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#### Disclosures

R. Mark Richardson, MD, PhD, is a consultant for Zimmer Biomet. He also receives grant and research support from Voyager Therapeutics.

#### Instructions

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## Intracranial Cognitive Neurophysiology Research in Epilepsy Patients

by R. Mark Richardson, MD, PhD



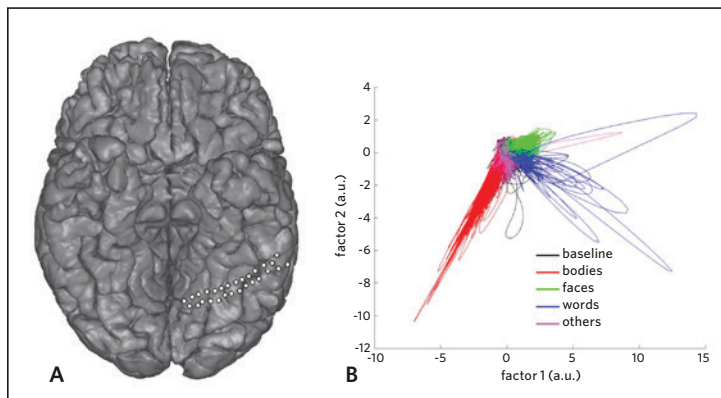
How do our brains apply meaning to what we perceive visually in the world around us? For the past several years, the department's Laboratory of Cognitive Neurodynamics, directed by Avniel Ghuman, PhD, has been studying how neural activity reflects information flow through brain networks responsible for visual perception of one's environment. Recognizing that recordings from electrodes implanted in the human brain provide a unique opportunity to gather neural data with far greater fidelity than non-invasive neural recordings, Dr. Ghuman has built a robust research program involving invasive recordings in patients undergoing intracranial monitoring for seizure localization.

Funded by the Biobehavioral Research Awards for Innovative New Scientists (BRAINS) from the National Institute of Mental Health, and working in collaboration with the department's Brain Modulation Lab, the Laboratory of Cognitive Neurodynamics has studied temporal lobe activity during the encoding of face information, word reading, and associative hallucinations, while developing new methods to explore the representational content of neural activity.

Recently, working with collaborators from Carnegie Mellon University, Dr. Ghuman

was awarded a BRAIN Initiative Award from the National Science Foundation for a research study, Decoding and Reconstructing the Neural Basis of Real World Social Perception. Social and affective perception is the critical input that governs how we interact with others during everyday life. These studies, involving patients in our Epilepsy Monitoring Unit undergoing intracranial monitoring, combine long intracranial recordings of natural behavior with cutting-edge gaze tracking technology, video analysis tools, and big data statistical and machine learning tools to understand the rapid, complex neural information processing that occurs during real-world social vision.

*(Continued on Page 7)*



**Figure 1: Tracking Neural Activity Trajectories During Vision.** Activity recorded from high-density ECoG over the left ventral temporal lobe (A) allows assessment of what a patient is looking at in real time by analyzing the trajectory of the neural activity projected into factors that maximally capture the information contained across electrodes (B).

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## Chairman's Message

# Artificial Intelligence and Telemedicine in Neurosurgery



The pace of advancements in technology is changing many aspects of our daily life. These advancements are clearly having a significant impact on the landscape of healthcare. We are beginning to take broad and bold steps in transforming the way we deliver healthcare. How will these changes affect neurosurgery? How will the patient experience change, and how will the role of the neurosurgeon change?

Given the magnitude of neurosurgical services provided by our department in 12 hospitals throughout western and central Pennsylvania, the opportunity to gather and analyze large amounts of patient and procedural data is significant. We have started to evaluate such data with a goal of enhancing our understanding of the outcomes of the many complex procedures we perform. Considering the challenges in performing randomized clinical trials in neurosurgery, applying artificial intelligence (AI) may be a strategy to generate answers to complex clinical questions. I suspect that over the next decade, we will implement AI as a central tool in our everyday practice. The goal will be to enhance the physician's ability to accurately diagnose and treat patients with complex medical disorders.

AI may also play a role in actual surgical procedures. Given the potential for significant morbidity associated with certain

neurosurgical procedures, I can see how computer oversight of each surgical step may alert us of imminent danger, or provide real-time advice on how to perform the next step in an operation with the greatest margin of safety. Cost analysis will likely play a role in the decision-making process when different options are available.

Another important technological change currently infusing itself into our practice is telemedicine. Given the ample geography we cover, many of our patients must travel hours to see us. This travel takes its toll in many ways including time, cost, and stress of travel, particularly for frail patients. In close collaboration with the UPMC Telemedicine department, we are actively implementing platforms to provide care at remote UPMC telehealth centers and, at times, even in the comfort of the patient's home. We are looking to significantly expand the impact of telemedicine as part of our patient-centric care.

At the UPMC Department of Neurological Surgery we embrace change in order to provide the most advanced care and remain neurosurgical leaders into the future.

*Robert M. Friedlander, MD, MA  
Chairman and Walter E. Dandy Professor of Neurological Surgery  
Co-Director, UPMC Neurological Institute*

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# Low Preoperative Serum Prealbumin Levels Increase Postoperative Surgical Site Infection Risk in Elective Spine Surgery

by David J. Salvetti, MD

Across numerous medical specialties, increasing attention is being focused on how nutritional deficiency negatively affects outcomes. In spine surgery, there is preliminary evidence that links the risk of preoperative nutritional deficiency to a risk of postoperative surgical site infection (SSI). In an initial retrospective cohort study by Tempel et al., 82 out of 83 (99%) patients with postoperative infections requiring surgical debridement were found to have abnormally low prealbumin levels at the time the postoperative infection was identified. While this was an important observation and has clinical utility in identifying patients who have infections, the causality of whether low prealbumin levels preoperatively portend increased risk could not be established, especially considering the known relationship of decreased prealbumin levels as part of an acute phase response. Subsequently, our group performed a case control study involving 32 patients who developed SSIs compared to 72 controls who did not develop SSIs. A preoperative prealbumin level of < 20 portended a hazard ratio of 2.12 for the risk of developing SSIs. This study was limited by its sample size, and therefore a follow-up study was devised to further define the relationship between a serum biomarker of nutritional status (preoperative prealbumin levels) and SSI.

A consecutive series of 387 patients undergoing posterior spinal surgeries with a preoperative prealbumin level was identified, and additional data was collected pertinent to the risk of SSI. Patients who developed a postoperative SSI were identified and the results were then analyzed to identify risk factors for postoperative SSI. Table 1 summarizes our patient cohort.

The infection rate for those patients with a preoperative prealbumin  $\leq 20$  was 13 out of 73 (17.8%) vs. 15 out of 314 (4.7%) for the patients whose preoperative prealbumin levels were greater than 20. On univariate analysis, low preoperative prealbumin levels were identified as statistically significant for increased risk of postoperative SSI with a crude odds ratio (OR) of 4.29 ( $p < 0.01$ ) and an adjusted OR of 4.24 ( $p < 0.01$ ). Table 2 summarizes the logistic regression.

The results of our study reinforce and strengthen prior findings that preoperative prealbumin levels are a useful predictor of risk for the development of deep SSIs. The ultimate goal is to utilize this information to decrease infection rates. After a patient is identified as being nutritionally deficient, nutritional supplementation could subsequently be implemented. Unfortunately, minimal work has been done in regard to nutritional supplementation in spine surgery and the trials that have been performed have largely had negative to negligible results. Substantial evidence shows that regimens containing protein supplementation, antioxidants, and calcium can promote wound healing, particularly in regard to chronic wounds such as sacral decubitus ulcers. Therefore, it

seems reasonable that such a regimen would have utility in the perioperative setting to promote postoperative healing. Further study is needed to elucidate whether preoperative administration of such a regimen can alter the risk profile of at-risk patients.

Our study represents the strongest evidence to date that preoperative prealbumin levels, a serum biomarker of nutritional status, correlates with the risk of SSI in spine surgery. Thus, we have begun deferring elective spine surgery in the setting of low prealbumin values while implementing nutritional supplementation regimens prior to undergoing an intervention.

	Prealbumin $\leq 20$ (n=73)	Prealbumin $> 20$ (n=314)	p-value
Age - mean (SD)	59.0 (12.5)	54.9 (15.4)	0.02
Mail Gender - no. (%)	36 (50)	148 (47.6)	0.14
BMI - mean (SD)	28.5 (6.7)	30.0 (6.5)	0.10
Surgery Time - mean (SD)	226.2 (85.3)	212.0 (89.0)	0.21
Current Smoking Status - no. (%)	18 (24.7)	70 (22.3)	0.66
Albumin - mean (SD)	3.72 (2.22)	3.89 (0.66)	0.54
Diabetes - no. (%)	7 (9.6)	61 (19.5)	0.05
Steroid treatment - no. (%)	5 (6.9)	32 (10.2)	0.38
Surgery type - no. (%)			0.79
Lumbar Fusion	58 (79.5)	245 (78.0)	
Lumbar Laminectomy	4 (5.5)	24 (7.6)	
Thoracic Fusion	2 (2.7)	8 (2.6)	
Thoracic Laminectomy	0 (0)	3 (1)	
Cervical Fusion	8 (11.0)	33 (10.5)	
Cervical Laminectomy	1 (1.4)	1 (0.32)	
Number of Operative Levels - median (IQR)	2 (2)	2 (2)	0.20

**Table 1: Baseline Characteristics of Patients** — Age, BMI, OR time, and albumin are expressed as: mean (standard deviation); Gender, smoking status, steroid treatment, and surgery type are expressed as: absolute number (%). Number of levels is expressed as: median (interquartile range). Means are compared with the use of T-tests for unequal variances, medians are compared with Wilcoxon. Proportions are compared with the use of the chi-square test. BMI: body mass index; IQR: interquartile range; SD: standard deviation.

	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Prealbumin $\leq 20$	4.29 (1.94-9.48)	<0.01	4.24 (1.70-10.56)	<0.01

**Table 2: Results of Linear Aggression Analysis** — 1. P-value based on a univariate logistic regression model. 2. P-value based on a multivariate logistic regression model including prealbumin, age, BMI and diabetes.

(Please note: Zachary J. Tempel, MD; Ezequiel Goldschmidt, MD, PhD; Nicole A. Colwell, MD; Federico Angriman, MD, MPH; David M. Panczykowski, MD; Adam S. Kanter, MD; and David O. Okonkwo, MD, PhD, also contributed to this article.)

# Stroke Study Encourages Dramatic Shift in Time Window for Invasive Stroke Treatment

by Benjamin Zussman, MD

Treatment paradigms for patients with acute stroke have rapidly evolved over the past five years. When a patient has a stroke caused by the blockage of a large, intracranial artery, such as the internal carotid artery or the first segment of the middle cerebral artery, that type of stroke is called a large vessel occlusion (LVO). Researchers have hypothesized that interventional procedures, like intra-arterial thrombectomy, could reopen the occluded vessel and restore blood flow to the brain quickly enough to prevent the completion of ischemic strokes and death of brain tissue.

In 2015, five randomized clinical trials showed a significant clinical benefit for acute stroke patients with LVOs who had interventional thrombectomy performed within six hours of stroke onset, in comparison to standard medical therapy with tissue plasminogen activator (tPA) alone. This data profoundly changed the way patients with acute stroke were treated because the results argued that interventional thrombectomy is the treatment of choice within the six-hour time window. However, many patients with strokes present outside of this time window. Patients who woke up with stroke symptoms were excluded from this time window because the timing of stroke onset was unknown. Patients who were last seen more than six hours before were excluded from this time window as well.

Neurosurgeons and neurologists treating stroke hypothesized that many stroke patients outside of the six-hour time window may also benefit from interventional procedures. For example, when a patient's clinical examination demonstrates neurological deficits that are disproportionately severe in comparison to the size of the stroke noted on brain imaging, it is likely that there is still significant viable brain tissue that could be saved if reperfusion could be achieved.

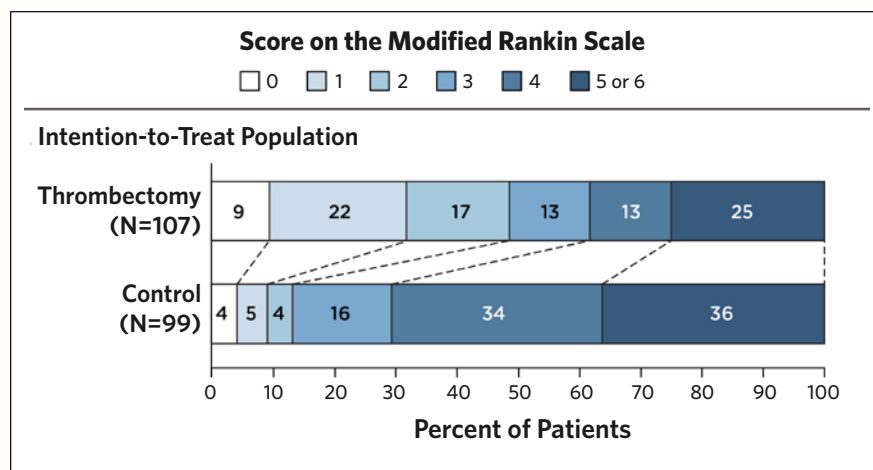
Led by UPMC faculty Tudor Jovin, MD; Ashutosh Jadhav, MD, PhD; and Brian Jankowitz, MD, the DAWN (DWI or CTP Assessment with Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurointervention with Trevo) trial studied patients with acute stroke who had last been known to be well six to 24 hours earlier and who had a mismatch between clinical deficit and infarct volume. Findings of this study were reported in the January 4, 2018 edition of the *New England Journal of Medicine*.

This international, multicenter study enrolled patients with occlusion of the internal carotid artery or proximal middle cerebral artery. There were 206 total patients enrolled, 107 assigned to the thrombectomy group and 99 assigned to the control group. The trial was stopped early because an interim analysis of the results showed that the disability scores for patients in the thrombectomy group were significantly better than the disability scores for patients in the control group. For example, the rate of functional independence at 90 days was 49% in the thrombectomy group but only 13% in the control group.

The number of patients needed to be treated with thrombectomy for one patient to have improved disability at 90 days was two, and the number needed to be treated to achieve functional independence at 90 days was 2.8.

The authors concluded that disability outcomes were better with thrombectomy than with best medical care alone among patients with acute stroke who received treatment six to 24 hours after they had last been known to be well and who had a mismatch

(Continued on Page 8)



**Figure 1:** This figure shows the distribution of scores for disability at 90 days after the stroke occurred for patients in the thrombectomy group compared to patients in the control group. Disability was graded using the modified Rankin scale, which ranges from 0 to 6, with a score of 0 indicating no disability and higher scores indicating more severe disability. The numbers in the bars are percentages of patients who had each disability score, and the figure visually depicts the finding that disability outcomes were better with thrombectomy plus standard medical care than with standard medical care alone.



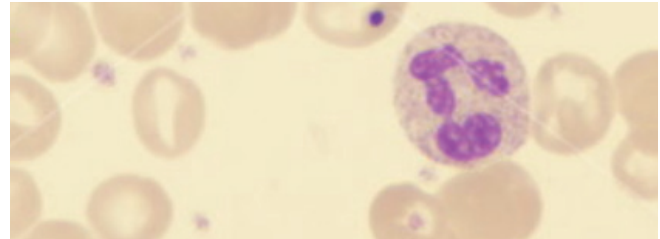
# Thrombocytosis May Prove Invaluable Initial Screening Tool in Traumatic Brain Injury Treatment

by William Ares, MD

Traumatic brain injury (TBI) is a leading cause of morbidity and mortality in all age groups. Given the limited resources of the current healthcare environment and the high costs of acute and chronic care of patients with severe TBI, early and efficient outcome prognostication is vital for appropriate allocation of resources. While a number of serum and cerebrospinal fluid biomarkers have been reported as potential prognostication agents in severe TBI, the generalizability of their use may be limited. To improve this generalizability, we investigated the utility of platelet levels derived from a complete blood count (CBC), a common and low-cost laboratory test, as a predictor of outcome in severe TBI. Post-traumatic development of elevated platelet count, or thrombocytosis, in critically ill patients has been reported in the literature and is believed to be secondary to a reactive process associated with cytokine release during the global inflammatory state. In the general polytrauma population, there is evidence that thrombocytosis is associated with decreased mortality and improved outcomes; however, this has not been investigated in the subset of this population with severe TBI.

To further investigate the potential relationship between thrombocytosis and outcome in patients with severe TBI, we reviewed the hospital charts of 120 consecutive patients with severe TBI (GCS<8) who were admitted to our neurotrauma ICU. Clinical data was retrospectively collected while clinical outcomes were part of a prospective registry. Patients were not included in our data analysis if they did not survive to hospital discharge or if they were lost to follow-up within six months. For the purposes of our study, we defined thrombocytosis as a peak platelet count greater than  $600 \times 10^3/\text{mm}^3$ . Our primary outcome measure was the Glasgow Outcome Scale (GOS) at six months but we also assessed six-month mortality, length of hospital stays, and incidence of deep vein thrombosis/pulmonary embolism (DVT/PE).

Forty-four patients were available for analysis after excluding in-hospital mortality (53 patients, 44%) and patients lost to follow-up (23 patients, 19%). At some point during their hospitalization, all patients demonstrated a platelet count greater than their count at admission. Twenty-one (47%) patients developed thrombocytosis during their hospital stay with an average platelet count of  $752 \times 10^3/\text{mm}^3$  and an average time to peak of 17 days. Twenty-three patients (53%) did not develop thrombocytosis with an average platelet count of  $472 \times 10^3/\text{mm}^3$  and an average time to peak of 15 days. Patients who developed thrombocytosis had a trend toward decreased GOS at six months (3.3 vs. 3.8,  $p=.08$ ) and toward longer hospital stays (37.5 vs. 21.5,  $p=.08$ ). Six-month mortality was unchanged between the two groups (4% vs. 4%,  $p=1$ ) as was incidence of DVT/PE (9% vs. 9%,  $p=1$ ).



Interestingly, relative increases in platelet counts appear to play a more significant role in outcome prognostication as patients with peak platelet counts greater than 200% of their admission baseline had significantly lower GOS at six months when compared to those that remained below 200% of baseline (3.4 vs. 4.1,  $p=.03$ ). Additionally, patients who remained below the 200% threshold had a significantly faster time to platelet peak (13 vs. 17 days,  $p<.005$ ). These findings were independent of length of stay, peak white blood cell count, white blood cell count on day of platelet peak, and incidence of DVT/PE ( $p>.05$  for all).

The development of post-traumatic thrombocytosis, while associated with lower mortality in the overall trauma population, may be associated with worse outcomes and longer hospital stays in a population of trauma patients with severe TBI. Relative reactive thrombocytosis greater than 200% of a patient's baseline may be more predictive of poor outcomes than strictly defined laboratory cutoffs. While the reason why patients with severe TBI differ in their response to thrombocytosis when compared to the general polytrauma population is still unclear, we hypothesize that it may be due to the particular sensitivity that patients with TBI have to inflammation. It is well known that systemic inflammation is a driver of secondary brain injury after TBI and a number of thrombopoietic and inflammatory cytokines have been correlated with poor outcomes after TBI. For example, inflammatory serum interleukins IL-6 and IL-8 have been associated in a dose-dependent fashion with poor outcomes in severe TBI and are also potent drivers of thrombocytosis. If thrombocytosis is, in fact, a surrogate marker for this inflammatory state, then it would make sense that greater exposure to high platelet counts would lead to worse outcomes. Correspondingly, the patients in our series who demonstrated a twofold or greater increase in their platelet counts had an average of 175% greater cumulative exposure to inflammatory mediators than the less-than-twofold cohort, and a subsequently worse score on the GOS.

As we move forward in our understanding of TBI and the plethora of factors that influence outcome after injury, thrombocytosis may prove to be a valuable initial screening tool for inflammatory state and, therefore, a potential insight into long-term outcomes.

## Center for Skull Base Surgery Offering Complex Endoscopic Endonasal Course

The UPMC Center for Skull Base Surgery, with collaboration between the Departments of Neurological Surgery and Otolaryngology, in conjunction with the University of Pittsburgh School of Medicine's Center for Continuing Education in the Health Sciences, is sponsoring a course on complex endoscopic endonasal surgery, June 7-9 at the University of Pittsburgh.

This course will focus on surgical decision-making and advanced techniques in endoscopic endonasal skull base surgery (training levels 3-5). Experts in the field will lead interactive case-based discussions on the indications, limitations, and technical nuances of the procedure by anatomical site.

The course will feature lectures (including 3D anatomy), round table discussions, case presentations, fresh anatomical specimen prosection and dissection, and an optional interactive live surgery demonstration on Wednesday, June 6. Participants will also train on a cadaveric-based internal carotid artery (ICA) injury simulator.

Directors for this course include world-renowned surgeons Paul Gardner, MD; Carl Snyderman, MD, MBA; Juan Fernandez-Miranda, MD; and Eric W. Wang, MD, all who have spent the better part of the last decade at the forefront of endonasal skull base surgery, advancing and developing new methods and skills in this groundbreaking surgical technique.

The Complex Endoscopic Endonasal Surgery course is intended for experienced skull base teams who wish to refine the technical nuances of endoscopic endonasal surgery of the ventral skull base and apply advanced endoscopic and reconstruction techniques to complex pathologies. The complex course

complements and builds on the principles demonstrated and taught in the UPMC Center for Skull Base Surgery's highly successful Comprehensive Endoscopic Endonasal Surgery course. As a prerequisite, those interested in the complex course must complete the comprehensive course before applying. Participants in the complex course will learn to:

- identify key anatomic landmarks to safely approach the skull base from an endoscopic perspective,
- utilize the full armamentarium of surgical tools and techniques,
- learn anatomic and technical keys for managing lesions that involve the internal carotid artery,
- develop treatment algorithms for malignant skull base pathology,
- manage revision reconstructions, and
- avoid and manage complications of endoscopic endonasal skull base surgery.

This course has been approved for *AMA PRA Category 1 Credit™*.

In addition to all lectures and hands-on anatomic dissection opportunities, registration for the course will also include the textbook, *Skull Base Surgery*, by Drs. Snyderman and Gardner, as well as social events and meals. Teams of two participants are required for this course.

For more information about the course, please visit <http://www.neurosurgery.pitt.edu/training/complex-endoscopic-endonasal-surgery-course> or contact the course's conference manager, Mary Jo Tutchko, at 412-647-8186 or [skullbasecourse@upmc.edu](mailto:skullbasecourse@upmc.edu).

Juan C. Fernandez-Miranda, MD, (right), conducts a 3D anatomy lecture in the University of Pittsburgh lab during the Complex Endoscopic Endonasal Surgery Course.



## News & Notes

### Niranjan, Lunsford, Richardson Publish New Book Volume on Movement Disorders

**Ajay Niranjan, MD; L. Dade Lunsford, MD; and R. Mark Richardson, MD, PhD,** are co-editors of a newly released book volume, *Current Concepts in Movement Disorder Management*, that summarizes the current state of movement disorder management and the role of surgical therapies as an alternative to medication. The book volume, published by Karger, is the 33rd volume in the publisher's popular *Progress in Neurological Surgery* series.

In the book, leaders in their fields describe the pathophysiology, functional neuroanatomy, clinical presentation, and medical management of Parkinson's disease, dystonia, and essential tremor. The spectrum of movement disorder surgery is discussed, from the lesioning procedures of radiofrequency ablation, stereotactic radiosurgery, and high-frequency ultrasound to the modulatory procedures of "asleep," image-guided deep brain stimulation (DBS) and "awake," microelectrode-guided DBS.

The book also discusses closed-loop DBS, drug delivery, gene therapy, and other emerging neurosurgical therapies, highlighting long-standing experimental strategies that are reaching exciting phases of clinical translation.

### Department Treats 15,000th Patient Using Gamma Knife® Surgery

On Thursday, December 7, 2017, the Center for Image-Guided Neurosurgery, under the direction of **L. Dade Lunsford, MD**, treated its 15,000th patient using the Leksell Gamma Knife® radiosurgery system. The patient was treated for a brain tumor and was able to go home the same day.

Gamma Knife surgery, also sometimes referred to as stereotactic radiosurgery (SRS), is a non-invasive alternative to traditional brain surgery and radiation therapy for the treatment of complex, difficult-to-treat brain conditions. It is used to treat a wide variety of brain tumors, vascular malformations, movement disorders, and facial pain. Targets are defined based on high-resolution brain imaging done with precision guiding devices. No surgical incision is required.

In a single outpatient procedure, SRS delivers a single, high dose of irradiation to affected tissue through the intact skull, and is a treatment option favored for its precise accuracy, efficiency, and outstanding therapeutic response. The stereotactic radiosurgery technique was

developed in the 1960's by the late Lars Leksell, a Swedish physician and professor of neurosurgery at the Karolinska Institute in Stockholm, Sweden.

The Gamma Knife was first introduced in the United States in 1987 at then Presbyterian University Hospital by Dr. Lunsford. He had studied at the Karolinska Institute under the direction of Dr. Leksell and Dr. Erik-Olof Backlund in 1980-81. Dr. Lunsford serves as the Lars Leksell and Distinguished Professor of Neurological Surgery at the University of Pittsburgh. He recently received the Herbert Olivecrona award from the Karolinska Institute in recognition of his innovative and pioneering use of the Gamma Knife.

"Gamma Knife was once a disruptive technology," Dr. Lunsford says. "With experience from 15,000 patients treated in Pittsburgh over the last 30 years, we can confirm that Gamma Knife brain surgery has become a sustaining technology because of its proven medical value, improved patient outcomes and quality of life, plus reduced costs to patients and health insurers."

### Congratulations

**Gurpreet Gandhoke, MD**, received the American Association of South Asian Neurosurgeons scholarship award from the Neurological Society of India and presented his paper, "Incidence of position-related upper extremity neuropraxia in 4,313 consecutive patients undergoing spine surgery: Role of SSEP monitoring," as a plenary talk at the group's annual conference, December 1 in Nagpur, India.

**Nima Alan, MD**, was awarded a \$5,000 development grant from the Society of Lateral Access Surgery (SOLAS) to help fund his research project evaluating the efficacy of intraoperative trans-cranial motor evoked potential (MEP) recordings for reducing lumbar plexopathy in L4/5 eXtreme Lateral Lumbar Interbody Fusion (XLIF). The preliminary results of Dr. Alan's findings will be presented at the SOLAS Annual Meeting, May 18-20 in San Diego, California.

**D. Kojo Hamilton, MD**, was selected as the Reviewer of the Month for December 2017 by the *European Spine Journal*.

**Ajay Niranjan, MD**, was named to UPMC's 2017 Excellence in Patient Experience, Physician and Medical Staff Honor Roll. Inclusion on the honor roll is for providers who consistently achieve a 9-10 rating in the "Rate Provider" domain on the CG-CAHPS survey.

## Intracranial Cognitive Neurophysiology Research *(Continued from Page 1)*

Most prior studies of the neural basis of social behavior have relied on artificial, laboratory-controlled experiments. These studies have provided important insights into the social brain, but do not capture the richness of true, real-life social behavior. Indeed, individuals with disorders of social behavior, such as autism spectrum disorders and post-traumatic stress disorders, often are only mildly impaired in laboratory conditions despite profound social impairments in the real world. Therefore, to better understand the neural basis of disorders of the social brain, a

model of how the social brain behaves during natural behavior is needed. Novel techniques developed by Dr. Ghuman's team (Figure 1, Page 1) are being applied now to natural vision to decode what patients are viewing over many hours, as they interact with doctors, nurses, and visitors. Thus, the goal of the current work is to generate a model that will allow investigators to understand how disturbances in the social brain lead to aberrant social behavior in the real world.

## Invasive Stroke Treatment *(Continued from Page 4)*

between the severity of the clinical deficit and the infarct volume as assessed by neuroimaging.

This study encourages a dramatic shift in clinical thinking about the eligibility of stroke patients for neurointervention, as traditional time window-based patient selection may be replaced by a combination of clinical examination and neuroimaging-based patient selection for interventional treatment. Importantly, this research shows that many properly selected patients with wake-up strokes, unwitnessed strokes, or even strokes up to 24 hours old experience significant benefit from invasive stroke therapy. It gives hope to patients and clinicians in cases where patients would have previously been left with severe disability or death.

UPMC physicians were uniquely involved in the design and execution of this study. Dr. Jovin was instrumental in the design of the trial and was one of the two principal investigators. Worldwide, UPMC was the highest enrolling clinical site in the trial. And, UPMC physicians from both the Departments of Neurosurgery and Neurology were represented as authors. We at UPMC are proud to have played a leadership role in this medical breakthrough and are committed to continuing to improve the care of stroke patients through scientific research and clinical excellence.

*(Please note: Brian Jankowitz, MD; Ashutosh Jadhav, MD, PhD; and Tudor Jovin, MD, also contributed to this article.)*

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