to going from film cameras to digital. Neuromodulators are the targets of many drugs, so understanding how they work will give us clues about how to build better ones."

Eric Gouaux, Ph.D.



◀ Cryo-EM can provide three-dimensional structural information on biological molecules with near atomic-level resolution detail. This technology allows researchers to visualize many new types of biomolecules (such as membrane proteins and receptors) that have escaped detection by traditional methods. Membrane proteins represent 50 percent of the market currently targeted by drug developers and will be an area of specialization at the Pacific Northwest Center for Cryo-EM.

► This image of a section of mouse hippocampus shows the distribution of astrocytes in green and microglia in magenta against the backdrop of tissue vasculature in red and nuclei in blue. Image by OHSU neuroscience graduate student Daniel Miller.



Advanced light microscopy expertise in tracking neuroanatomy

As the expense and complexity of the instrumentation increased, OHSU chose to centralize equipment into shared resources starting in 2006. Stefanie Kaech Petrie, Ph.D., director of the Advanced Light Microscopy Core at the Jungers Center for Neuroscience Research, has seen her role evolve, as the technical expertise necessary requires a facilitator to guide and train investigators in selecting equipment, preparing samples and translating the resulting data. More than 100 funded investigators use the equipment in the Advanced Light Microscopy Core during any given year, with about 350 people booking time on the microscopes.

“About half those researchers are neuroscientists attempting to capture the complexity of brain and nervous tissue,” Kaech Petrie said. “A new approach is to keep the architecture of the neurons and glia intact and to detect their relational anatomy in cleared tissue specimens, taking advantage of optically sectioning imaging techniques.”

Using microscopes designed to 3-D scan these specimens, investigators can now use thicker and thicker specimens, which is important for understanding function in neuronal circuitry in health and disease. However, the surge in data leads to computational issues, Kaech Petrie said.

“Because the data are bigger and bigger, we need not only a biologist but a computational biologist at the same table to help with data analysis, particularly related to brain samples,” she said. “More than ever, research at this level goes beyond the know-how of microscopy experts and investigators to creatively utilize these new avenues.”



◀ Stefanie Kaech Petrie, Ph.D., director of the Advanced Light Microscopy Core at the Jungers Center for Neuroscience Research.

Investing in the best

OHSU has 15 centrally administered cores on campus, of which the Advanced Light Microscopy (ALM) Core is one. Kaech Petrie says that the over \$5 million in equipment in the ALM is superseded approximately every three years as technology advances. Current instruments apply technologies that go beyond a century-old dogma of diffraction limits in microscopy, use powerful lasers and unconventional illumination strategies, and rely on advanced detectors to separate out signatures of multiple labels from tissue-intrinsic background.

Investigating brain signals for communication

Locked-in syndrome (LIS) is among the most challenging of diagnoses for neurologists, patients and families. OHSU is developing a new brain-computer interface (BCI) for patients who are cognitively intact but without motor skills to communicate, through a unique combination of technologies and expertise. Less than a dozen research groups in the country are working with BCI, and several aspects make the OHSU model unique.

BCI uses technology to detect changes in brainwaves that form choices, like a mouse click. At OHSU, investigators are seeking a noninvasive BCI communication method to elicit the P300 event-related potential, bypassing the neuromuscular system and relying on the brain signal as a keystroke.

“For patients with LIS from ALS, spinal cord injury, brainstem stroke or a host of other spinal cord, nerve or muscle diseases, the BCI system will offer a way to access their worlds. Harnessing the power of the brain signal for intentional choices, this technology will soon provide individuals without movement a means to control their environments, to communicate successfully and to make meaningful contributions to society again,” said Melanie Fried-Oken, Ph.D., C.C.C.-S.L.P.

Unusual combination of expertise

Fried-Oken collaborates with the OHSU-based Oken Cognitive Neuroscience Lab, the OHSU Center for Spoken Language Understanding and the Department of Electrical and Computer Engineering at Northeastern University in Boston, Massachusetts, as well as individuals with LIS and their families. This combined team represents expertise in electrical engineering and computer science, clinical neurophysiology, clinical rehabilitation, and computational linguistics, a field that uses computers to analyze language and develop computational models of language. OHSU’s team is the only BCI group to include computational linguistics, which serves an important interdisciplinary role.



◀ Patient and active research team participant, Greg Bieker.

Participatory action research

The OHSU team is one of a small group of BCI researchers nationally that emphasize user-centered design by relying on input from individuals who experience incomplete LIS, their families and caregivers at every stage of development and research.

Fried-Oken met Gregory Bieker, a patient with LIS following a brainstem stroke, in clinic. Bieker is now part of the investigative team, helping researchers design studies and beta test equipment. He accompanied the team to an international BCI conference, the only person with LIS to ever attend the conference as an active participant.

Watch Greg use OHSU's brain-computer interface technology at www.ohsu.edu/innovate.

Predictive text a possible gamechanger

Fried-Oken's four teams of researchers adopted a novel way to present letters for brainwave typing called Rapid Serial Visual Presentation (RSVP). With this method, large individual letters are quickly flashed on a screen. When patients see the letters they want, their brainwaves change. These are taken as keystrokes. In this application, individualized neurophysiologic data inform the spelling. The BCI system will predict upcoming letters, much like the natural language processing on a smartphone which suggests words when you're typing. At the signal processing level, the system fuses the EEG signal with the language model probabilities.

"The system gets predictive and smarter, which has a profound effect on typing speed and accuracy," Fried-Oken said. "Language fusion is a huge technological leap, and we are uniquely poised to use it with the specialized knowledge of our four teams, particularly computational linguistics."

Research is still in the discovery stage, needing more robust and reliable systems before the BCI systems can be translated to the home setting, Fried-Oken said, but the work is promising.



OHSU ALS and Neuromuscular Disease Center receives Center of Excellence designation

In 2018, the ALS and Neuromuscular Disease Center at OHSU became an ALS Association Certified Center of Excellence, recognized for the specialized, compassionate and team-based care we provide our patients.



◀ Lead investigator Melanie B. Fried-Oken, Ph.D., C.C.C.-S.L.P., is a certified speech-language pathologist and an internationally known clinician and researcher in the field of augmentative and alternative communication. She and her teams are working to make computer-based communication clinically useful for individuals with LIS.

Accelerating discovery in facial pain

With a challenging differential diagnosis, people can experience excruciating facial pain without ever finding the right specialist. Fortunately, an online self-assessment tool created by OHSU neurosurgeon Kim J. Burchiel, M.D., F.A.C.S., sets an internationally recognized standard for diagnosing different facial pain syndromes.

Burchiel, who leads the OHSU Facial Pain Program, began basic research into trigeminal neuralgia in the 1970s during his neurosurgery training. What began as a slow stair climb in the 1970s is now a high-speed elevator ride as technology and communication advances broaden the reach, reduce the costs and enhance the possibilities of his research.

“The lab work we’ve done in the past on the mechanism of trigeminal neuralgia has led to effectively understanding what causes it, and we are beginning to use the advanced technology tools available now to investigate that,” Burchiel said. “We have an international research collaboration studying this condition that goes back decades. It demonstrates the kind of progress you can make when you take an area of focus and drill down on it. And I’m still drilling, 35 years on.”

In 2003, Burchiel developed a questionnaire-based classification scheme that evolved into the world’s first online artificial neural network able to diagnose facial pain conditions with a high degree of accuracy. This diagnostic tool created an international database of verified cases of trigeminal neuralgia, which exploded new research pathways. Burchiel and his collaborators are currently working on the results of studies investigating a genetic basis for trigeminal neuralgia.

“It appears that some people may be predisposed to trigeminal neuralgia based on inherited anatomical factors, such as skull shape,” he said. “Also, through this genetic work, we’ve discovered a whole class of patients — women under 35 — previously inaccurately diagnosed with multiple sclerosis as the basis for their pain.”



◀ Kim J. Burchiel, M.D., F.A.C.S., an internationally known expert on trigeminal neuralgia, leads the OHSU Facial Pain Program. Over the last five years, he and his team have treated more than 1,000 patients with trigeminal neuralgia and other facial pain.

“It’s a very exciting time of research, with so many lines of evidence and the tools to pursue them,” Burchiel said. “We are poised to make huge progress in trigeminal neuralgia, including future treatment based on genetics. I believe this research will also seep into research and treatment for other pain conditions.”

Artificial neural network that diagnoses facial pain

OHSU’s Trigeminal Neuralgia Diagnostic Platform uses a secure, web-based artificial neural network to recognize and correctly diagnose patients with facial pain syndromes. The classification scheme has 22 yes/no questions for the patient that establish a target diagnosis, based primarily on patient history. A 10-year analysis demonstrated high accuracy in this self-assessment tool. While the tool does not replace clinical evaluation and imaging, it helps provide a consistent frame of reference for meaningful comparison. To view the questionnaire, visit neurosurgery.ohsu.edu/tgn.php.

Teaming for headache diagnosis and treatment

Embracing multidisciplinary collaboration is as much about enthusiastic and flexible attitude as it is organizational structure, and OHSU is a recognized hub for encouraging clinicians to cross disciplines.

“OHSU makes it very easy to work in multidisciplinary teams; there is no barrier to getting things started,” said Juliette Preston, M.D., director of the OHSU Headache Center. “It feels like working at a startup company where everything is very mobile. There are opportunities and the liberty to innovate and collaborate.”

Preston coordinates with the OHSU Facial Pain Program for patients with surgical needs, but she also works with OHSU colleagues from very different disciplines, including dentistry and OB-GYN, to cross-pollinate expertise for better diagnosis and treatment options.

Multidisciplinary orofacial pain clinic

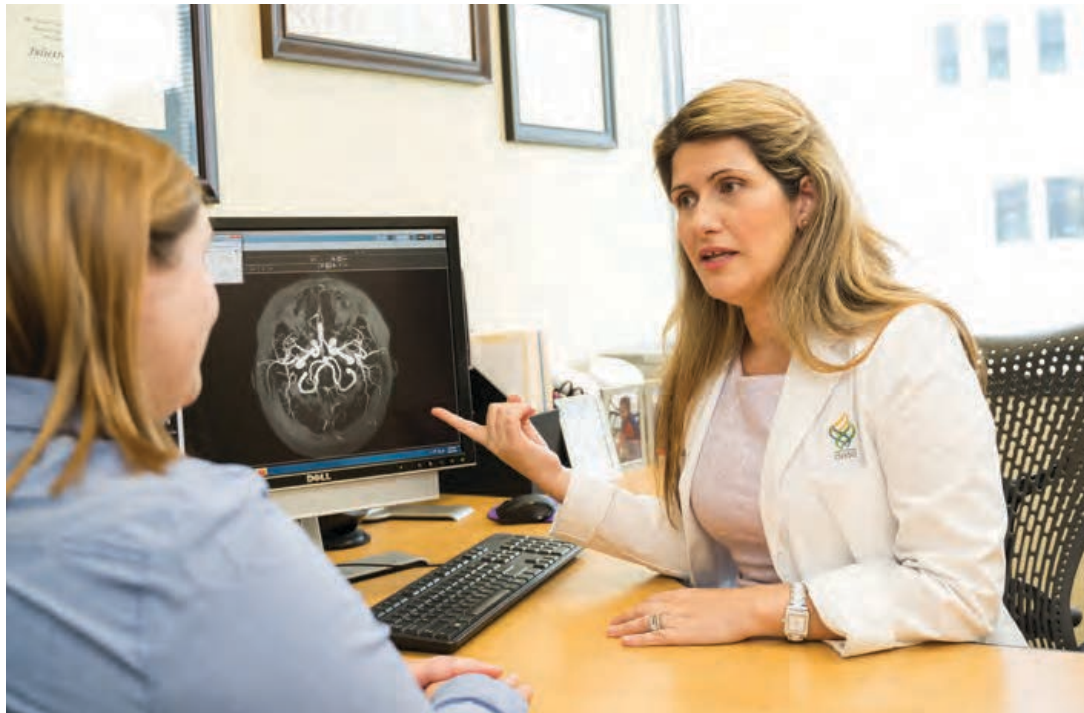
If patients have pain in the teeth or in the face near the mouth, the first resource they seek is typically a dentist. That’s why Preston joins her colleague from the OHSU School of Dentistry, Ying Wu, D.D.S., M.S.D., Ph.D., to lead a monthly multidisciplinary orofacial pain clinic, one of the few in the country and the only one in the region.

“Working together gives us great insight into overlapping conditions,” Preston said. “We enjoy learning from each other. Dr. Wu specializes in orofacial pain and pathology, so we interpret the patient’s problems from our respective points of view. We catch a lot of trigeminal neuralgia and temporomandibular joint disorders.”

Managing migraines in pregnancy

In an unfortunate paradox, hormone triggers in early pregnancy can bring on and worsen migraines at a time when clinicians have the fewest options to offer while also protecting the fetus, Preston noted. In another example of multidisciplinary collaboration, OHSU OB-GYN clinicians send all their pregnant mothers suffering from headaches to Preston. She primarily uses occipital nerve blocks to prevent or stop the migraines for this subset of patients who cannot take typical medications.

“We find this is beneficial for the patient and has minimum effect on the fetus,” Preston said. “Because OB-GYNs are limited in what they can offer to treat headaches, this has become an important partnership for helping our shared patients through their pregnancies.”



◀ Juliette Preston, M.D., is the director of the OHSU Headache Center and an assistant professor of neurology.

Fast-pass migraine admissions

If you have an intractable migraine, the last place you want to be is an emergency department waiting room. OHSU has implemented a system to directly admit migraine patients from the clinic to the hospital neurosciences inpatient unit to receive a dihydroergotamine mesylate infusion in a monitored environment.

Creating an education model for clinical cannabis



OHSU is at the vanguard of cannabis medical education at a time when as clinicians, we find ourselves caught between patient curiosity and a lack of medical training to address the bevy of questions about the benefits, risks, varieties and interactions of cannabis and cannabinoid products.

In 2017, the Oregon Medical Board published a guideline that any physician who recommends the medical use of marijuana should complete a minimum of three hours of category 1 continuing medical education related to medical marijuana.

OHSU experts Michelle Cameron, M.D., P.T., M.C.R., and Kim D. Jones, R.N.C., Ph.D., F.N.P., F.A.A.N., jumped in to fill the void, as no such training previously existed. The pair presented “Clinical Cannabis for the Health Care Provider: Show Me the Evidence” twice in 2018 to more than 250 participants, representing about half the states in the nation.

“Clearly, there is a need for education in this topic. As clinicians, we need to get up to speed on the latest literature, so we can give our patients current information on benefits and risk. Clinical cannabis represents a potential new therapy that our patients are already using. We want patients to feel comfortable having these conversations in providers’ offices rather than at the dispensary or online.”

Kim D. Jones, R.N.C., Ph.D., F.N.P., F.A.A.N.

In addition to their own expertise in multiple sclerosis and chronic pain respectively, Cameron and Jones called on Joseph Bubalo, Pharm.D., B.C.P.S., B.C.O.P., an oncology clinical pharmacy specialist at OHSU, to discuss the pharmacology of cannabis, and Colin Roberts, M.D., a pediatric neurologist at OHSU, for insight into the role of cannabinoids in seizure management. They also invited representatives from Veterans Affairs (elevated risk/addiction in select populations) and state regulatory agencies (testing for purity and biohazards) to share their knowledge. Then they took an unprecedented step by engaging exhibitors from local dispensaries and growers to display information about their products.

Lots of data, but clinical research trails behind

“There is a misconception among clinicians that there are no data,” Cameron said. “In fact, there are some high-quality data, but these are limited to select arenas and cannabinoid products produced pharmaceutically where we know the ratios of tetrahydrocannabinol (THC) and cannabidiol (CBD) without other active components.”

Jones also noted many studies limit participation to younger subjects who have previous experience with cannabis. However, she added that there is a wealth of anecdotal and cross-sectional research that looks promising, as more rigorous testing is underway.

In the seminar, Cameron and Jones focused on literature related to clinical trials that produced evidence regarding cannabinoids as a treatment for symptoms of multiple sclerosis, seizures, pain and insomnia.

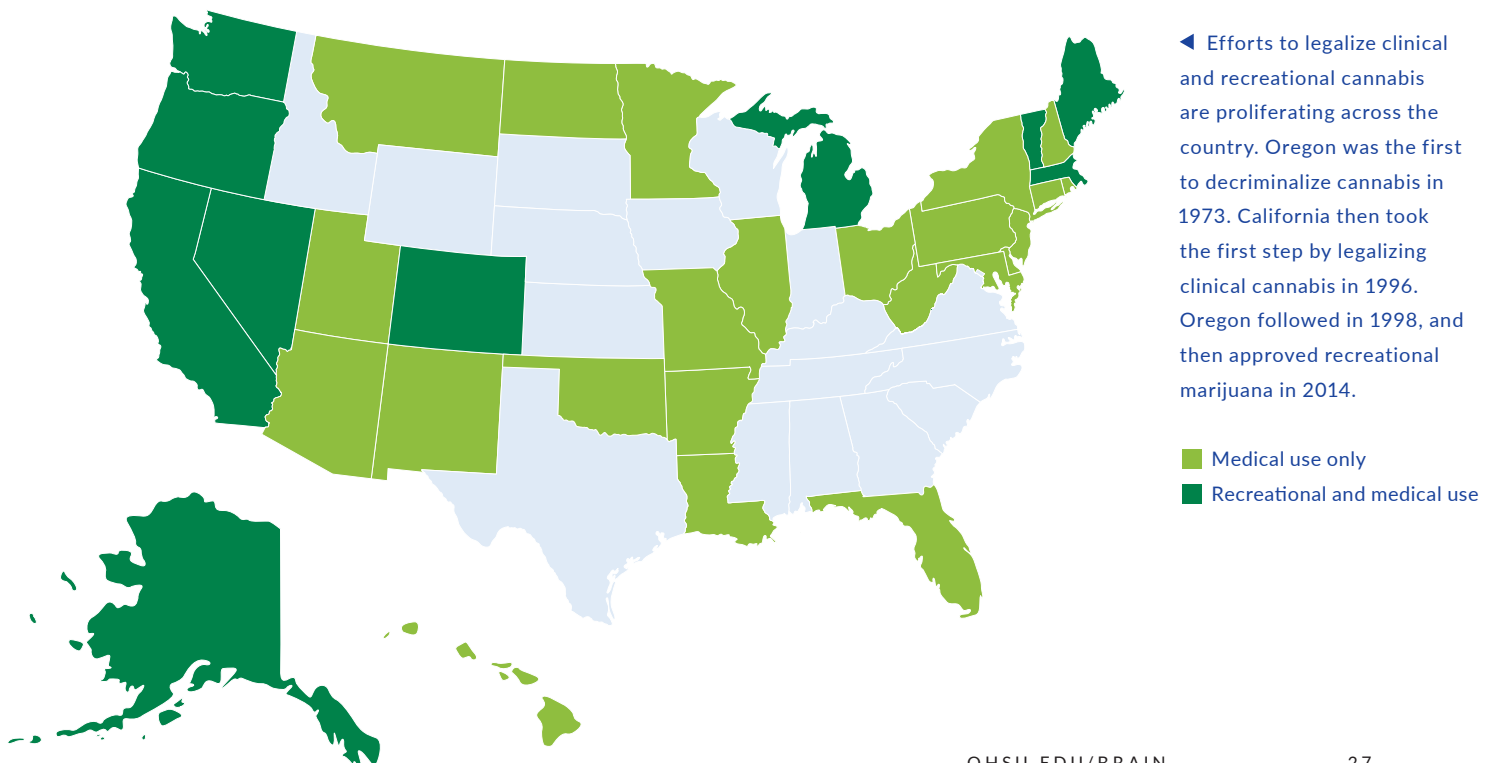
Participant feedback was overwhelmingly positive, as many complained of struggling with the questionable information circulating among the public. Participants reported feeling better informed and equipped to respond to patient inquiries. Test scores demonstrated substantial gains in knowledge, from an average of about 55 percent before the program to an average of nearly 85 percent after the program.

“This is a topic that is going to be relevant for a long time,” Cameron said. “We hope in the future a review of clinical cannabis will be integrated into health care professional training. Meanwhile, we are refining and improving our class and making it available for virtual participants to extend our reach.”

Learn more: ohsubrain.com/cannabiscme

OHSU policy, guided by federal law, prohibits physicians from prescribing clinical cannabis in all its forms and bans the use of clinical cannabis on campus. If patients ask about CBD, doctors will share their perspective as they would for other treatments that patients can purchase without a prescription.

OHSU policy, guided by federal law, prohibits physicians from prescribing clinical cannabis in all its forms and bans the use of clinical cannabis on campus. If patients ask about CBD, doctors will share their perspective as they would for other treatments that patients can purchase without a prescription.



Exploring the frontiers of tubular surgery

Since transforming spine surgery in the early 2000s, the versatility of tubular surgery is continually expanding the indications for minimally invasive spine surgery. OHSU neurosurgeon Donald Ross, M.D., has been at the forefront of exploring the boundaries of possibility since he designed a prototype tubular retractor in 1992. He now treats a plethora of spinal conditions with this technique, which only requires an incision of 22 mm or less.

► Donald Ross, M.D.



“We are now performing surgeries we wouldn’t have attempted down a tube 18 years ago. The minimal incision makes a huge difference in how patients respond, helping them recover more quickly and return to normal activity sooner.”

Donald Ross, M.D.

Zero infection rate

In a review of over 2,000 extradural nonfusion spine surgeries performed by Ross through tubular retractors, no patients experienced wound infections, an unprecedented result even for modern spine surgery. Of the 2,000 cases, only 33 experienced a minor durotomy, or opening

in the covering of the CSF spaces, and none suffered from an external or symptomatic internal cerebrospinal fluid leak requiring additional treatment.

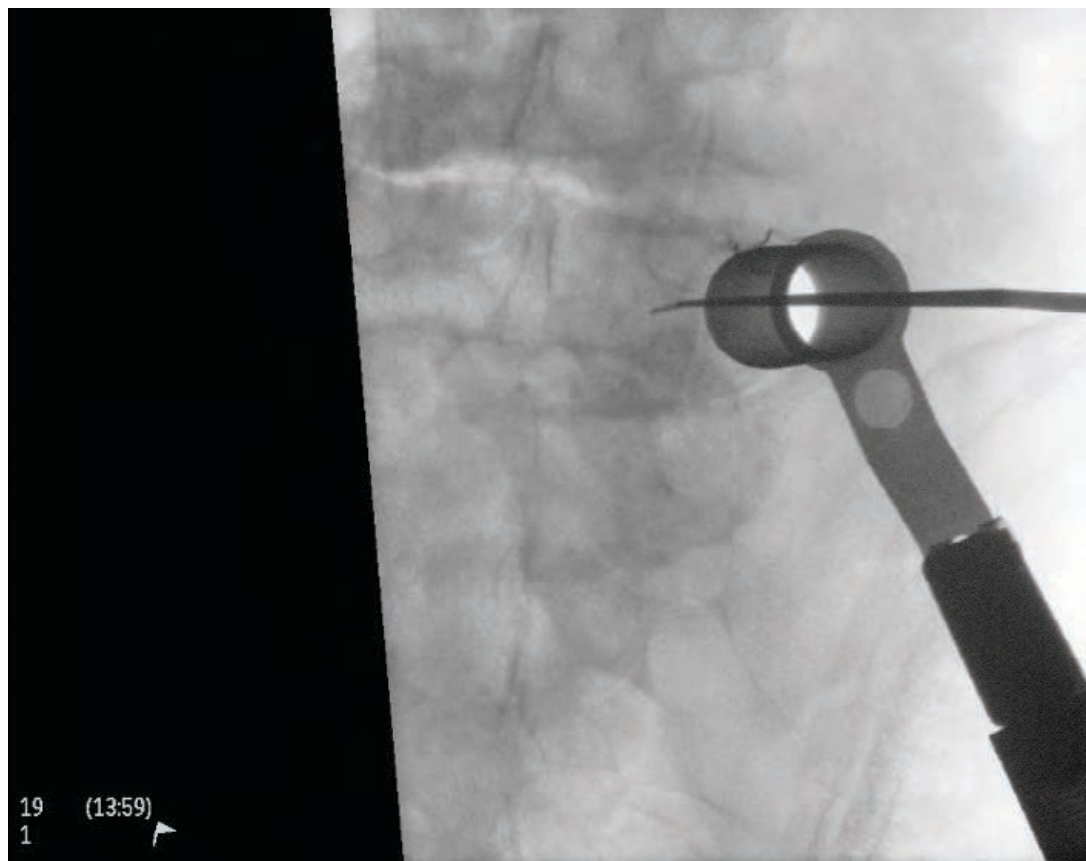
As a leader and advocate for the tubular technique, Ross believes the evidence compares favorably to open surgeries. Advantages include reduced blood loss, shorter operative time, reduced postoperative pain, low complication rate, earlier discharge and rapid return to normal activities.

Advancing minimally invasive cervical laminectomy for spondylotic myelopathy

To date, Ross has applied the tubular retractor technique to 18 different spine procedures. Cervical laminectomy for

spondylotic myelopathy is the latest. Though surgeons have successfully performed open surgeries for spinal decompression for decades, patients often have a slow recovery and ongoing issues with pain, atrophied muscles and scarring. Ross began using a tubular approach for cervical spondylotic myelopathy 12 years ago and has now treated 50 cases. OHSU is the only hospital with a large report of a series of this type of surgery, with the only other report of any size based in Japan.

“Originally, I proposed this surgery for medically fragile patients for whom more invasive procedures would be dangerous,” he said. “The early patients’ responses were so positive, we’ve expanded the use of this surgery to all demographics.”



◀ Shrapnel is removed by Ross with the tubular technique.

2018 highlights

► Trial participant Kelly DeKay (left) loses her balance while performing exercises as research assistant Alexa Beeson (right) helps stabilize her.



DoD grants of \$6.6 million fund two concussion studies at OHSU

OHSU's Laurie King, Ph.D., P.T., M.C.R., is principal investigator for two clinical trials into mild traumatic brain injuries (mTBI) funded by the Department of Defense, totaling \$6.6 million in research grant funds awarded in 2018. The goal of the four-year studies is to provide physicians with the best protocol in treating patients with mTBI. One study will compare outcomes between patients who begin physical therapy right

away after a concussion and those who have a rest period. OHSU will also be leading a study to learn more about post-concussive syndrome and the connection among the inner ear, walking and the brain following mTBI. For the study, OHSU is developing wearable inertial sensors to provide real-time feedback on movement and balance.

OHSU receives \$2.2 million NIA-T32 training grant for neuroscience of aging

The National Institute on Aging (NIA) awarded OHSU a five-year training grant in 2018 that will cover the stipends of three postdoctoral fellows and five graduate students to study biological mechanisms of neurodegenerative diseases, with a special emphasis on Parkinson's disease and Alzheimer's disease. Henryk Urbanski, Ph.D., D.Sc., who serves as co-director of the OHSU Healthy Aging Alliance, submitted the grant. "By increasing the number of talented new investigators with expertise in the neuroscience of aging, we hope to be better equipped to tackle health problems associated with the changing demographics of the nation," he said.

OHSU influences national educational policy for clinical neuroscience

In 2018, OHSU neuroscience leaders again stood out for defining national training requirements and standards for United States physicians, as formulated by the Accreditation Council for Graduate Medical Education (ACGME):

–Dr. George Keepers, M.D., professor and chair of psychiatry at OHSU, served as the national co-chair of a commission to revise the ACGME Common Program Requirements, which govern the accreditation of all U.S. medical and surgical residency programs, which train almost 100,000 physicians nationally.

–Dr. Kim Burchiel, M.D., Raaf Professor of Neurological Surgery, served as the national co-chair of a commission to revise the ACGME standards for the learning and working environment in all U.S. residency

programs, including revising the so-called resident “duty hours.”

–Dr. Nathan Selden, M.D., Ph.D., Campagna Professor and Chair of Neurological Surgery, led an ACGME work group that published a major revision to the national training goals for all U.S. neurosurgery residents, the neurological surgery “Milestones.”

OHSU receives resident complement increase

The Accreditation Council for Graduate Medical Education Review Committee for Neurological Surgery approved a total complement of 21 (three per year for a seven-year program) neurological surgery residents at OHSU for 2018 forward.



◀ Nathan Selden, M.D., Ph.D. (left), watches as neurosurgery resident Stephen Bowden, M.D., practices brain surgery techniques using simulation technology developed at OHSU.

Faculty

Department of Neurology

Dennis Bourdette, M.D., F.A.N.A., F.A.A.N.

Chair and Roy and Eulalia Swank Research Professor

Ambady, Prakash, M.D.

Anderson, Shannon, M.P.A.S., P.A.-C.

Beattie, Zachary, Ph.D.

Bernard, Jacqueline, M.D.

Boespflug, Erin, Ph.D.

Boudreau, Eilis, M.D., Ph.D.

Bozorgchami, Hormozd, M.D.

Brotsky, Matthew, M.D.

Cameron, Michelle, M.D.

Chahin, Nizar, M.D.

Chaudhary, Priya, Ph.D.

Chung, Kathryn, M.D.

Clark, Wayne, M.D.

Croff, Raina, Ph.D.

Dimitrova, Alexandra, M.D.

Dodge, Hiroko, Ph.D.

Doolittle, Nancy, Ph.D.

Durrant, Julia, M.D.

Emery, Ben, Ph.D.

Ernst, Lia, M.D.

Erten-Lyons, Deniz, M.D.

Friedman, Daniel, M.D.

Gray, Nora, Ph.D.

Hiller (Peterson), Amie, M.D.

Hills, Barbara, M.D.

Hinson, Holly, M.D.

Hofer, Scott, Ph.D.

Horak, Fay, Ph.D.

Hugos, Lucinda, P.T.

Hutchison, Kim, M.D.

Johnson, Steven, M.D., Ph.D.

Kaech Petrie, Stefanie, Ph.D.

Karam, Chafic, M.D.

Kaye, Jeffrey, M.D.

Kellogg, Marissa, M.D., M.P.H.

Kim, Ed, M.D.

King, Laurie, Ph.D.

Kraakevik, Jeff, M.D.

Lane, Michael, M.D.

Lim, Miranda, M.D.

Lindauer, Allison, N.P., Ph.D.

Logan, Mary, Ph.D.

Lutsep, Helmi, M.D.

Mancini, Martina, Ph.D.

Marracci, Gail, Ph.D.

Martin, Ian, Ph.D.

Mass, Michele, M.D.

McCaskill, Matthew, M.D.

Motika, Paul, M.D.

Muldoon, Leslie, Ph.D.

Natonson, Andrew, M.D.

Neuwelt, Edward, M.D.

Nutt, John, M.D.

Offner-Vandenbark, Halina, Dr. Med.
 Oken, Barry, M.D., Ph.D.
 Panduranga, Anup, M.D.
 Pfeiffer, Ron, M.D.
 Pierce, Aimee, M.D.
 Preston, Juliette, M.D.
 Quinn, Joseph, M.D.
 Robinson, Fred, Ph.D.
 Safarpour, Delaram, M.D.
 Salinsky, Martin, M.D.
 Shinto, Lynne, N.D.
 Silbert, Lisa, M.D.
 Singh, Asha, M.D.
 Smith, W. Brewster, M.D.
 Soumyanath, Amala, Ph.D.
 Spain, Rebecca, M.D.
 Speese, Sean, Ph.D.
 Spencer, David, M.D.
 Spencer, Peter, Ph.D.
 Stacey, Michelle, M.D.
 Tshala-Katumbay, Desiré, M.D., Ph.D.
 Tucker, Tarvez, M.D.
 Unni, Vivek, M.D., Ph.D.
 Vandenbark, Arthur, Ph.D.
 Visser, Amy, M.D.
 Westbrook, Gary, M.D.
 Whitham, Ruth, M.D.
 Wild, Katherine, Ph.D.
 Yadav, Vijayshree, M.D.
 Yaylali, Ilker, M.D., Ph.D.

Department of Neurological Surgery

Nathan R. Selden, M.D.,
 Ph.D., F.A.C.S., F.A.A.P.
 Chair and Mario and Edith Campagna Chair
 Adams, Joanna, P.A.-C.
 Anderson, Jim, M.D.
 Baird, Lissa, M.D.
 Mario and Edith Campagna Professor
 Bates, Micah, M.S., P.A.-C.

Burchiel, Kim J., M.D., F.A.C.S.,
 John Raaf Professor
 Cetas, Justin S., M.D., Ph.D.
 Chang, Jason J., M.D.
 Ciporen, Jeremy N., M.D.
 Dogan, Aclan, M.D.
 Domreis, Wendy O., M.S., R.N., C.P.N.P.
 Fleseriu, Maria, M.D., F.A.C.E.
 Fong, Jeremy, M.P.A.S., P.A.-C.
 Frank, Edmund H., M.D., F.A.C.S.
 Gragg, Antonia, M.S., P.A.-C.
 Haboush, Lily Christine, M.S.N, M.S.,
 A.G.A.C.N.P.-B.C., F.N.P.-C., C.E.N.
 Han, Seunggu Jude, M.D.
 Heinricher, Mary M., Ph.D.
 Ingram-Osborn, Susan L., Ph.D.
 Koerner, Ines, M.D.
 Liu, Jesse, M.D.
 Madden, Christopher J., Ph.D.
 McCartney, Shirley, Ph.D.
 McNeil, Patty, M.S.P.A.S., P.A.-C.
 Morrison, Shaun F., Ph.D.
 Nazemi, Kellie, M.D.
 Nesbit, Gary, M.D.
 Ohm, Erika, M.S., R.N., C.P.N.P.
 Ono, Dara, M.S., P.A.-C.
 Orina, Josiah, M.D.
 Portelance, Elizabeth, N.P.
 Raslan, Ahmed M.T., M.D.
 Remling, Janette K., M.S., P.A.-C.
 Robinson, Melissa, P.A.-C.
 Ross, Donald A., M.D.
 Sayama, Christina M., M.D., M.P.H.
 Than, Khoi D., M.D.
 Thompson, Catherine, M.P.T., P.A.-C.
 Tupone, Domenico, Ph.D.
 Varlamov, Elena, M.D.
 Verderman, Aaron C., Ph.D.
 Yablon, Laurie, M.S., C.P.N.P.
 Yedinak, Chris G.,
 D.N.P., F.N.P.-B.C., M.N.

Recent representative publications

Neurological surgery

Barajas RF, Hamilton BE, Schwartz D, McConnell HL, Pettersson DR, Horvath A, Szidonya L, Varallyay CG, Firkins J, Jaboin JJ, Kubicky CD, **Raslan AM, Dogan A, Cetas JS, Ciporen J, Han SJ**, Ambady P, Muldoon LL, Woltjer R, Rooney WD, Neuwelt EA: Combined Iron Oxide Nanoparticle Ferumoxytol and Gadolinium Contrast Enhanced MRI Defines Glioblastoma Pseudo-progression, *Neuro-Oncology*, 2018.

Bowden SG, Han SJ: The Evolving Role of the Oncologic Neurosurgeon: Looking Beyond Extent of Resection in the Modern Era. *Frontiers in Oncology* 8:406, 2018.

Gadelha MR, Kasuki L, Lim DS, **Fleseriu M**: Systemic complications of acromegaly and the impact of the current treatment landscape: an update. *Endocr Rev* 2018.

Han SJ, Morshed RA, Troncon I, Jordan KM, Henry RG, Hervey-Jumper SL, Berger MS: Subcortical stimulation mapping of descending motor pathways for perirolandic gliomas: assessment of morbidity and functional outcome in 702 cases. *J Neurosurg*:1-8, 2018.

Hardaway FA, Raslan AM, Burchiel KJ: Deep Brain Stimulation-Related Infections: Analysis of Rates, Timing, and Seasonality. *Neurosurgery* 83:540-547, 2018.

Holste KG, **Hardaway FA, Raslan AM, Burchiel KJ**: Pain-free and pain-controlled survival after sectioning the nervus intermedius in nervus intermedius neuralgia: a single-institution review. *J Neurosurg*:1-8, 2018.

McClelland S, 3rd, **Ciporen J**, Mitin T, Jaboin JJ: Long-term stroke risk of single-fraction photon-based stereotactic radiosurgery for meningioma. *Clin Neurol Neurosurg* 173:169-172, 2018.

McPherson KB, Leff ER, Li MH, Meurice C, Tai S, Traynor JR, **Ingram SL**: Regulators of G protein signaling (RGS) proteins promote receptor coupling to G protein-coupled inwardly-rectifying potassium (GIRK) channels. *J Neurosci* 2018.

Mohammed M, **Madden C, Burchiel K, Morrison S**: Preoptic area cooling increases the sympathetic outflow to brown adipose tissue and brown adipose tissue thermogenesis. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology* 2018 315:4, R609-R618.

Shlomo A, **Fleseriu M**: Vitamin D Hormone: Where Do We Stand, Where Are We Heading? *Endocrinology and Metabolism Clinics of North America*. Volume 46, Issue 4, Pages 815-1136 (December 2017).

Neurology

Benedek G, Meza-Romero R, Jordan K, Zhang Y, Nguyen H, Kent G, Li J, Siu E, Frazer J, Piecychna M, Du X, Sreih A, Leng L, Wiedrick J, Caillier SJ, Offner H, Oksenberg JR, **Yadav V**, Bourdette D, Bucala R, Vandenbark **AA**. MIF and D-DT are potential disease severity modifiers in male MS subjects. *Proc Natl Acad Sci USA*. 2017 Oct 3;114(40):E8421-E8429. doi: 10.1073/pnas.1712288114. Epub 2017 Sep 18.

Brock PR, Maibach R, Childs M, Rajput K, Roebuck D, Sullivan MJ, Laithier V, Ronghe M, Dall'Igna P, Hiyama E, Brichard B, Skeen J, Mateos ME, Capra M, Rangaswami AA, Ansari M, Rechnitzer C, Veal GJ, Covezzoli A, Brugières L, Perilongo G, Czauderna P, Morland B, **Neuwelt EA**. Sodium Thiosulfate for Protection from Cisplatin-Induced Hearing Loss. *N Engl J Med*. 2018 Jun 21;378(25):2376-2385. doi: 10.1056/NEJMoa1801109.

Croff RL, Witter IV P, MLWalker, Francois E, Quinn C, TC Riley, Sharma NE, Kaye JA. *Things Are Changing So Fast: Integrative Technology for Preserving Cognitive Health and Community History, The Gerontologist*, gny069, <https://doi.org/10.1093/geront/gny069>

Hugos C, Cameron M, Chen Y, Chen Z, Bourdette D. A multicenter randomized controlled trial of two group education programs for fatigue in multiple sclerosis: Long-term (12-month) follow-up at one site. *Multiple Sclerosis Journal*, 2018 May 1:1352458518775920. doi: 10.1177/1352458518775920. PMID: 29761722.

Mitew S, Gobius I, Fenlon LR, McDougall SJ, Hawkes D, Xing YL, Bujalka H, Gundlach AL, Richards LJ, Kilpatrick TJ, Merson TD, **Emery B**. Pharmacogenetic stimulation of neuronal activity increases myelination in an axon-specific manner. *Nature Communications*. 2018 Jan 22; 9(1):306. PMID: 2935875

Opel RA*, Christy A*, Boespflug EL, Weymann KB, Case B, Pollock JM, Silbert LC, **Lim MM**. Effects of traumatic brain injury on sleep and enlarged perivascular spaces. *Journal of Cerebral Blood Flow and Metabolism*. 2018 Aug 10:271678X18791632. doi: 10.1177/0271678X18791632.

Promjunyakul N, Dodge HH, Lahna DL, Boespflug E, Kaye JA, Erten-Lyons, D, Rooney WA, **Silbert LC**. Baseline normal appearing white matter structural integrity and cerebral blood flow predict white matter hyperintensity expansion over time. *Neurology*. 2018; 90(24):e1-e8.

Purice MD, Ray A, Münzel EJ, Pope BJ, Park DJ, **Speese SD**,* **Logan MA***. A novel drosophila injury model reveals severed axons are cleared through a Draper/MMP-1 signaling cascade, *eLife*, 2017 Aug 21;6. pii: e23611. doi: 10.7554/eLife.23611. *Co-senior authors.

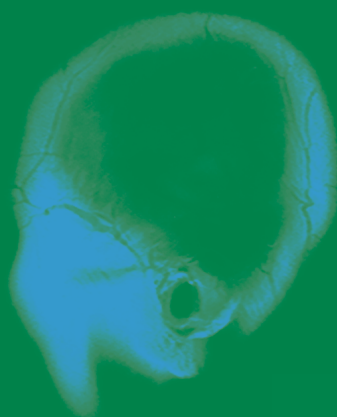
Valdes, R.A., Suits, A., Palmer, V.S., Okot, C., Okot, R.A., Atonywalo, C., Kitara, D.L., Gazda, S.K., Lantum, M., and **Spencer, P.S**. A real-time medical cartography of epidemic disease (nodding syndrome) using village-based lay mHealth reporters. *PLoS One Neglected Tropical Disease*, Jun 15;12(6):e0006588. doi: 10.1371/journal.pntd.0006588. eCollection 2018 Jun.

Woods NI, Vaaga CE, Chatzi C, Adelson JD, Collie MF, Perederiy JV, Tovar KR, **Westbrook GL**. Preferential Targeting of Lateral Entorhinal Inputs onto Newly Integrated Granule Cells. *J Neurosci*. 2018 Jun 27;38(26):5843-5853. doi: 10.1523/JNEUROSCI.1737-17.2018. Epub 2018 May 23. PMID:29793975



AFL

10cm

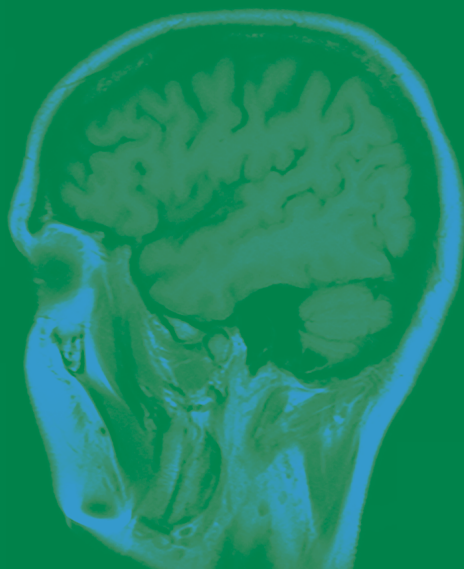


AFL

10cm



W 898
C 426



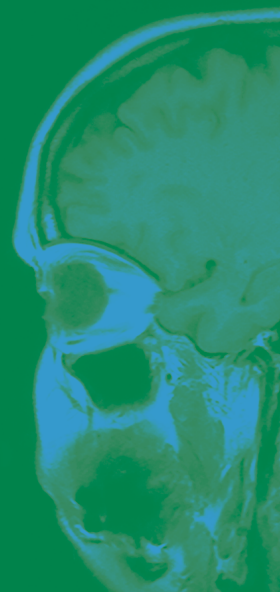
10cm

W 929
C 423



10cm

W 938
C 423



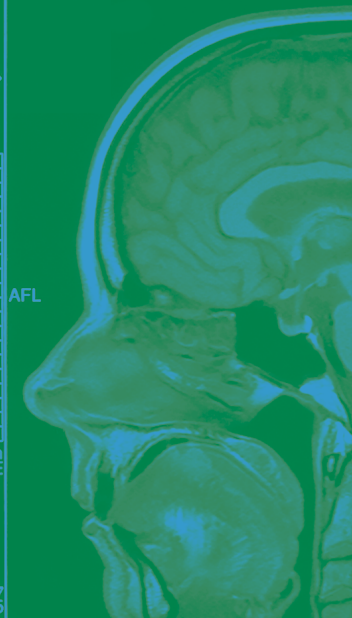
10cm

W 855
C 385



10cm

W 857
C 386



AFL