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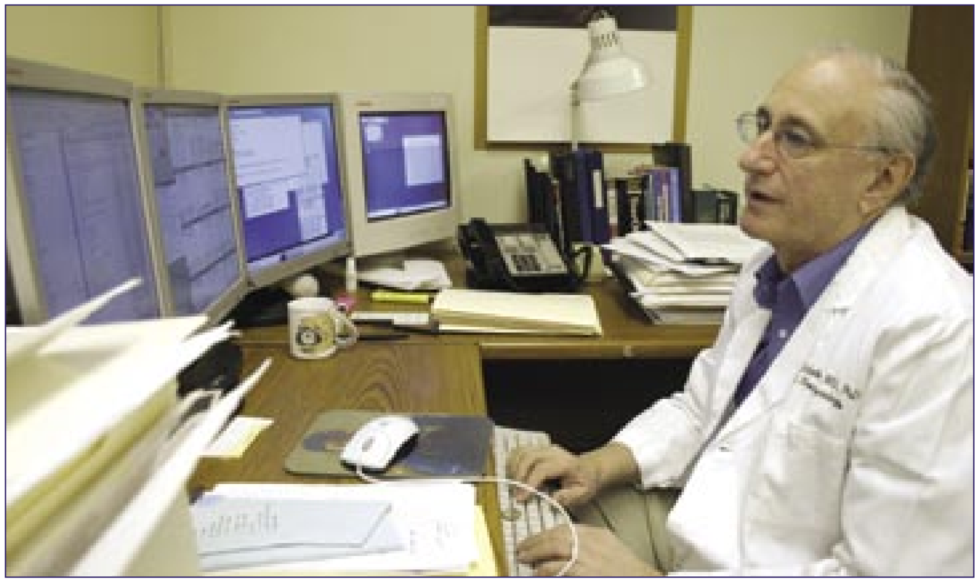
Patient Care • Teaching • Research

Advanced neurophysiology technology improves patient care, reduces costs

by Robert J. Sclabassi, MD, PhD
Director, Center for Clinical Neurophysiology

The Center for Clinical Neurophysiology (CCN) was organized twenty five years ago to provide a focused program for a number of testing modalities useful in assessing the functioning of the central nervous system. These modalities include diagnostic evoked potentials, transcranial doppler studies, xenon133, diagnostic and continuous studies in the intensive care unit and intraoperative neurophysiological monitoring (IOM) of the central nervous system. Besides providing services at UPMC Presbyterian, UPMC Shadyside and Children's Hospital of Pittsburgh, the CCN provides clinical services to approximately thirty hospitals not associated with PUH and CHP through Computational Diagnostics, Inc (CDI) , much of this work using unique technology to support telemedicine, developed at the University of Pittsburgh. Using this technology our groups provide IOM services to approximately 4500 patients a year.

The clinical activities of the CCN are supported by myself, Jeffrey Balzer, PhD, Donald Crammond, PhD, a group of twenty highly trained and superb neurotechnologists, and a number of technical and administrative support personnel. Besides the clinical activities, the CCN maintains an active research laboratory, The Laboratory for Computational Neuroscience, which was organized in 1981 to focus on the development of technology in support of neurosurgery, and which is now under the direction of Mingui Sun, PhD.



Robert Sclabassi, MD, PhD, director of the Center for Clinical Neurophysiology, monitors multiple operative cases using NeuroNet® monitoring system. (See complete story on page 8.)

Intraoperative Neurophysiological Monitoring (IOM)

Limitations in the ability to clinically assess nervous system function during surgery have led to the development of IOM techniques. IOM provides a realtime control loop around a system composed of the surgeon and the patient. The goals of the control loop are both the reduction of morbidity and a dynamic assessment of structure-function relationships of the patient's nervous system. This is accomplished by making specific and sensitive measurements that reflect the interactions between the surgeons intraoperative manipulations and the functioning of the central nervous system.

The achievement of this goal requires both as close to real-time measurement of CNS function as is possible and the obtaining of multiple simultaneous measures of CNS function. This combination of rapid acquisition and extensive observation of that portion of the neuroaxis being directly affected by the operation allows a close and dynamic correlation with operative manipulations.

Our approach to intraoperative monitoring emphasizes the utilization of the simultaneous measurement of multiple neurophysiological measures.

Depending on the surgical procedure, measures may be observed which are directly dependent on the functioning of the cortex (the electroencephalogram, somatosensory evoked potentials and visual evoked potentials, direct cortical stimulation), the brainstem (brainstem auditory evoked potentials and brainstem somatosensory evoked potentials), and cranial nerves II, III, IV, V, VI, VII, VIII, IX, X, XI, and XII spontaneous and evoked EMGs), the spinal cord (sensory and motor potentials), and peripheral nerves (evoked EMGs and compound action potentials).

*(See **intraoperative** on page 6)*

Neurosurgery faculty among region's top doctors in magazine survery

A. Leland Albright, MD, Amin Kassam, MD, Douglas Kondziolka, MD, L. Dade Lunsford, MD, Joseph Maroon, MD, and Ian Pollack, MD, (left to right above) have been named among this area's top doctors in a national survey published locally in *Pittsburgh Magazine*. For more information, please see *News & Notes* on page 7.

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CHAIRMAN'S LETTER

Continuing ed courses critical in life-long learning process

Continuing medical education (CME) activities are critical for the life-long learning commitment of neurological surgeons in practice. Our state board licensure, our medical staff privileges, our professional society continued memberships, and even our maintenance of our American Board of Neurological Surgery certification is dependent on continuing demonstration of CME activities.

The Department of Neurological Surgery at the University of Pittsburgh has been a leader in providing advanced learning courses, often using multi-disciplinary faculty.

Among the activities that our department has sponsored include *Principles and Practice of Gamma Knife Radiosurgery*, given seven times per year. This course includes one week of intensive practical and didactic training, often serving as an initial credentialing mechanism for neurological surgeons, radiation oncologists and medical physicists who anticipate practicing gamma knife stereotactic radiosurgery in the United States or abroad.

Over the years, our department has trained 291 neurosurgeons, 223 radiation oncologists, and 86 medical physicists in the practice of gamma knife radiosurgery. As the field continues to expand and sales of new units remain high, the need for a crash course in radiosurgery is critical.

Our faculty includes myself, Douglas Kondziolka, MD, John Flickinger, MD, Ann Maitz, Ajay Niranjan, Becky Emerick of the International Radiosurgery Support Association, Mike Sheetz from the University of Pittsburgh Radiation Safety Office, Dr. Jim Greenberg from pediatric anesthesia, Dr. Peter Gerszten from our own department, as well as our staff.

Each course has about 20 registrants. The course is 42 hours of intensive training which includes didactic lectures, hands on experience with the Gamma knife, and practical experience in robotics, medical physics, and radiobiology. Forty-three courses have been given to date.

The Spine Center of Excellence course sponsored by Dr. William Welch and Zimmer, Inc. continues to attract a wide variety of surgeons who wish to hone their knowledge of spine, degenerative disease of the spine, bio-mechanics, and stabilization systems.

Drs. Kassam, Snyderman and Carrau have offered several courses in advanced endoscopic skull base surgery, demonstrating their extensive knowledge in the ever-expanding role of endoscopic skull base surgery. This minimally invasive approach to widespread and maximally invasive skull base surgery requires technical expertise and significant re-training from traditional microsurgical skills.

The efforts of these pioneers have now moved to hosting the first World Congress of Skull Base Endoscopy at the end of September and the first week of October 2005. This multi-disciplinary international meeting promises to attract otologists, neurosurgeons, and endoscopic practitioners from across the world. There is much to learn and problems still to solve as this technique continues to gain a major foothold. It already seems to be the most promising method to perform traditional pituitary surgery.

These activities are all focused on the post-graduate physician, including those who are well past their formal neurosurgical training. Those in academic medicine must continue to re-invent themselves. While doing so, we are constantly challenged by our trainees as to why, on whom, when, where, and how? Continuing medical education activities are a critical component of the academic environment, and our department is proud to sponsor these special learning opportunities. •

L. Dade Lunsford, MD
Lars Leksell Professor
Chairman, Department of Neurological Surgery

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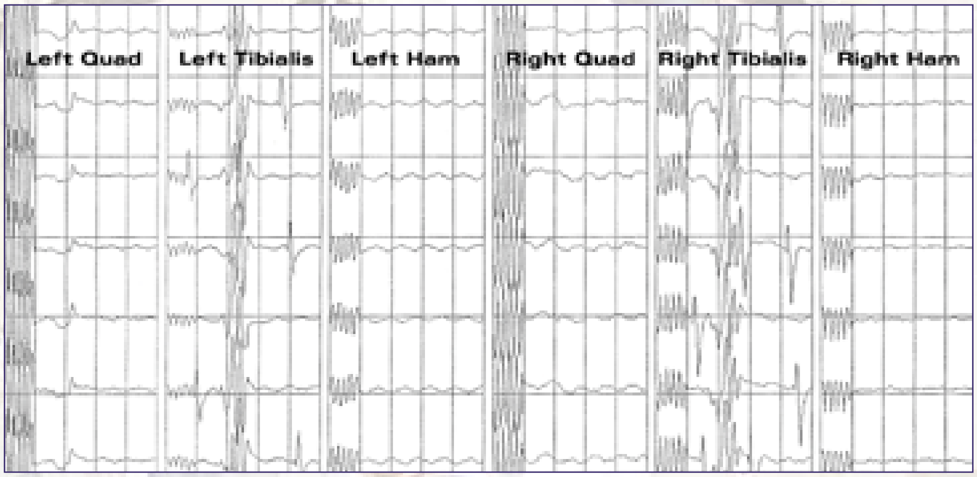
Motor evoked potentials advance non-invasive, timely, intraoperative feedback

by Jeffrey R. Balzer, PhD
Associate Professor of Neurological Surgery

Somatosensory evoked potentials (SSEP's) long have been utilized during surgical procedures involving the spinal cord and column. Their effectiveness in preventing and reducing iatrogenic neurological injury has been well documented and they continue to be the gold standard for decompressive, stabilization and corrective procedures involving the cervical, thoracic and lumbosacral spine. However, over the years, several isolated incidents of postoperative motor deficits in the absence of SSEP changes have been reported. For this reason, a great deal of time and effort has recently been expended in an attempt to develop technology and techniques to safely and confidently assay the descending (ventral) pathways involved in the generation of voluntary motor activity in the operating room.

Although SSEP monitoring has been established as a reliable measure of spinal cord function, its usefulness and dependability is constrained by the fact that only limited portions of the spinal cord are assayed using this technique. In an attempt to assay and protect the more ventral descending pathways of the spinal cord, motor evoked potential (MEP) techniques have been developed that, like somatosensory monitoring, allow for non-invasive and timely feedback concerning anterior spinal cord function.



Multi-channel tcMEP's recorded during scoliosis surgery. High-frequency pulse-trains are delivered to the scalp and EMG is recorded from bilateral lower extremity muscle groups simultaneously. MEP recordings are performed along with SSEP recording throughout the procedure.

Transcranial Electrical Stimulation:

Transcranial electrical stimulation of the cerebral cortex has existed for nearly five decades. In response to the perceived need for the generation of a reliable descending MEP, many investigators, using these early studies as a guide, have developed a variety of stimulation and recording techniques to reliably generate a transcranial MEP recorded as an electromyographic (EMG) potential from the upper and lower extremity musculature that is recordable in the operating room.

Current Techniques:

Transcranial electrical stimulation is performed using commercially available neuromonitoring devices capable of delivering high intensity, brief trains of electrical impulses. These short, high frequency trains of stimulation are thought to be optimal, approximating the rate of cortical discharge of the upper motor neurons during voluntary movements. Stimulation is delivered to the scalp using standard electrodes similar to those used for SSEP recording and EMG responses are recorded, using surface electrodes, as compound muscle action potentials from upper and lower extremity muscle groups.

Advantages and Limitations:

Due to the continued advancements in instrumentation and technique development, transcranial electrical MEP's can routinely and reliably be recorded in the intraoperative setting. MEP's in response to transcranial electrical stimulation appear to be sensitive to the detection and prevention of iatrogenic spinal cord injury during certain spinal cord procedures. Specifically, the use of MEP monitoring during the resection of intramedullary spinal tumors and descending thoracoabdominal aneurysms has been shown to reduce iatrogenic injury and, in fact, be predictive of long-term neurologic outcomes. Additionally, recent data concerning the improvement of outcomes in procedures such as anterior and posterior cervical decompressions and scoliosis beyond that which SSEP monitoring provides has been published.

The major limitation in utilizing MEP's in the operating room is the interpretation of significant change and hence, appropriate alarm criteria. Several different alarm criteria for MEP monitoring have been proposed ranging from modest changes in amplitude of the EMG response (similar to that used for SSEP) to changes in waveform morphology to waiting until the MEP response is completely abolished before altering the operating surgeon. A general lack of consensus with regards of alarm criteria could lead to a high instance of false positives and more importantly, the possibility of insensitivity of the technique.

A second limitation has to do with the anesthetic regimen that needs to be followed in order for reliable and repeatable MEP responses to be recorded. For example, the use of even very low concentrations of volatile anesthetics (0.4% isoflurane) precludes transcranial electrical MEP monitoring. Other anesthetic agents, such as nitrous oxide and benzodiazepines also have been shown to severely depress response amplitude and the ability to reliably evoke these potentials. The anesthetic limitation with the greatest impact is that no paralytic agents can be used during transcranial MEP recording due to the fact that the MEP is recorded in the form of an EMG response. Ideally, a total intravenous (TIVA) technique should be employed using agents such as fentanyl and propofol in the absence of any paralytic agents.

Safety:

There is little evidence to suggest that transcranial electrical stimulation used for the generation of MEP's poses any significant risks to normal patients (tissue heating and burns, hearing loss, headaches, permanent changes in EEG, kindling seizures or compromised cognition). One of the most cited complications attributable to transcranial stimulation of the motor cortex is a self-inflicted tongue bite associated with strong facial contractions; however, this complication is easily prevented by placing a bite block in the mouth. Exclu-

*(See **MEP** on page 6)*

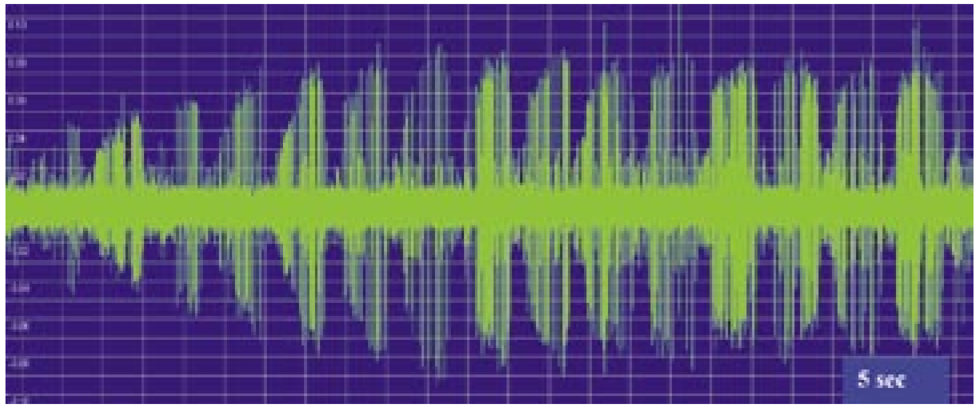
Micro-electrode recording (MER) key in deep brain stimulation treatment

by Donald J. Crammond, PhD
Assistant Professor of Neurological Surgery

In 2004, about 5000 devices were implanted into the brains of patients suffering from movement disorders including Parkinson's Disease, Essential Tremor and Dystonia. Currently, a single device, the Activa Therapy (Medtronic), is approved for use in the USA. The device delivers Deep Brain Stimulation (DBS) using one or two permanent electrodes implanted into the target structure that are connected to a pulse generator and battery implanted subcutaneously near the clavicle.

Altered levels or patterns of activity in various structures that comprise the motor system are the hallmark characteristic of all movement disorders. In Essential Tremor, the focus is on the motor nuclei of the thalamus, Dystonia the Globus Pallidus, and Parkinson's Disease the complex motor circuits of the Basal Ganglia, Sub Thalamic Nucleus (STN), Thalamus and Cerebral Cortex. Implantation of DBS into the target structure and subsequent activation of patterned stimulation trains has been shown to significantly reduce patient symptoms and to augment the ongoing medical management of these disorders. Although the mechanisms underlying DBS treatment remain poorly understood, DBS is thought to act by reducing the high ***levels*** of neuronal discharge signals that occur in the deep motor nuclei of movement disorder patients, and/or by restoring the normal ***patterns*** of neuronal discharge arising from these structures.

Neurophysiologists assist in the neurosurgical procedure to implant DBS by using microelectrode recording (MER) techniques to record the discharge patterns of single neurons that identify and confirm the location(s) of target structures. The target structure and plan for getting a small canula close to the target safely using stereotactic coordinates are selected by the functional neurosurgeon.



(Figure A) **Thalamus: Single unit. Large amplitude. Tonic non-spontaneous discharge phasic modulation with arm manipulation.**

By definition, DBS targets are at the center of the head and furthest from the skull regardless of the trajectory taken. In movement disorder surgery, the deepest target is the STN. The STN is a lens shaped structure about 5 mm x 10 mm x 5mm that lies about 120 mm from the start of a stereotactic trajectory from outside of the skull. At most, the half-width of the STN is 5 mm. The problem can be thought of as the shape of a cone where the tip is the start point of the tract with the width of the STN as the base. Any tract that remains within the angular confines of this cone will get to the STN. However, for a tract to completely miss the STN, the angular deviation (error) from the direct path need only be 2.4°. This error may be accounted for by small compounding errors in radiology imaging, stereotactic registration and anatomical factors that will vary from patient to patient. Thus, a stereotactic trajectory alone may often miss the target structure, especially if the target is the STN, currently the target selected for DBS therapy in most Parkinson's patients.

The surgical procedure for DBS implantation is done with the patient awake and with the scalp locally anesthetized. The patient's head is placed into a stereotactic frame and the neurosurgeon makes a small burr-hole opening in the skull over the entry point at the cortical surface. An electronically controlled micro-drive is then positioned in the frame over the burr-hole to which a very long but fine metal microelectrode is attached. The microelectrode (which is handmade by FHC microTargeting) is constructed of a Platinum/Iridium metal alloy that is electrochemically etched to a tip of a few microns in diameter that is insulated using a molten glass coating so that the exposed tip length is about 10-15 microns. The impedance of the exposed recording surface is about 1 M-Ohm and this, along with the fine electrode tip configuration allows the microelectrode to record action potentials from single neurons. The electrode is manually advanced into the brain along the stereotactic tract towards the target. At about 10 mm above target, the electronically controlled microdrive is then used to advance the electrode at a resolution of steps as small as 1 micron. MER is used to continuously identify the firing patterns of neuronal activity as the microelectrode is advanced. When a neuron's discharge is recorded, the depth and general characteristics

Neurophysiologist Donald Crammond, PhD, foreground, works with patient and surgeons using microelectrode recording (MER) planning software (upper left) to help obtain the best path and treatment options in deepbrain stimulation procedure.

of the unit, firing level and discharge pattern are documented, as is the relationship of the neuron's discharge to a clinical sensory and motor examination of the patient.

The electrode is advanced and this process is repeated until a map of neuronal activity recorded from dozens of neurons has generated for the entire electrode tract. The electrophysiological data is then synthesized to determine the location of parenchyma versus white matter, the top and bottom of the STN and the total STN thickness. Typically, for DBS to be successful, about four millimeters of the STN must be confirmed. Otherwise, the microelectrode is withdrawn and a new trajectory is selected and the process repeated. After MER is completed for a given tract, the microelectrode is removed and the DBS electrode placed in the same microdrive that is used to position the DBS electrode into the target structure.

In our experience, MER has proven useful at guiding the final placement of the DBS electrode in the target structure as compared to what would have occurred had the DBS placement been based on stereotactic planning alone. MER data from the first 24 DBS implants into the STN identified two separate sources of error: In 29% of tracts, there was an "X-Y" error, i.e., the tract was wide of the STN or passed too little STN tissue. In a further 38% of tracts, the STN was either higher or lower than expected (Z error) by more than 1.5 mm. Altogether, in about two thirds of tracts, MER improved the targeting of the STN and every DBS placement was confirmed to be completely within the STN. Overall, MER is a very useful neurophysiological tool that can guide targeting to very small nuclei located at the base of the skull. Furthermore, this application of MER, a research technology, is a great example of taking methods developed at the bench to the bedside: both MER and DBS are being used clinically because of the efforts of basic research scientists and countless research animals. DBS is a successful treatment for movement disorders and the future is very bright: Not only will MER help guide DBS placement, MER data will also be used to understand the underlying neuropathological mechanisms in movement disorders that will help develop more refined devices that target specific movement disorder symptoms and develop new indications for DBS, including pain, psychiatry and even obesity. Possibly, long-term DBS treatment may confer a level of protection to CNS structures against pathological change. •

Celebrating 35 years of marriage after risky procedure to treat Parkinson's

(***Editor's note***: The following story appeared in the February 23 *Pittsburgh Post-Gazette*. Rena Koteski was treated by Douglas Kondziolka, MD, using deep brain stimulation.)

By Judy Laurinatis
Pittsburgh Post-Gazette

John Beale, *Post-Gazette*

Rena Koteski is doing well after subthalamic nucleus deep brain stimulation treatment for Parkinson's Disease.

Rena and Larry Koteski picked the weekend before Valentine's Day to commemorate their long marriage by renewing their vows.

But the Plum couple's 35 years of matrimony were just part of their celebration. They were also celebrating Rena Koteski's return to a full life, one in which she can drive again and dress herself and walk with the brisk stride of a person on a mission.

They were celebrating the success of a risky procedure Rena Koteski, 61, believed was her only alternative when faced with a life that had become so limited from her Parkinson's Disease, she felt she wasn't living at all.

"I've been reborn," she said.

And she wants to get the word out.

This past fall, she underwent subthalamic nucleus deep brain stimulation at UPMC Presbyterian Hospital. The procedure, done only about a dozen times in Pittsburgh, involves implanting electrodes in the brain. They are stimulated by pacemakers that are placed under the collarbone of the patient.

She still has the bright red scars just below her neck where the two pacemakers were placed. Her hair has started to grow back where it was shaved when the stints were inserted.

No one knows why it works, just that it does, she said.

In the three and a half months since the operation, Koteski has almost completely stopped having involuntary tremors, cut back by about a third on the number of pills she must take and found she can walk and dress herself like the independent woman she prides herself on being.

Her whole family discussed the operation, which carries risks of stroke or even death, before she decided to have it done. Ultimately, though, it was her decision, Larry Koteski said.

"My whole life was not what I wanted it to be," Rena Koteski said.

In an April 2002 entry in her journal, she called her disease "this monster." She wrote that it was "degrading" to have her husband cover her in bed at night because her tremors made it impossible for her to do it.

In another, later entry, she describes her pain and how difficult it was to move her legs. "My body hurts. Sometimes the neuropathy in my left foot is unbearable," she wrote.

But the last straw, the moment of clarity when the couple knew she would have the operation came when they watched a taped broadcast of a Plum school board meeting at which she presided. Her tremors were so pronounced she looked out of control.

Rena Koteski has been a board member for 16 years. Last year she served as president. Before that she was an involved parent.

She had been a reporter for the Valley News Dispatch in Tarentum, a job she started in 1962 and kept after she married Larry Koteski in 1970 at St. Joseph Church in Natrona Heights.

But when daughter, Allison, was born in 1972, Rena Koteski decided she would become a full-time mom and left the job. Three other children, Jon, Rena Lynn and Wesley, followed. She became involved in their lives and activities and in the community where they lived.

As the children grew up, went to college and moved on with their own lives, Rena and Larry Koteski figured it was time for a new phase in their lives. They bought a recreational vehicle and enjoyed using it.

Then one Christmas morning in the early 1990s, Rena Koteski's limbs were shaking with involuntary tremors.

A doctor's visit did not determine the cause of her shaking, since several conditions could cause the problem. Medication helped.

Eventually, though, she was diagnosed with Parkinson's.

Now that her health has improved, Rena Koteski said she and her husband, who is a vice president at Mellon Financial, have just bought a new RV and plan to take time to enjoy life.

She said she'd felt so positive about her newly reacquired abilities, she proposed to her husband and asked him to marry her -- again. They selected Feb. 11 because it was just before Valentine's Day and close to their Jan. 31 anniversary date.

Rena Koteski said doctors have told her that her newly implanted electronic equipment will likely last about five years.

Larry Koteski is just happy that his wife has progressed as she has and that she's upbeat about her illness. He can even find a little joke in it now.

"I never thought I'd be married to a bionic woman," he teased. •

Intraoperative neurophysiological monitoring helps reduce morbidity rate

(continued from page 1)

Neurophysiological measures are available which provide a functional map of nearly the entire neuroaxis. These measures include: the electroencephalogram (EEG), an unstimulated measure of cortical function suitable for providing information concerning the degree of cortical activation related to either metabolic processes (for example, hypoxia) or to pharmacological manipulation (for example, pentobarbital induced burst suppression to protect the patients cortical function); the somatosensory and visual cortical potentials (SEPs and VEPs) which provide additional measures of cortical function specific to certain pathways and vasculature; the auditory and somatosensory brainstem potentials (BAEPs and BSEPs) which provide information about the functioning of the brainstem specific to certain pathways; compound nerve action potentials providing information from both the spinal cord (SCAPs) and peripheral nerves (CNAPs); and finally, both continuous and evoked EMGs (CMAPs) recorded from muscles innervated by the various cranial and peripheral nerves, which provide direct information about the integrity of the cranial nerves, they're underlying brainstem nuclei the spinal cord, and peripheral nerves.

A Specific Example

Somatosensory evoked potentials (SEPs) are used during spinal surgery, vascular procedures, and cranial base procedures. For most cases we simultaneously stimulate the median or ulnar nerve at the wrist, and the common peroneal nerve as it passes under the head of the fibula, or the posterior tibial nerve at the medial malleolus. In addition, dermatomal SEPs are of use in selected cases where concern exists about protecting particular nerve roots, for instance during tethered cord release.

Somatosensory evoked potentials are dependent on the stimulation of large afferent fibers of peripheral nerves. Following stimulation of peripheral nerves in the arms or the legs, SEPs can reproducibly be recorded over the spine and scalp. In the spinal cord, the SEPs are conducted primarily through the dorsal columns and extensive work has been done to clarify the generators for the various components of the SEPs. In humans, loss of posterior column function is associated with abnormality of the SEPs; however, extralemniscal pathways may also mediate some mid- and long latency scalp SEP components.

It has been our experience that SEPs are extremely sensitive and specific to spinal cord injury whether it occurs in the dorsal or ventral pathways. This is confirmed in the literature [Nuwer, et al], where a false-negative rate of .063% was found for 51,263 spinal cases in which SEPs were the only modality monitored. Furthermore, the negative predictive value (i.e., the likelihood of normal spinal cord function in the presence of stable SEPs) was 99.93%. This is a significant improvement over the .72% to 1.4% incidence of spinal cord injury reported for unmonitored cases.

Summary

Successful neurophysiological monitoring requires the simultaneous acquisition of as many appropriate neurophysiological variables as possible. It also requires a highly trained neurophysiologist to rapidly interpret complex data often recorded in less than optimal conditions. In our institution, as in many others, the demand exists for monitoring many cases simultaneously. The telemedicine technology which we utilize allows a single trained clinical neurophysiologist to consult on multiple cases simultaneously [Sclabassi, et al]. The appropriate utilization of both IOM and supporting technology reduces costs in health-care delivery. IOM reduces the length of time patients are hospitalized by reducing the morbidity associated with major surgery. •

MEPs provide timely, non-invasive feedback

(continued from page 3)

sion of patients from receiving transcranial electrical stimulation include those who present with epilepsy, head injury, skull defects, or implanted mechanical or electrical devices (pacemakers, vascular clips, bullet fragments, bone plates, cochlear implants or deep brain stimulators), patients with implantable devices and patients with boney defects of the skull.

Utilization of MEP's:

Optimal intraoperative monitoring of spinal cord function requires both sensory and motor pathway stimulation. At present, the challenge may be best met by using transcranial electrical MEP's along with traditional SSEP monitoring. Noninvasive methods for depolarization of the cortical mantle of the unexposed motor areas have been cited as marking the beginning of a new era in clinical neurophysiology, permitting the first intraoperative evaluation of central motor pathways. The future role and efficacy of transcranial electrical MEP's utilization during spinal cord procedures depends on: 1) establishing reliable alarm criteria, 2) prospective studies demonstrating its predictive efficacy, and 3) development of compatible anesthetic protocols for its reliable use. •

Recent donations to the department

Children's Neurosurgery Chair
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Robert Morgan Entwisle III
United Way of Allegheny County

Lars Leksell Chair
• Up to $1,000:
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Department Faculty Honored as 'Region's Top Doctors'

A. Leland Albright, MD, **Amin Kassam, MD**, **Douglas Kondziolka, MD**, **L. Dade Lunsford, MD**, **Joseph Maroon, MD,** and **Ian Pollack, MD**, have been named among this area's top doctors in a national survey published locally in *Pittsburgh Magazine*. The survey, conducted by Castle Connolly Medical Ltd, utilizes an exhaustive process to identify leading physicians.

In the survey process, physicians are nominated by hospital executives including presidents, vice-presidents of medical affairs, and chiefs of service in a variety of specialities. Selectors base their nominations on professional qualifications, interpersonal skills and by answering the question "to whom would you send members of your family."

The nomination pool is then refined through interviews and by referencing databases confirming board certification, licensing, education, appointments and disciplinary history.

Neurophysiology Lab Receives Patent for Research

Research recently performed in the Laboratory for Computational Neuroscience, Center for Clinical Neurophysiology of the Department of Neurological Sugery has been awarded a U.S. patent entitled "Method of Data Communication with Implanted Associate Apparatus." Investigators for the project include **Mingui Sun, PhD**, and **Robert Sclabassi, MD, PhD**, of the Department of Neurological Surgery and Marlin Mickle of the Department of Electrical Engineering at the University of Pittsburgh.

The research describes an apparatus and method of communicating data employing current pulses transmitted by an implanted device through living biological tissue to an external device. The method also contemplates transmission of current pulses from the external device through living biological tissue to an implanted device. Uniquely configured antenna electrodes are preferably employed in the implanted device. Increase in signal-to-noise ratio is achieved through sychronization. The method may be employed in diagnostic, theraputic and general monitoring activities in connection with human beings.

Ongoing research in this area is continuing with funding from the NIH and the U.S. Army.

Gamma Knife Unit Upgraded with Latest Technology

New software technology, enabling physicians to more quickly and more easily evaluate multiple patient data studies for treatment with the Leksell Gamma Knife, has been installed at the Center for Image-Guided Neurosurgery.

The 4-C Gamma Knife model represents the most up-to-date and unique version of the gamma knife brain surgery technology. The new software package now facilitates merger of multiple imaging data sets, including tumor PET, MRI, CT, and magnetoencephalography data, a technology currently planned for installation at UPMC Presbyterian in the spring of 2005.

UPMC Presbyterian was the first hospital in North America to place the gamma knife technology in the clinical arena. Since 1987 almost 7,000 patients have undergone gamma knife brain surgery here for brain tumors, vascular malformations, and pain among other indications. No other site in the United States has more than one unit in operation.

Neuroendovascular Surgery Book Volume Available

Michael Horowitz, MD, director of the Department of Neurological Surgery's Center for Endovascular Therapy, is co-editor of a newly released book volume *Neuroendovascular Surgery*, discussing the most common procedures in this subspecialty. The book, published by Karger, is the latest volume in the publisher's Progress in Neurological Surgery series, edited by department chairman, L. Dade Lunsford, MD.

Elad I. Levy, MD, PhD, former resident with the department and currently with the University of Buffalo, is co-editor of this book volume.

More information on this volume—and the series in general—can be found on the Karger website at www.karger.com.

Announcements

• **Dr. Kondziolka** served as visiting professor at Swedish Hospital in Denver, CO, February 17-18.

• **John Lee, MD**, chief resident, received the AANS/CNS Section on Spine and Peripheral Nerve's Mayfield Basic Science Award at the group's meeting in Phoenix, AZ, March 10.

• **Dr. Kassam** was a guest lecturer at the 3rd Biennial International Instructional Masterclass in Milan, Italy, March 4.

• **Joseph G. Ong, MD**, PGY-5 resident, was awarded the 2005 AANS NREF/DePuy Research Fellowship.

Media

• **Peter C. Gerszten, MD**, was featured in a live webcast, January 14, on or-live.com discussing nucleoplasty. Visit www.or-live.com/UPMC/1279 fo a replay of the webcast. The webcast was sponsored by ArthroCare.

New Research Grants

"Study of Percutaneous Intradiscal Nucleoplasty Efficacy." PI: **Dr. Gerszten**. ArthroCare ($40,612).

Welcome

Gary Boyd, practice manager for Tri-State Neurosurgical Associates; **Zhifang Yuan**, senior research specialist for the Center for Injury Research and Control; **Naomi R. Agostino**, research assistant for Dr. Pollack.

Congratulations

Twin baby girls (Ella and Emma, December 27) to **Paul Gardner, MD**, PGY-4 resident, and wife Kara.

Upcoming Events

• May 9-13: **Principles and Practice of Gamma Knife Radiosurgery**. Training course targeted at neurosurgeons, radiation oncologists and medical physicists interested in Gamma Knife radiosurgery confirmation. Additional course dates are June 6-10 and July 11-15. Contact Charlene Baker at (412) 647-6250 for more information.

• June 3-5: **Minimally Invasive Endoscopic Surgery of the Cranial Base and Pituitary Fossa Course**. Series of lectures discussing approaches for endoscopic surgery of the cranial base and pituitary fossa. Experts on the subject will present technical aspects of those operations along with risks, benefits and outcomes. Live cases are included. Contact Melissa Hawthorne at (412) 647-6358 for more information. •

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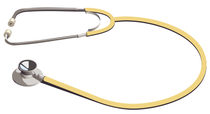

Patient Referrals
(412) 647-3685

Neurological Surgery
University of Pittsburgh

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NeuroNet® monitoring provides immediate assessment of operative effects

NeuroNet®, the intraoperative monitoring system developed in the Department of Neurological Surgery and utilized at the University of Pittsburgh was designed to provide tools for acquiring, processing, and displaying multiple types of neurophysiological data in real-time and for facilitating communication, collaboration, and information sharing among members of the surgical team in a real-time mode.

Intraoperative neurophysiological monitoring imposes stringent time constraints on system performance. It does little good to inform the surgeon 10 minutes after a significant event occurs.

Successful neurophysiological monitoring requires the simultaneous acquisition of as many appropriate neurophysiological variables as possible and immediate assessment of operative effects on the nervous system through the interpretation of these variables, with implications for adapting the surgical approach based on the feedback of this functional information. Highly trained neurophysiologists must rapidly interpret complex data recorded in what may be less than optimal conditions.

NeuroNet enhances the correct interpretation of neurophysiological measures by enabling the display of all acquired data in a way that facilitates comparison both with current data and baseline data acquired both at the beginning of the case and from preoperative studies.

Additionally, in our institution, as in many others, the demand exists for monitoring many cases simultaneously. This means requiring a highly trained individual to be present in each operating room all the time or providing access to the data remotely along with multidirectional communication facilities so that a single trained individual may consult on multiple cases simultaneously.

The system was developed to support intraoperative neurophysiological monitoring for a large health center and the surrounding medical community where the demand for this service far exceeds what a few trained individuals can provide. Thus, this system presents the various data types in a way that allows medical personnel at distributed sites to consult meaningfully about the shared data.

A fundamental feature of NeuroNet is its ability to support multiple instrumentation carts with remote viewing capabilities. All data acquired at any of the instrumentation carts can be viewed at any other cart or workstation connected to the internet which has the NeuroView® software installed. Thus one neurophysiologist can monitor multiple procedures at the same time from any node in the network including home pcs.

The system also provides instant typed or audio communications between users. Using the NeuroNet system, the Center for Clinical Neurophysiology currently supports services at over forty hospitals throughout western Pennsylvania and other states. •