



Spine Center strives for comprehensive, high quality care

The Spine Services Division at the University of Pittsburgh's Department of Neurological Surgery is a multidisciplinary organization composed of specialists in the field of physical therapy, chiropractic care, rehabilitation and physical medicine, neurological surgery, and orthopaedic surgery.



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*Spine Center
doctors Gerszten,
Welch and Moosy.*

Specialists from these fields work together as a unified group to provide the highest quality care for patients and athletes who have spine injuries, painful disc conditions, neck, arm, back or leg pain. Immediate access is available to all of UPMC Health System's extensive medical and surgical resources through the Spine Specialty Center.

Led and developed for the past eight years by Dr. William Welch, M.D., the section is comprised of fellowship-trained surgeons specializing in spinal surgery. Other members include Drs. Peter Gerszten, M.D., John Moosy, M.D., Donald Marion, M.D., and P. David Adelson, M.D.

Dr. Gerszten joined the department in 1999 as a spine fellow and is now an assistant professor with special interest in spinal tumors, outcomes research and stereotactic radiosurgery of the spine. Dr. Moosy specializes in peripheral nerve disorders, including carpal tunnel syndrome and ulnar neuropathy, and pain procedures such as implantation of spinal cord stimulators and implanted pumps for pain disorders. Dr. Marion provides services related to traumatic injuries of the spine and Dr. Adelson specializes in spine, peripheral nerve and brachial plexus surgery in adults and children.

The Spine section provides a comprehensive evaluation of patients and provides referring physicians, patients and insurers with cost-efficient, comprehensive, proven, and effective treatment options. The section is an integral component of the UPMC Health System Comprehensive Spine Center/Spine Specialty Center and has close relationships with the departments of Physical Medicine and Rehabilitation, Orthopaedic Surgery, Neurology, Anesthesia Pain Management, Physical Therapy, and Occupational Therapy.

Complete diagnostic testing of all spinal and nerve disorders is available through the center. The center also offers all nonsurgical adjunctive therapies including intradiscal electrothermy for painful disc conditions, acupuncture, traction, physical therapy modalities, steroid injections, and others.

All efforts are made to reduce fragmentation of services, and provide a centralized service delivery process, while providing high-quality clinical delivery of services. To this end, the Department performs approximately 2500 spinal operations each year.

In addition to the extensive clinical services, the division performs corporate, local and federally-funded research projects. It establishes new clinical protocols, performs investigatory studies, cooperates in the development of new treatment protocols, and has established ties with outpatient physical therapy services.

The division is a recognized "Center of Excellence" and has programs to teach visiting physicians new surgical techniques and to train fellows in spinal surgery. Physicians from the center also teach spine surgery at international centers. The division also sponsors joint conferences and actively participates in national symposia.

The goals of the Spine Specialty Center at the Department of Neurological Surgery are to deliver comprehensive, excellent quality, outpatient medical care to patients with spinal disorders. Other goals include the advancement of clinical knowledge through academic activities, establishment of new clinical protocols, and deliver the highest quality and cost-efficient inpatient care. ■



Neck pain management involves therapeutic challenges

by Peter Gerszten, M.D., M.P.H.



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Dr. Gerszten
Assistant Professor
of Neurological Surgery

Pain of cervical origin has long been a challenge to physicians and a plague to mankind. The incidence of neck pain is largely unknown. Some attempts have been made to identify the incidence of degenerative changes in the cervical spine. There is some degree of degenerative disc disease in 80% of all persons over the age of 55. Although it is tempting to conclude that these degenerative changes are directly responsible for cervical pain syndromes, this may not necessarily be the case. One study found that 75% of asymptomatic patients had degenerative changes comparable to those seen in a symptomatic group on magnetic resonance imaging. Although nonoperative treatment of neck pain is firmly rooted in ancient medical texts, the topic remains a timely subject for an increasingly prevalent complaint.

Pain of cervical origin can be attributed to many causes, including soft-tissue injury, degenerative vertebral or disc disease, fracture, infection, or tumor. Numerous nonradicular sources of neck pain have been identified. The most obvious are the facet joints and intervertebral discs and their respective caliginous envelopes, joint capsules, and annular ligaments. Muscles, particularly the dorsal paraspinal muscles, may be a source of pain, as may be the other ligaments of the spine including the intraspinal ligament and anterior and posterior longitudinal ligaments. The primary criterion for nonoperative treatment of any of these conditions is that they have a low probability of producing neurological deficit. Under certain conditions, any of these causes is capable of producing devastating neurological damage, and these situations must be determined by appropriate objective evaluation.

Much of the confusion surrounding the treatment of the various types of neck pain arises from a cumbersome body of terminology. Such terms as whiplash, cervical strain, soft-tissue injury, hard disc, soft disc, spondylosis, facet arthralgia, foraminal spurring, and spondylitic

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Cervical immobilization using a rigid collar is often effective at reducing intervertebral motion and thus pain.



myelopathy may have different connotations to different observers. For the sake of simplicity, it is convenient to think of all of these as points within a single disease spectrum that have resulted in abnormal or excessive biomechanical stress. This can occur acutely, as in traumatic lesions in which soft tissue, muscle, ligament, or disc is more likely to be involved. It can also occur as the result of chronic biomechanical stress in which soft tissues are first altered but in which the major effect is seen in bony architecture such as degenerative joints and osteophyte formation.

The pain derived from this spectrum is first characterized as mechanical, with hypermobility resulting from soft tissue laxity or trauma, or from degeneration of the disc itself. The pain may finally become neurogenic as subluxation or narrowing of the neural canal or foramina resulting from osteophyte formation begins to exert direct pressure on neural structures. Between these two points is a broad zone where the two overlap and the pain is both mechanical and neurogenic in nature.

Neck pain management may fall into one of two broad categories, nonoperative and operative treatment. Regardless of ideology, certain general principles of nonoperative management apply to all conditions resulting in pain that originates in the cervical spine, when there is no apparent ongoing risk to the neural elements. In many ways, devising a surgical strategy to treat neck pain is more difficult and less rewarding than dealing with other clinical problems related to cervical spondylolysis. The challenge is at least two fold: defining the source of pain and then identifying a specific therapeutic maneuver to deal with the pain.

One of the primary principles of management of any painful muscular skeletal problem is immobilization. In the cervical spine this is most easily accomplished by the use of an orthotic device. The purpose of immobilization is the reduction of intervertebral motion that may lead to compression, mechanical irritation, or stretching of the affected nerve roots. The position of the cervical spine is of great importance. In general, mild flexion is more beneficial than extension because of the tendency to open the neural foramina, thus to mechanically decompress the nerve roots.

In a general sense, traction is another form of immobilization. Additionally, and probably most importantly, traction provides mechanical distraction of the cervical spine. Theoretically, this opens the neural foramen and tends to flatten a bulging disc by placing the posterior longitudinal ligament under stretch.

(see *Neck pain management...* on page 6)

Outcomes Research: Guiding the future

by Dr. Joseph T. King, Jr., M.D., M.S.C.E.

Outcomes research is "... a technology of patient experience designed to help patients, payers, and providers make rational medical care-related choices based on better insight into the effect of these choices on the patient's life" (Paul Ellwood, 1988). Early outcomes research in the neurosurgical and neurologic literature focusing on "morbidity and mortality" is now giving way to an increasingly diversified assessment of neurosurgical disease and its treatment. The five broad categories of neurosurgical outcomes are similar to those used for other medical specialties: administrative outcomes, clinical outcomes, functional outcomes, quality of life, and economic outcomes.

Administrative Outcomes

Administrative data include hospital and intensive care unit (ICU) length of stay (LOS), inpatient morbidity and mortality rates, and readmission data. These data are readily obtained from hospital databases, which are primarily designed for billing and administration functions, or from government sponsored insurance programs, such as the Medicare data files maintained by the Health Care Financing Administration (HCFA). The advantages of administrative data include large numbers of patients, information from multiple institutions, and low costs. Unfortunately, administrative databases are usually not primarily designed to collect information that is of interest to physicians, thus limiting the analysis of clinical issues.

Administrative databases are becoming more familiar to physicians with the advent of physician "profiling" or "report cards." Many organizations now provide individual physicians with feedback on length of stay and costs relative, and benchmark comparisons with intra- and extra- institutional colleagues. The goal of these reports is often both institutional quality control and cost containment.

Clinical Outcomes

Clinical outcomes data include death, morbidity, and diagnostic testing (radiology, pathology, or laboratory medicine) results. Health care systems invest considerable resources to maintain elaborate clinical patient databases (e.g., paper or computerized charts, radiology or laboratory medicine databases). Because the data are difficult to compile, and individual physician experiences are often limited, most clinicians obtain clinical outcomes information from formal reports published by colleagues in the medical literature.

Functional Outcomes

Functional outcomes determine how well a patient is able to function on specific tasks or activities of daily living. The instruments for measuring functional outcomes fall into two broad categories: 1) general instruments that can be applied to all patients, e.g., the Karnofsky Performance Scale that describes an individual's ability for self-care on a zero to one hundred point scale, or 2) disease specific instruments that assess functional outcomes in patients with a particular disease, e.g., the Glasgow Outcome Scale (GOS) classifies patients with brain injuries in one of five outcomes categories.

Quality of Life

The assessment of health-related quality of life is increasingly common in neurosurgery and other specialties. Numerous approaches have been taken to the measurement of quality of life. One approach is to measure "utility," the value that a patient places on their health state. Utility can be measured using techniques such as the standard gamble, time-trade-off, or rating scales. All of these methods express quality of life as a single value on a zero to one scale. These values can also be combined with survival data to derive quality-adjusted survival. Quality-adjusted survival can be combined with economic data to produce cost-effectiveness analyses.

An alternative approach is to decompose quality of life into several domains, each of which is assessed on a separate scale. The popular SF-36 is a 36 item patient-completed questionnaire that measures patient well-being in each of six areas: physical functioning, role functioning, social functioning, mental health, health perceptions, and pain.

Economic Outcomes

Escalating health care costs and the motivation of patients and third party payers to reduce expenditures have caused a proliferation of economic outcomes research. The perspective of the analysis is crucial in determining the results of the analysis. An analysis can take the perspective of a patient, a hospital, a payor, or society — each perspective will produce a different view of the problem, and a different answer. Costs associated with health care can be classified as direct medical (e.g., hospitalization expenses, physician's fees, pharmaceuticals), direct nonmedical (e.g., home aids, health care-related food or transportation costs), indirect (wages lost because of illness or disability), and intangible (non-monetary sequelae of illness, such



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Dr. King
Assistant Professor
of Neurological Surgery

(see *Outcomes research...* on page 6)

Surgical treatments for Parkinson's Disease and other movement disorders offer new avenues of hope

by Douglas Kondziolka, M.D. and L. Dade Lunsford, M.D.



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Dr. Kondziolka
Co-Director, Center
for Image-Guided
Neurosurgery



▲
Dr. Lunsford
Co-Director, Center
for Image-Guided
Neurosurgery

Parkinson's Disease affects more than one million people in the United States. Since the majority will experience drug-related side effects and become less responsive to medical therapy within five years, the number of patients who eventually become surgical candidates is high. Many more people suffer with tremor, limb spasticity, and other movement disorders. Most of these respond poorly to drug therapy. Brain lesioning represents the earliest known standard treatment for Parkinson's Disease. The surgical results for Parkinson's Disease patients prompted the use of surgery for other movement disorders such as dystonia, chorea, essential tremor, and post traumatic syndromes. There has been a renewed interest in movement disorder surgery in the last eight years since pallidotomy was shown to improve Parkinsonian rigidity, bradykinesia, tremor, and drug-induced movements. This rekindled interest in movement disorder surgery is shared both by physicians and patients. An understanding of the different surgical therapies is important to counsel patients with these common problems.

The use of ablative surgery in Parkinson's Disease is based on an understanding of the physiologic circuitry. Patients suitable for ablative procedures have Parkinson's Disease rather than another degenerative neurologic disorder. Patients with "Parkinson's plus" syndromes respond poorly, presumably because the underlining pathophysiology is different. This spectrum of diseases includes Shy-Drager syndrome, striatonigral degeneration, progressive supranuclear palsy, olivopontocerebellar atrophy, and other disorders sometimes referred to as

"multiple system atrophy." Signs of autonomic dysfunction, long tract signs, cerebellar deficits, extraocular movement abnormalities, and lack of response to levodopa therapy are important clinical indicators that a "Parkinson's plus" syndrome may be present. Preoperative MRI to rule out a multiple-infarct state or positron emission tomography (PET) to identify striatonigral degeneration may be of use in specific patients. Thus, the correct diagnosis must be made before considering surgery. It may be necessary that specific patients are seen by a movement disorder neurologist.

Brain Targets for Other Movement Disorders

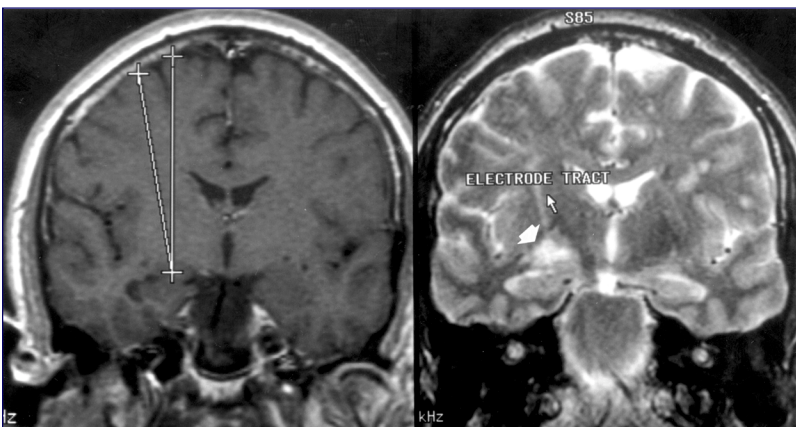
Other tremor-related movement disorders can be treated with thalamic surgery. Essential tremor (intention tremor), posttraumatic tremor, multiple sclerosis tremor, and stroke-related tremor all respond to thalamotomy in a similar way as do Parkinson's Disease patients. As with Parkinson's Disease, the thalamic target can differ depending on the surgeon and the intraoperative findings. Interruption of nerve projections from the subthalamus, to the pallidum, thalamus and cortex may be the common link between all of these targets. Thalamotomy for dystonia (primary or secondary) is a useful procedure for patients when medical therapy provides little sustained benefit.

Locating the Therapeutic Target

Physiological confirmation of the basal ganglia target is essential. During pallidotomy, the target is bordered by the internal capsule medially and the optic tract inferiorly. For thalamotomy, identification of physiologically-induced tremor arrest and rigidity reduction without affects in the laterally located internal capsule or sensory thalamic nucleus is required. Macroelectrode stimulation using a radiofrequency (RF) lesioning electrode is a safe and effective physiologic technique, as is microelectrode recording of cellular units. Stimulation of the pallidum is often associated with an increase in contralateral limb tone, while reduction of tremor and rigidity may be found with thalamic testing. The onset of tonic limb or facial contraction indicates too close proximity to the internal capsule and visual complaints indicates proximity to the optic tract. We test optic tract function with intraoperative visual evoked potential monitoring.

To Lesion or to Stimulate

Permanent lesions are desirable in patients who are older, and who desire a less complicated procedure to achieve improvement. In younger patients or in



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Coronal MR scans during pallidotomy planning (left) and 24 hours after surgery (right) showing the immediate pallidotomy effect. This patient had marked reduction in Parkinson's symptoms with significant improvement in function.

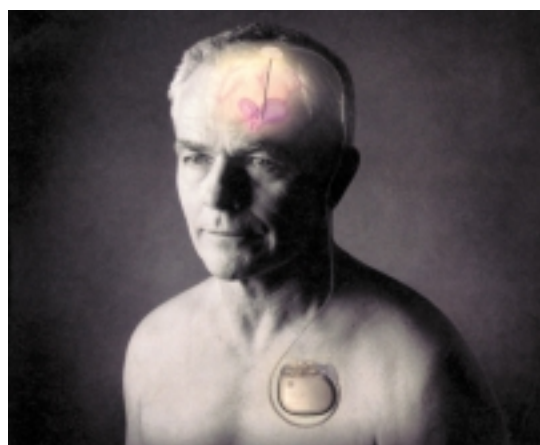
those who might benefit from an adjustable system, we recommend placement of a deep brain stimulator. To create a permanent thalamotomy or pallidotomy, we use the heat created by a radiofrequency electrode, or radiation energy from the Gamma Knife. After the therapeutic target is found, we make a reversible (“test”) lesion produced by heating the target to 45°C for 30 seconds. We then assess the patient for side effects before permanent lesioning. This includes clinical testing and evoked potential measurements. Permanent lesions are produced at 70-80°C for 60 seconds. We then withdraw the electrode 2-3mm and make a second and/or third lesion. The final lesion is tailored into a cylindrical volume corresponding to the desired shape. Lesions are typically 3-4mm in diameter and 4-6mm in the superior-inferior dimension. In some patients a gratifying postoperative result is found, only to lessen over the next few months. It is in such patients that an adjustable system such as a brain stimulator, that could be turned “up,” might be of benefit.

Gamma Knife Thalamotomy for Tremor

The Gamma Knife can create a focal radiosurgery brain lesion without the need for opening the skull and introducing an electrode into the brain. This eliminates the risk for brain hemorrhage and is particularly desirable in older patients or those with coagulopathy or other major medical problems. We have performed over 35 radiosurgical thalamotomies for tremor (Parkinson’s, Essential tremor, and Multiple Sclerosis tremor). Most patients (over 80%) note tremor reduction beginning two months following surgery, as the radiosurgical lesion develops. We have had gratifying results in patients even as old as 92 years, with return of handwriting ability and significant improvement in quality of life. Rare patients can develop some brain edema surrounding the target that can lead to transient limb weakness.

Deep Brain Stimulation

A deep brain stimulator system has the advantages of adjustability, as well as the fact that a permanent lesion is not being made in the brain. Disadvantages include the placement of hardware, as well as the requirement for more extensive surgery. Nevertheless, we have placed stimulators in healthy patients up to 82 years old. At present, thalamic stimulation is approved by the FDA for the treatment of Parkinson’s tremor or essential tremor. It is hoped that stimulation of other brain areas (subthalamus or pallidum) will be approved for general use in 2001. The majority of patients achieve long-lasting tremor suppression with stimulation. Some require more frequent adjustments than others. Most patients turn the device on in the morning (by placing

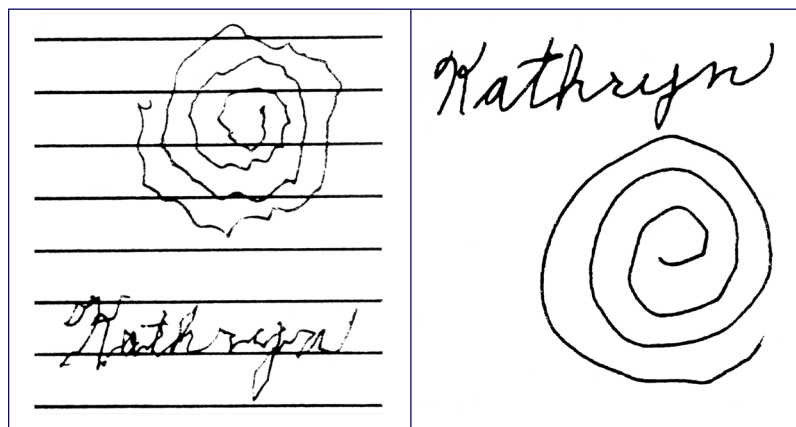


▲ *Tremor Control Therapy is a totally implanted therapy. The system stimulates the brain’s thalamus through an insulated wire lead. The lead is surgically implanted in the brain and connected, using an extension, to the pulse generator implanted near the collarbone.* (Courtesy of Medtronic Neurological)

a small magnet over the battery), and turn it off at bedtime. Others simply leave it on at all times. The pulse generator battery that powers the system lasts a number of years, and eventually requires replacement.

Summary

Movement disorder surgery is safe and effective for many patients with severe disabilities that do not respond to medical therapy. Stereotactic frame technology, neurodiagnostic MR imaging and physiological mapping techniques have improved to such an extent that movement disorder surgery has moved into mainstream neurosurgery. Movement disorder patients are common, particularly with an aging population, and may be suitable for a number of different treatment approaches. ■



▲ *Handwriting of a patient with essential tremor before (left) and four months after gamma knife thalamotomy (right). The thalamotomy effect is seen on her MRI scan.*

Neck pain management requires thorough knowledge base

(from page 2)

Furthermore, if accomplished with some flexion, it may relieve the pressure of osteophytes on the ventral floor of the neural canal. The presence of myelopathy is a relative contraindication to cervical traction in patients with severe spondylosis or disc disease.

Medication can play an important role in the management of cervical pain, particularly in the initial phase of treatment. Three broad categories of medication are commonly utilized: analgesics, muscle relaxants, and anti-inflammatories. No specific medication has universal application, and often patient tolerance dictates the choice of one drug over another. Analgesics play a major role in the initial treatment of acute cervical pain. Muscle spasms frequently accompany acute pain syndromes and can often be a source of a large component of the overall pain problem. Nonsteroidal anti-inflammatories are particularly beneficial when a large portion of the cervical pain is believed to be derived from degenerative joint disease.

Regional block techniques are reserved for patients who do not respond to immobilization and medication therapies. Such techniques include epidural steroid injections and trigger-point injections.

Physical therapy can be an invaluable part of the nonoperative management of cervical pain. Physical therapy techniques include heat application, direct electrical stimulation of the affected muscle groups, and traction. Exercise and patient education in proper body mechanics are also important components of the physical therapy process.

The operative management of neck pain is rather limited. There are few unequivocal and isolated facet joint problems that correlate well with a clinical state. The one exception is arthrolysis of the C1-C2 facet joint. Such instability is effectively treated by cervical fusion. Painful facet joints can be confirmed fluoroscopically by instilling local anesthetic, often with steroid medication. If this provides temporary relief, dorsal cervical fusion at the level of a diseased and painful facet joint may be considered. Facet denervation procedures may also be considered for the treatment of painful facet joint disease. Such procedures may be indicated in patients who are not considered good candidates for major surgery involving bone fusion.

A cervical intervertebral disc suspected as the source of neck pain can be injected with local anaesthetic for diagnostic purposes. The treatment of choice for patients felt to have neck pain of discogenic origin is an anterior cervical discectomy and interbody fusion.

In summary, the nonoperative treatment of a great majority of neck pain can be expected to provide good results over a period of time. Surgery is reserved for cases in which a clear focus of pathology can be isolated with confidence. In this select group of patients, surgical outcomes are good. A thorough knowledge of the various modalities and techniques available to the treating physician as well as an understanding of the limitations and appropriate application of each may shorten the time involved in successfully treating the patient and may decrease symptoms during this period of recovery. ■

Outcomes research paving the way for improved health care

(from page 3)

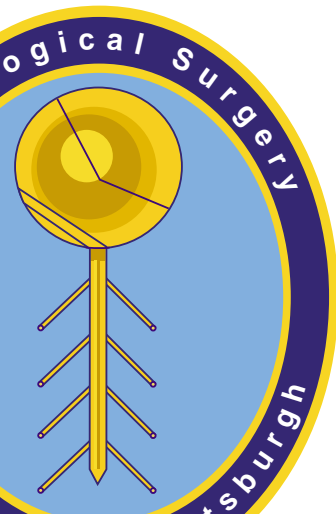
as anxiety, pain, or suffering). An economic analysis by a hospital will focus on the direct medical costs during inpatient hospitalization; a health maintenance organization will include physician fees and outpatient pharmaceuticals, and the direct non-medical costs of a home aid; a social planner may also include the indirect costs of wages lost to death and disability, and even try to quantify intangible costs such as pain and suffering.

The distinction between costs and charges complicates economic analyses. It is well known that hospital charges, as reflected in the bills sent to patients and third party payers, are quite different from costs. In fact, it has been stated that "the first rules of charges is to make the institution solvent" (Steve Finkler, 1982).

Ideally, an economic analysis should use cost data instead of charge data.

Neurosurgical Outcomes

Neurosurgical outcomes researchers are increasingly using the many tools available to measure neurosurgical disease and treatment outcomes. The Joint American Association of Neurological Surgeons and the Congress of Neurological Surgeons Outcomes Committee is coordinating a nationwide outcomes data collection effort for common neurosurgical procedures such as carotid endarterectomy, lumbar disc surgery, and subdural hematoma. The more we know about neurosurgical disease and outcomes, the better job we can do to improve the health and well-being of our patients. ■



Neurosurgery Clinic Exam/Reception Area Expands at UPMC Presbyterian

The Department of Neurological Surgery has just completed phase two of a clinic renovation project at UPMC Presbyterian almost doubling the previous examination area and bringing the total number of exam rooms to 17. These additional rooms will help reduce waiting time.

This expansion follows the opening, in early October, of the department's new, larger relocated patient reception area. The spacious, brightly decorated patient reception area is approximately 50% larger than the department's old area and is intended to improve patient comfort and increase office efficiency.

In addition to facilitating a more comfortable flow of patient traffic, the expansion will help accommodate the department's growing patient volume and faculty and help improve the processing of administrative matters.

Located just a few steps from UPMC Presbyterian's main elevators in the hospital's 4th floor central corridor, patients will also find the clinic much easier to access.

Recent Grant Awards:

- "Dose Escalation Study of LBS-Neurons Implanted into the Basal Ganglia of Patients Following Stroke," **Douglas S. Kondziolka, M.D.** from Layton Bioscience, Inc. (\$462,488). Phase II study of patients with a cerebral infarction involving the basal ganglia and fixed motor deficit who receive stereotactic implantation of LBS-Neurons into portions of the basal ganglia.

- "A Prospective, Randomized, Controlled Multicenter Clinical Study to Evaluate the Safety & Effectiveness of the COOLGARD™ System with COOL LINE™ Catheter to Reducing Fever in Neurointensive Care Unit Patients," **Donald W. Marion, M.D.** from Alsius Corporation (\$87,500). Study to demonstrate the safety and effectiveness of the COOL LINE catheter with the COOLGARD system for fever reduction.

- "Enhancement of Radiosurgical Effects on Brain Tumors using Neural Stem Cell-Based Gene Expression," **Ajay Niranjana, M.B.B.S., M.S., M.Ch.** from The Brain Tumor Society (\$100,000). Study to evaluate the effects of enhancing the radiation sensitivity of infiltrating tumor cells using implanted neural stem cells genetically altered to express a radiation-sensitizing agent.

- "Radiotherapy to Prevent Fibrosis After Lumbar Laminectomy," **Peter C. Gerszten, M.D., M.P.H.** from National Institutes of Health, National Institute of Arthritis and Musculoskeletal and Skin Diseases (\$150,000). Study to determine if preoperative low dose external beam radiation given 24 hours prior to lumbar laminectomy will decrease the amount of peridural fibrosis.

- "Utilization of the Microcarriers with Retroviral-Producing Cells Containing the Interferon- β for the Treatment

of Malignant Gliomas," **Hideho Okada, M.D., Ph.D.** from Titan Pharmaceutical (\$12,009). Study analyzing the delivery of retroviral vector producing cells to enhance the efficacy of cytokine gene based gene therapy for brain tumors.

- "Hypothermia During Intracranial Aneurysm Surgery," **Amin Kassam, M.D.** and Michael M. Todd (University of Iowa) from National Institutes of Health, National Institute of Neurological Disorders and Stroke (\$23,440). Study to determine whether lowering in body temperature, hypothermia, during surgery to repair bleeding (ruptured) intracranial aneurysm will have an effect on the course of the surgery, post-operative recovery and long term neurologic outcome.

Additional information on these, or any of our other current studies, can be obtained by visiting our web site at www.neurosurgery.pitt.edu/research.

Awards:

Ava M. Puccio, R.N., M.S.N., research nurse, was chosen as the 2001 recipient of the Society of Critical Care Medicine Annual Scientific Award for the oral presentation of "APOE4 Genotype and Extracellular Glutamate, Lactate and Pyruvate in Severe Traumatic Brain Injury" to be presented at the SCCM Scientific Symposium in San Francisco on February 14.

Promotions:

C. Edward Dixon, Ph.D., associate professor tenure stream; **William Welch, M.D.**, conferral of tenure.

New Employees:

Karen Boehm, research specialist for Dr. Ian Pollack; **Betty Caldwell**, administrative secretary for Dr. William Welch; **Melanie Sudduth**, administrative secretary for Dr. Ian Pollack.

Upcoming Events:

- The Department of Neurosurgery presents a quarterly course, **Principles and Practice of Gamma Knife Radiosurgery**. This year's courses are scheduled for January 8-12, May 7-11, July 9-13, October 8-12. This training course is targeted to neurosurgeons, radiation oncologists and physicists interested in Gamma Knife treatment certification. If you are interested in attending, please contact Cheryl Thurston of the Elekta Corporation at 800-LEK-SELL.

- March 21-22: **Henry Brem M.D., F.A.C.S.**, Professor of Neurosurgery, Ophthalmology and Oncology and director of John Hopkins University's Neurosurgical Oncology will speak as part of the Visiting Professor Lecture Series. Dr. Brem has developed new clinical treatments for brain tumors including the local delivery of chemotherapeutic agents in biodegradable polymers, intraoperative navigation systems, brain tumor vaccines, and anti-angiogenesis agents. Call (412) 647-3685 for more information. ■





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Department of Neurological Surgery
University of Pittsburgh
UPMC Presbyterian/Suite B-400
200 Lothrop Street
Pittsburgh, PA 15213
(412) 647-3685

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