THE FUTURE OF NEUROSURGICAL EDUCATION
In this issue of the CNSQ, we explore the Future of Neurosurgical Education. Specifically this issue reviews the present interest and expansion of utilizing simulators for education purposes in neurosurgery. Through advances in technology and material properties this field is rapidly expanding, such that training on cadavers may be obsolete in the future.

The CNS is dedicated to neurosurgical education and has made a significant commitment to develop the field of simulation in neurosurgery. One recent addition is by sponsoring a whole day practical course for residents at the CNS Annual Meeting using these sophisticated neurosurgery simulation tools. The lead article in this issue of the CNSQ, written by the CNS Simulation Committee’s leaders Darlene A. Lobel and Ali Rezaei is entitled, Frontiers in Neurosurgery: Simulation in Resident Education. The following three articles in subspecialty development are: Cranial Virtual Simulation Models, (Ali Rezaei), devices in vascular neurosurgery, (Simulation in Vascular Neurosurgery – Salah G. Aoun, Bernard R. Bendok, J D. Mocco, and Elad I. Levy) and spinal procedures (Spine Simulation – James S. Harrop, Ashwini D. Sharan, and Vincent C. Traynelis). Alejandro M. Spiotta and Richard Schlenk discuss the use of Simulation in Neurosurgical Residency Training: A New Paradigm followed by Paul A. Anderson’s discussion of Surgical Simulation: Dural Repair. Then Nathan R. Selden, Costas G. Hadjipanayis, Thomas C. Origitano, Christopher C. Getch, Kim J. Burchiel, Nicholas M. Barbaro review the present use of simulation in education, Boot Camp Course for Incoming PGY1 Neurosurgery Residents Utilize Simulation to Improve Training and Safety. Srinivas Prasad concludes the simulation portion of the issue looking into the future of simulation with the expansion of robotics in Robotics and Simulation. The CNS has several avenues in which to further our educational mission.

The final focus of this issue is a look at the upcoming CNS Annual Meeting in Washington DC; E: Pluribus Unum: Preview of 2011 CNS Annual Meeting by Ganesh Rao, Russell R. Lonser, Alan Scarlow, Christopher C. Getch and H. Hunt Batjer. We hope this issue provides helpful knowledge and we look forward to continuing this discussion of Neurosurgery Education in the Fall issue which is dedicated to the 2011 CNS Annual Meeting taking place October 1-6 in Washington, DC. We are arranging for that issue to be printed and delivered earlier to aid in your choosing the appropriate courses and lectures to maximize your experience.

James S. Harrop, MD, FACS

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Images in Neurosurgery
The Congress of Neurological Surgeons (CNS) was founded over sixty years ago to enhance health and improve lives worldwide through the advancement of education and scientific exchange. Because of the Organization’s unwavering commitment to this mission, its willingness to invest substantially in the science and process of education, combined with the creativity and dedication of its members and their diligence this has resulted in a varied array of novel and effective educational products. The last ten years, for example, has seen the expansion of SANS (self assessment in neurological surgery) to a dynamic, interactive online format, the introduction of Integrated Medical Learning (IML) and the CNS University, and the evolution of the CNS Annual Meeting to include innovative educational formats such as the Neurosurgical Forum, Consensus Sessions and Masters 3D Cadaveric Surgical Dissection, to name just a few.

With the growth and interconnectivity of the World Wide Web, medical education has evolved utilizing internet based methods and products that can more easily reach all neurosurgeons worldwide. The CNS has recognized the increasing challenge to deliver an efficient, high quality, cost effective educational experience for our members, which has resulted in the dedication of significant resources to exploring and developing internet based products such as SANS. The commitment to and investment in this area is clearly visible as well on our society’s website www.CNS.org, which has evolved and expanded rapidly, serving as a portal to all that the CNS offers including the CNS University, our platform for the many new opportunities available for online neurosurgical education. In addition, the site contains the NeuroWiki which is a resource not only for neurosurgeons but also the public seeking specific neurosurgical information.

With the rapid growth of science and understanding of the potential for new treatments, the current challenge to neurosurgical education is not just limited to the acquisition and delivery of the substantial and rapidly expanding knowledge base that can be addressed only in part by internet based resources, annual meetings, journals etc. What may be as important is keeping abreast of new procedural technologies and the acquisition and maintenance of practical surgical skills. The CNS is always exploring opportunities to provide newer and more advanced ways to meet the variable educational demands placed on all levels of neurosurgeons, from the early residency through the senior practicing neurosurgeon. It is this challenge of the varying levels of proficiency, knowledge base, and needs particularly across continents that the CNS has continued to grapple with. This issue is perhaps best illustrated by the declining surgical experience of surgeons in training, as a result of work hour restrictions, who require potentially more time performing repetitive procedures under the microscope to achieve proficiency. For the practicing neurosurgeons the challenges are different. There is an ever increasing demand to acquire surgical proficiency in new techniques that are rapidly being added to the armamentarium of the practicing physician, technologies not even thought of during one’s residency. As well, there is increasing demand to continually meet ever changing certification requirements and CME methodology while increasing productivity and preserving income.

Christopher C. Getch, MD
President, Congress of Neurological Surgeons
At present the CNS is strongly supporting the research and development of “Simulation” for neurosurgical education. As the articles in this issue of the CNSQ clearly illustrate, there are numerous adaptations for simulation in neurosurgery from developing basic practical neurosurgical skills training in a repetitive “no risk” educational experience, to reducing risk of infectious disease transmission as cadaver tissues are not employed, to lower training costs. There is the potential for consecutiveness and portability to where neurosurgeons practice either here or abroad, the cost effective training in new technologies and techniques such as new coiling techniques or new spinal procedures and the ability to personalize the educational experience to the level and proficiency of the surgeon from in training to the practicing neurosurgeon. The CNS in conjunction with both institutional and industry partners is actively expanding our development and application of simulators and presently this effort is being coordinated through the CNS Simulation Committee headed by Drs. Ali Rezai and Darlene Lobel. At this year’s Annual Meeting in Washington, DC the CNS is dedicating one afternoon of the practical sessions to a resident course on simulation. There will be 40 residents who will rotate through four stations (spine, trauma, vascular and cranial) with various existing and new simulation devices, providing a unique and challenging experience. The technology of these simulations include basic computer based simulations to more advanced simulation incorporating physical models. The course will serve several purposes. It will bring together a number of devices that represent the current state of technology such that they can be compared and contrasted for the quality of the simulated operative experience. Furthermore, through the evaluation of each of these technologies, it is essential to develop and validate methodology to assess the effectiveness of simulation as a teaching method as well as improve on the experience going forward.

Despite the promise of simulation, there are clear obstacles that need to be overcome in order to make a simulated experience optimal. For example there have been several cerebral aneurysm clipping simulation models developed, but as yet, the technology that currently exists is limited by both imaging resolution and materials science. The virtual environment cannot at present reproduce the clinical detail such as variable wall thickness or perforator anatomy. Furthermore, the current models of simulation cannot reproduce the unpredictable nature of surgery, the tactile sensation or haptic experience when applying a clip to the aneurysm neck or the “emotional training” such as occurs with intraoperative rupture. Maybe not available now, but it is likely this will be the wave of the future as the technologies and science develop.

The relevance and value of internet based education and of neurosurgical simulation is increasing rapidly. Presently, through the advances in technology, the now reasonable costs of producing and deploying these new methods of education and a willingness of surgeons to embrace new ways of learning are all positive factors in the evolution of neurosurgical education. Recognizing these factors, the CNS has and will continue to make a significant investment in the future of virtual surgical education for the benefit of its members as part of it commitment and mission.

> BECAUSE OF THE ORGANIZATION’S UNWAVERING COMMITMENT TO THIS MISSION, ITS WILLINGNESS TO INVEST SUBSTANTIALLY IN THE SCIENCE AND PROCESS OF EDUCATION, COMBINED WITH THE CREATIVITY AND DEDICATION OF ITS MEMBERS AND THEIR DILIGENCE THIS HAS RESULTED IN A VARIED ARRAY OF NOVEL AND EFFECTIVE EDUCATIONAL PRODUCTS. <
Simulation in medicine evokes images of a fantastical world of virtual reality (VR). The intrigue associated with the concept of performing a virtual brain surgery in a virtual OR, similar to the immersive flight simulation experience that pilots and astronauts have implemented as an essential part of their training, certainly piques the interest of both residents and neurosurgical educators alike. With recent quips in the news and on the internet about Canada’s VR based Neurotouch simulator (Figure 1), YouTube video examples of medical applications of augmented reality, and virtual hospitals and medical environments in web-based programs such as Second Life (Figure 2), it is no wonder that we as neurosurgeons, as innovators in the field of medicine, are attracted to this visionary concept of integrating simulation technology into our current practice and into the educational experience for our residents.

While clearly intriguing, we must ask whether VR is truly the best method to enhance technical skills of trained surgeons and to teach clinical skills to our young residents. We must also understand that simulation, in medicine in particular, involves much more than the flash and glamour of VR. Simulation encompasses any technique designed to replace or amplify real experiences with guided experiences, often immersive in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion. So, in addition to VR experiences, simulators may include physical models, web-based programs, and live role playing interactions. According to this broad definition, simulation techniques can be used not only to teach surgical skills, but also patient and family interactions, professionalism, and many of the core competencies that the ACGME emphasizes as critical to resident education.

Simulation as a training tool has been integrated over the last several years into many medical residency programs, most notably emergency medicine, ob/gyn, ENT, and general surgery. In fact, the ACGME now requires general surgery residency programs to incorporate simulation as a component of the training program. While validity studies, which assess efficacy of simulation techniques are limited at the present time, there is some evidence to support improvement in surgical skills after training using simulators. The results of two studies demonstrated improvement in laparoscopic techniques after surgical residents trained on VR simulators. The study by Seymour revealed that simulator trained residents were almost 30% faster in surgical dissection and made 1/6 of the errors of their non-simulator trained counterparts. Dayal et al. published a study which evaluated the benefit of training both novice and expert surgeons on a VIST endovascular simulator. There was significant reduction in the time for stent placement, use of fluoroscopy, and reduction of errors in carotid stent placement by novices who trained using the VIST device. Furthermore, after only two hours of training, novices felt increased confidence in performing endovascular procedures. While the evidence in these studies supports improvement in technical skills training using simulation techniques, there are also studies to support improvement in non-technical skills, such as teamwork and leadership ability, which
can play an integral role in improving patient care and outcomes.\textsuperscript{5,6}

As stated above, there is evidence that training using a variety of simulation techniques can improve both technical and non-technical skills. And, simulation training carries an innate intrigue that should engage both learners and educators in the medical field, and in neurosurgery, in particular. Furthermore, there is clearly a need to integrate such technologies into the residency programs, given the perceived limitations in surgical training due to resident work hour restrictions. Residents are spending approximately 35% less time in the operating room than before the new work hours were established. Many educators have cited the need to effect a paradigm shift in our training processes in order to deliver the same level of training to our residents. Furthermore, with ever increasing emphasis on patient care and safety; it is becoming less acceptable to have residents “practice” procedures for the first time on actual patients.

So, what is the current status of simulation use in neurosurgical residency training programs today? Our residents have some exposure to simulation during their “boot camp” experience as they commence residency. There are some programs in the country that promote residents use of cadaver labs, and a select few programs permit resident use of endovascular, temporal bone dissection, or other advanced simulators. There are some courses and exhibits at the national meetings that allow exposure in a limited fashion to VR based techniques as well.

In order to fully assess the use of simulation in neurosurgical residency programs, the Council of State Neurosurgical Societies (CSNS) recently conducted a survey which was sent out to all NS residency programs in the US. Responses were gathered from 42% of these programs. These results suggest there is minimal to no use of simulation, including virtual reality techniques, physical simulators, and task trainers in current neurosurgical residency programs (Figure 3). And, those few programs that do provide simulators have not formally integrated them into their training curriculum. As expected, most residents welcome the opportunity to incorporate simulation into their training experience (Figure 4).

The need to integrate simulation into our training process is there, along with the desire to do so. How do we now create and implement an effective simulation training platform? In order to achieve the greatest benefit from simulation techniques, two requirements must be met. First, simulation as a training modality must be integrated formally into the curriculum. The concept of a curriculum which teaches defined fundamental skills is essential to graduate medical education.\textsuperscript{7,8} Simulators should not be simply purchased as an additional learning experience for residents to use at will, but their use must be matched to a core curriculum goal.

\textbf{Figure 2:} Second Life image of operating room. Courtesy of the Imperial College of London.

\textbf{Figure 3:} CSNS survey results to assess current use of simulation in NS residency programs. Litvack ZN and Lobel DA. State of the Art: Use of Simulation in Neurosurgery Residency Programs. AANS Abstract 2010.
and incorporated in a defined way into the training program. In this way, it will be possible to meet the second requirement, namely testing the validity of the simulators, or their ability to meet the educational goals. Very few validity studies have been conducted or published to date, particularly in the neurosurgical arena. Therefore we find ourselves in an opportune moment to begin to define not only a simulation-based curriculum, but also a program which will lend itself to validity testing.

In developing this curriculum, we will meet a few challenges. First, we may find that while the intrigue of VR simulation techniques first draws residents’ and educators’ interest into the field, that more of a multi-modality approach, using different simulation techniques may prove more useful and effective to teach the technical and non-technical skills necessary to optimally train our residents. Second, in choosing the simulators to become part of the curriculum, we must proceed with caution. The options are to adopt simulators that are currently available, or to partner with companies to create novel simulators. In simulator development, it is important to include the end user, namely the neurosurgeon, as a key component in product creation. Many simulators, including the physical, VR, and web-based programs that are currently available, were created by companies that did not utilize the expertise of neurosurgeons. There are technical gaps and limitations in many such products. The use of such simulators must be weighed against the cost and time for developing new simulators.

Another important consideration in developing a simulation curriculum is cost. While some of the lower fidelity simulators are reasonably priced, many of the VR components can cost several hundred thousand dollars, or more, to purchase a single unit. There is government funding available for grants to fund creation of simulation curricula through AHRQ and other venues. There are bills in both the House and Senate which will potentially offer $50 million in funding for simulation over the next several years. However, it is daunting to consider the possibility that residency programs may be left to their individual university resources to fund development a strong simulation curriculum.

Funding challenges, combined with the necessity to develop a validation proven simulation curriculum, speak to the need for the creation of a unified program that can be instituted on a national level. A single simulation based curriculum, developed by leaders in the organization, with the assistance of subject matter experts, would allow consolidation of efforts and funding to create a neurosurgical simulation platform that can serve to refine and cultivate the optimal resident training experience for the future.

The CNS Simulation Committee is developing several simulation approaches for neurosurgical education that will employ curriculum-based teaching in conjunction with validation and testing methods. These simulation initiatives include physical models, VR- and web-based modules for general neurosurgery, spine, trauma, vascular and skull base.

References:

Figure 4: CSNS survey results to assess desired use of simulation by NS residents and educators. Litvack ZN and Lobel DA. State of the Art: Use of Simulation in Neurosurgery Residency Programs. AANS Abstract 2010.
The surgical profession’s training has traditionally employed cadaveric specimens. Although an elegant way to learn surgical principles, it has become increasingly difficult and less practical to obtain access to cadaveric specimens. Furthermore, exposure to hazardous chemicals such as formalin, as well as the increasing cost related to the preparation and maintenance of specimens makes the use of specimens continuously problematic.

To overcome the limitations of cadaveric specimens use, many have pursued the use of physical correlates. However, these models are also limited by cost, biofidelity, and basic limitations in physical wear and breakdown.

Over the past decade, advances in computer technology and haptic feedback have facilitated the development of medical virtual reality simulators as growing and increasingly utilized training tool. Virtual simulators have been used in many other industries for decades. For example, through virtual simulation, pilots are required to train for many hours in simulators before actual flight. We have begun seeing this trend in medical training, where society is expecting a commensurate level of training, particularly from surgeons. Many surgical specialties are adopting simulation technologies to circumvent the limitations of traditional approaches, and neurosurgery is no exception.

It is now technologically feasible to create a multifaceted virtual reality approach that simulates the visual, aural, and forces encountered in surgery. Recently, the CNS has initiated a multidisciplinary collaboration and partnership between neurosurgery, otolaryngology and modeling and simulation experts from the Ohio Supercomputer Center to establish a working group with a focus on skull base surgery simulation. The group builds on existing expertise that have resulted in skull base visualization, functional endoscopic sinus surgery (FESS) and temporal bone surgical simulation, more specifically, a complete mastoidectomy with facial recess approach. The OSU/OSC group

Figure 1: Left - User in system w/stereo glasses and two haptic interfaces. Above - Surgical view w/bleeding/irrigation.
is renowned for its work in emphasizing virtual simulation over physical models. Recent developments have been funded under R21 DC004515-01 and R01 DC011321-01A1 from the National Institute on Deafness and other Communications Disorders (NIDCD), and ARRA funding from the National Center for Research Resources (NCRR - UL1RR025755), of the National Institutes of Health.

The CNS skull base simulation collaborative effort will create a simulation environment that integrates stereo graphics, audio, and force-feedback (haptics) for emulation of manual instrumentation (See Figure 1). The development of neurosurgical skull base simulators is a multi-step effort. The current system that is being developed will provide the surgeon a haptic feedback during tissue manipulation. This system is ideal for bone as the surgeon is able to perform drilling of the skull base and understanding the anatomy in a multi-dimensional platform where one can also see the internal structures through the skull bone if desired. The student is able to drill the bone with a “probe” that is connected to a haptic device that gives feedback to the surgeon in terms of the hardness of the tissue and the sensation of drilling of the structures as if they were real. This haptic feedback is so sensitive that it can differentiate the sensation of drilling in between the cortical and cancellous bone, which is essential in skull base work.

The Congress of Neurological Surgeons’ skull base translational simulation program will develop multiple modules for emulating neurosurgical approaches. At this fall’s CNS Annual meeting in Washington, D.C., the team will demonstrate skull base surgery simulations including pterional, pre- and retrosigmoid approaches. Future developments will include the emulation of additional neurosurgical procedure from a simple craniotomy to the performance of complex orbitozygomatic and far lateral approaches. The eventual inclusion of soft tissue with haptic feedback will require continuous development that will expand the number of approaches to include endoscopic skull base procedures and fine microscopic dissections.

Our goal is to leverage collaborative efforts in training, research and clinical applications, including pre-surgical assessment, planning, testing and validation, and extensions to robotics. This effort will be supported through the establishment of a digital data repository that includes multi-scale and multi-modal 3D acquisitions of various regions of the skull (See Figure 2). We will promote and lead a national effort to develop standards and the exchange of techniques to provide for wider extensibility and dissemination.

References:

Figure 2: SUPERIOR view of cranial vault with segmented structures.
Simulation has been used by many institutions and organizations including the airline industry and the military for decades to enhance and assess skills and knowledge. Simulation allows for an acceleration of learning curves, particularly for skills which are difficult to acquire and for which real-world training would be impractical, expensive, dangerous or impossible. How do you train a pilot to maneuver through a tornado or to respond to a failed engine? How do you enhance the ability of a military to fight in hitherto unfamiliar territory?

Simulation is playing a growing role in medical training, and is increasingly being incorporated into medical student education, resident training and board certification. The need for simulation has grown due to a number of converging factors including an increased focus on reducing “medical errors”, advances in computer technology, and an evolution of competency definitions from more abstract to more concrete definitions. The reduction of resident work hours has also garnered increased interest in simulation as a way to enhance educational efficiency.

Procedural simulator models can be relatively simple, like those used in anesthesia for intubation and intravenous access, or extremely complex, involving a computerized audio-visual interface, haptic instrumentation and multiple training scenarios. Simulation was brought into surgical training after endoscopy was introduced. General surgeons quickly realized that mastery of open abdominal surgery did not necessarily translate into mastery of endoscopic procedures. This led to the development of simulation programs which were proven to accelerate learning curves. The first successful virtual simulation model was created for endoscopic surgical practice in 1993, and was capable of rendering cartoon-quality images of various intra-abdominal contents. Today’s version includes high definition images of organs that mobilize with gravity, bleed or empty their contents when injured, and provide the operator with proprioceptive feedback.

Figure 1A: Mentice VIST-C portable simulation system.

Figure 1B: Coiling of a basilar apex aneurysm using the Mentice simulator.
Over the past decade, simulation has made its way into mainstream neurosurgical education. The complexity of neurosurgical procedures makes simulation an attractive training tool. Steep learning curves in open vascular and endovascular neurosurgical procedures, as well as the number of hours of practice required to attain mastery (10,000 to 20,000 hours) pose a challenge when it comes to resident training. The Congress of Neurological Surgeons has taken a leadership role in this. While cadaver training could be considered simulation and has been practiced for centuries, modern simulation training using computer programs awaited software advances which only became mainstream in the past decade. Since 2005, the CNS has held a practical course on endovascular simulation training which has continuously evolved with advances in computer software. The practical course features case discussions and hands-on experience with realistic simulators of carotid stenting, aneurysm coiling, intracranial stenting, liquid embolization for aneurysms and AVMs, and stroke thrombolysis. Both computer-based simulators and in-vitro simulators are utilized. Computer-based simulators allow for better incorporation of varied anatomy from real cases. In-vitro simulators may better mimic device behavior during real procedures. Both are valuable and are educationally synergistic. An example of computer-based simulation is the Mentece Simulator which is used by Codman to educate on carotid stenting and aneurysm coiling (with and without a stent) (Figures 1A–1B). This simulator is computer-based and provides haptic feedback and a number of real-life cases. An example of in-vitro simulation is the Microvention in-vitro aneurysm coil model (Figures 2A–2B) which allows students to coil various silicone aneurysms while watching the behavior of the catheters and coils on a video monitor (no fluoroscopy utilized). Stroke thrombolysis can also be nicely simulated with the Penumbra clot retrieval system (Figures 3A–3B). This course is open to residents and neurosurgeons of varying backgrounds and training levels.

To enhance earlier exposure to a neurovascular surgery career that incorporates endovascular techniques, the AANS/CNS Cerebrovascular Section has for the past two years held a junior resident endovascular course (Figures 4A–4B). This course has also incorporated simulation as a way to give junior residents a firsthand experience with basic endovascular
techniques which are discussed by faculty. The course has been attended by over 50 residents each year and has been received very positively.

For open vascular neurosurgery, modern simulation has been slower in coming. Despite the advantages and versatility offered by virtual reality, 3D computer reconstructions cannot yet emulate the mechanics and tactile experience of neurovascular microsurgery. Cadavers are the oldest and perhaps the most reliable simulation models available today, but are difficult to obtain and prepare. In an effort to remedy these shortcomings while preserving the fidelity of anatomical representation, the Japanese company Ono and Co started using DICOM data from CT scans and MRIs to create their own line of synthetic models called Kezlex. Kezlex skulls are made of polyamide-nylon and glass beads and mimic the texture of human bones. They can be drilled for academic training purposes or to design or modify new approaches. The line also incorporates non-bony structures including life-like brain, aneurysms and vessels (Figure 5). Kits for deep vascular bypass as well as aneurysm clipping are also available (Figure 6). The most intriguing feature of these models is the possibility to use actual patient’s CT or MR images and recreating patient specific anatomy, soft tissue and pathology. This could be very useful in complex cases where a simulated procedure could be instrumental before actually operating on the patient. The models have been successfully used by Mori et al and Wanibuchi et al to create educational tools for neurosurgery residents.

In light of future challenges which neurosurgical trainees will face, it has become obvious that next-generation virtual reality simulation models will be needed to meet educational and practice needs. The CNS strives to be at the forefront of this evolution in neurosurgical education. Vascular neurosurgery learning curves will likely be accelerated and made more manageable with these efforts. Future directions include further refinements of software programs, the development of goal directed curriculums centered around simulation and further enhancements in patient specific simulation capabilities.
The education of neurosurgeons, beginning with exposure to the elementary neurosurgical skill set continuing to mastering more advanced and newer techniques, has always been a challenge. This challenge has been particularly difficult since the educational paradigm has become encumbered with certain time restrictions. Neurosurgery educational training has evolved from the primarily mentor-based or apprenticeship models to the present-day condition. The teaching scheme in past years for residency is believed to have defined this nomenclature. The neurosurgical “students” were so immersed in the details of the patients and the required exposure to patients was so great that they needed to have a “residence” inside the medical facility. The ACGME through their review of the medical education process has limited the number of hours neurosurgical residents can be trained or educated. Simultaneously, there have been great advances in technology and science. One significant advancement in the educational field has been the ability to create artificial patient environments so as to reconstruct real-life scenarios and modify behaviors and thought processes. These artificial environments or structures are broadly defined as medical education simulators.

The classic example of simulation-based education and learning is flight or airplane simulation for pilots. Due to the valuable equipment (plane) and its cargo (humans, etc.) and the expense of training time, the costs of flying an airplane in terms of gas and technology and wear and tear of the machinery, the airline industry developed flight simulators. The goal of this technology was to artificially create and manipulate the training environment to realistically expose the pilot to challenging and potentially dangerous situations. This model was such a great success other fields have adopted its use. The surgical field is similar to the airline industry in that practice in a safe environment is important and errors can have devastating consequences (i.e. death). This has fostered tremendous interest in simulation and/or modeling for neurosurgical procedures.

Presently there are several complex computer simulation devices for neurosurgery procedures, but unfortunately these have not been adapted to spine and spinal cord procedures. However, numerous simpler models to simulate spine surgery have been utilized, some of which have a relatively long history. The use of human cadavers for anatomical teaching and surgical technique training is one form of simulation. These are the simplest form of simulators and serve as a physical model. Inherent differences between the simulator and an actual patient are obvious in terms of lack of blood flow as well as tissue compliance. Nevertheless, with human cadavers the spinal anatomy in terms of bone quality, ligaments, muscle and nerve structures are the same. The use of cadavers has been reduced over time due to increased cost, fear of infectious disease transmission and government regulations. Additionally cadavers may not be available in some regions of the world due to religious or cultural beliefs. Anatomic animal models, such as calf and goat spines, are anatomically similar to humans and are less expensive than human cadavers but they are still associated with infection, disposal, and cost concerns.

Presently, the most commonly used spine surgical simulators are a synthetic physical model spines or hands-on models, where the most well known are referred to as “Sawbones” (Figure 1). These physical models simulate the bony anatomy of the spine well and are useful for teaching the placement of spinal instrumentation. Modifications such as adding tantalum to replicate the radiodensity of bone can be incorporated (Figure 2). However, the placement of instrumentation is only a small component of what a neurosurgeon needs to master in spinal surgery. Neural decompression and opening and repairing the dura mater are other necessary skills.

Paul Anderson, MD, developed a spinal dura simulator for dural repair and closure techniques, which is described in detail in this issue of the CNSQ (Figure 3). This is a signifi-
significant accomplishment in that it allows the surgeon to simulate the repair of the thecal sac in a controlled environment and manner. Thus, when a dural “tear” occurs in an actual patient, the resident or trainee has already established the steps to repair the thecal sac. In this model there is also the ability to obtain an objective assessment of the quality of the dural closure by measuring the pressure gradient until the closure leaks. Therefore, this model is advantageous since it provides the surgeon with feedback on their surgical technique. With an improved dural closure there would be a higher pressure required for a leakage to occur.

With the significant advances in computer technology over the last several decades, technology has been adapted and implemented in simulator models. One example is the use of technology from the video game industry such as the ability to send vibrations or a shaking motion to the hand device, commonly known as haptic simulation. Haptic is defined as relating to the sense of touch or a tactile reflex. While haptic simulators are entering the neurosurgery training arena unfortunately they are not readily available for spinal surgery.

One computer-based simulation product that has been utilized in spine surgery is virtual simulators which have been demonstrated at neurosurgery annual meetings. With the virtual system the user creates or simulates a surgical procedure with a computer generated virtual spine. In this example, a model is displayed on the computer screen and a “virtual” pedicle screw is placed in what the trainee believes is the ideal position. This can be performed simultaneously on the computer screen as well as in a physical simulation model. Using a navigation system the ideal entry point can be determined and superimposed against the points the trainee chooses on the virtual and physical models. Further, the trainee’s entry points can then be measured and quantified against the ideal trajectories and a numerical score given.

One of the most exciting applications of simulation in spine surgery is advancing through the use of image-guided technology. Several physical simulation models have been incorporated into advanced spinal navigation systems. In these models the surgeon has a more realistic environment where the “patient” can be in the operating room setting.

Further these models have simulated artificial skin and muscle with a consistency such that the surgeons feel like they are actually dissecting an actual patient. It is after this superficial dissection that the spine is exposed. Similar to an actual patient, spinal instruments can be placed or a decompression performed. The artificial skin and muscle obstructs the surgeon’s view. The trainee has to decide the ideal trajectories for the instrumentation, which again can be quantified and measured through the navigation system.

Overall, this is an exciting time for the advancement of spinal surgery. There has been rapid advancement in the use of spine simulation devices in order to improve education not only for residents, but also for seasoned surgeons in order to maximize patient outcomes. These simulation devices provide a greater understanding of the anatomy of the spine, spinal cord and nerves. Already there have been efforts to develop these simulators further specifically so they can be used to educate surgeons in many pathologic conditions, such as scoliosis, degenerative disease, spinal stenosis, and deformity techniques.
ROBOTICS AND SIMULATION

Introduction

The landscape of surgical robotics has evolved dramatically over the last 20 years. A particularly powerful architecture that has taken root over the last decade is the “master-slave” architecture embodied in telesurgical platforms like the da Vinci® robot. In addition to conferring significant surgical benefits, the telesurgical paradigm could readily serve as the platform for neurosurgical simulation and education. This article will explore the architecture of telesurgical systems within the context of the familiar surgical “control loop” and lay the foundation for the development of meaningful simulators.

The Traditional Surgical “Control Loop” Schema

Control Theory explores the interaction between different actors in a system. More specifically, it defines methods for collecting information, processing that information and responding to it. This is clearly applicable in the surgical context and control theory principles can be applied to the traditional surgical environment as illustrated schematically in Figure 1.

There are two principal actors – the surgeon and the patient. From the surgeon’s perspective, afferent information is acquired during surgery, processed using the rules and experience acquired through training and experience, and efferent manipulations are exerted in response. This makes up the primitive surgical control loop.

Afferent information includes visual information which can be enhanced using inline devices like surgical loupes, a head light or an operating microscope; these serve to improve or increase available visual information. Tactile information is available when tissues are directly manipulated but commonly used devices like gloves and surgical instruments reduce this. With experience, surgeons have learned to compensate by incorporating alternate cues (e.g., visualized tissue deformation as a surrogate for force information). Importantly, in the traditional surgical control loop there is a direct mechanical connection between surgeon and patient. Within this context, although optical instruments are available to enhance visual information, haptic instruments are currently not available to enhance tactile information.

The Telesurgical “Control Loop” Schema

The telesurgical platform mechanically uncouples the surgeon from the patient. This is represented schematically in Figures 2-4. This separation can be imagined either symbolically (with afferent and efferent limbs as shown in Figure 3) or physically (with surgeon console and patient console as shown in Figure 4). Afferent information is collected within the patient console, converted to digital signals, and relayed to the surgeon through the surgeon’s console. Similarly, efferent information is collected from the surgeon at the surgeon’s console and converted to mechanical manipulations by the robotic arms of the patient console. Although this seems unnatural at first, the telesurgical paradigm introduces significant value in its potential to offer major information enhancements.

On the afferent side, visual enhancements available in telesurgery include traditional magnification and illumination as with an operating microscope. Additionally, tactile information can be collected using
instrument-based sensors and relayed to the surgeon. Just as optical magnification enhances the resolution of visual information, haptic amplification offers the potential to dramatically enhance tactile information: pushing a needle through tissue paper can be made to feel like pushing a needle through cardboard or wood, depending on the amplification. More applicably, retraction forces could be scaled when applied to the brain, blood vessels or nerve roots.

On the efferent side, mechanical uncoupling offers very interesting potential. Surgeon maneuvers could be post-processed to achieve tremor reduction, motion scaling or maintenance of “no-fly zones”. Complex maneuvers could be performed more readily at a depth or around a corner. Virtual constraints could be created to facilitate movement along desired trajectories or anatomic structures, much like using a ruler when drawing or a jig when wood-working.

Finally, mechanical uncoupling affords a value beyond the scope of either afferent or efferent limb. Since information is displayed remotely to the surgeon, the potential exists to superimpose multi-modal information from alternate devices (e.g., navigation information) or sensors (e.g., acoustic information, physiologic information like oxygen tension, etc). The robotic arms may operate in a more confined space or from alternate, less morbid approaches (e.g., working “around a corner”).

The Telesurgical Platform and Simulation

The telesurgical paradigm offers a wide range of training, simulation and evaluation benefits.

On the simplest level, performing maneuvers on physical models using the robot (e.g., drilling the shell off of an egg) affords a more quantitative evaluation of surgical performance. Using a robot would allow us to measure how much force a trainee/examinee is applying, how often they are violating “no-fly zones”, the amplitude and frequency of tremor, etc. This is certainly a more refined use of physical simulators.

On the highest level, the telesurgical paradigm can serve as the framework for surgical simulation akin to flight simulation. At the surgeon’s console, information is displayed and mechanical maneuvers are collected. In a simulation environment the telesurgical paradigm allows trainees to be presented with virtual information and collects mechanical maneuvers which can be measured. Much like a flight simulator, this is critically dependant on the development of virtual scenarios. Perhaps more difficult is the creation of a set of rules whereby mechanical maneuvers are translated into manipulations within the virtual model. Trainees can practice basic surgical procedures and ascend the base of the learning curve in a simulated environment. Additionally, variant anatomy and intra-operative complications can be handled more frequently and consistently than routine practice allows.

Conclusion

The telesurgical paradigm creates an entirely new way of imagining surgical intervention. Current technology is clearly not at the level discussed in this essay, but there are numerous intervening milestones which are of significant clinical value between technology today and our vision of technology tomorrow.
INTRODUCTION

Training of technical skills is becoming increasingly complex requiring newer educational methods. Decreasing resident work hours, an emphasis on patient safety, and cost constraints limit trainee experience and the surgical time allotted to the development of technical skills. Competency of a greater variety of procedures and skill sets is now required, without any increase in duration and in reality a decrease in overall time spent during training. One method to address these problems is surgical simulation.

A learning curve is present with most technical skills and practice by repetition can be used to overcome this. Several new pathways that allow trainees to develop technical skills through the process of repetition are in use. Virtual surgery uses computer programs, high resolution monitors, and kinesthetic equipment that simulate surgical instruments and give appropriate feedback. These have been shown to be effective in a number of surgical models including laparoscopic surgery and arthroplasty. Other methods utilize human cadaveric, animal cadaveric and synthetic models. These processes are often limited because practice time is short and only one or two attempts may be performed. Howells has shown that skills are far better retained if they are repeated over 4-6 weeks even with short time periods rather than over a weekend which is a common method to teach practicing surgeons new technology.1

Little research has been done in simulation of spinal surgery. At the University of Wisconsin two spine simulation models have been developed: dural repair and laminoplasty. The goal of these models is to teach the critical skills needed to perform tasks where errors or imprecision could cause significant patient harm.

The simulation allows repetition; has objective performance measurements; uses regular surgical instruments techniques and tissues; and is low cost. Further, the risk of transferable disease is minimized. For this project, animal specimens have been selected. Our laboratory has used calf spines extensively for biomechanical testing. These have recently been shown to have excellent anatomic, kinematic and material properties to simulate human’s tissue which prompted their selection in this study. This article will describe the dural repair model and report the early experience.

Prior to simulation, training included reviewing a technique manual and a video of the procedure performed by an expert. The experts were available for critique and problem solving as the student progresses.

**Dural repair model**

Calf spines obtained from a local slaughter house (Strauss Veal and Lamb, Hales Corner, WI) consisting of the spinal column including the surrounding soft tissue as well as an intact spinal cord and dura. Two 14 French two-way Foley catheters are placed into the dural space, one from the cranial end and one from the caudal end (Figure 1). These are advanced until they are positioned above and below the spinal segment to be tested. The caudal Foley catheter is clamped with a hemostat. The cranial Foley catheter is connected to a reservoir of normal saline using continuous bladder irrigation tubing and a drip chamber. The balloons in each catheter are inflated to isolate the spinal segment to be tested and to create a closed system for pressure measurement.

With the Foley catheters positioned, the clamp is opened from the reservoir to the cranial Foley catheter and saline is infused into the dural space. By elevation of the reservoir, the pressure in the system is increased from 30 mmHg to 90 mm Hg in 10 mmHg increments. The flow rate of the fluid into the system is measured by counting drops per minute from the drip chamber.

*Figure 1:* Schematic drawing of calf spine dural repair model. Foley catheters are inserted into both ends of the dura and inflated creating an isolated 4 cm space to be tested for hydraulic seal. The cranial Foley is attached to a stop cock and connected to a drip chamber and reservoir which can be elevated from 30-90 cm in height. The caudal end of the Foley is clamped. Water is feed from the drip chamber into the isolated dural space and leakage rate determined by measuring the flow rate as a function of reservoir height.
Surgical technique

Once the baseline flow rate is obtained, a 4 cm length of dura is exposed by a laminectomy. A midline 1 cm durotomy is made using a template with a 15 blade. The tubing is opened to allow leakage from the durotomy site to ensure flow in the system and then clamped. Dural repair is performed using a 6-0 Prolene running locked technique under loupe magnification. Special fine needle holders and pickups are provided. After repair, the flow rate from 30-90 mmHg is then tested again. We have found that the dural repair can be performed 2-3 times per specimen by adjusting the positioning of the catheters. Each trainee will perform the procedure ten times.

Assessment

The time for performance of each procedure was recorded. The hydrostatic quality of the repair was calculated by subtracting flow rate at each height after repair from that of the baseline. This quantity is plotted as a function attempt number.

RESULTS

Time for repair

Nine residents repaired a 1 cm dural incision ten times. The time to repair decreased from 10.2 to 7.2 minutes after the ten attempts. This improvement was significantly different. We found that the learning curve for time reached a plateau after five attempts, Figure 2.

Quality of repair

The hydrostatic quality of repair significantly improved over number of attempts, Figure 3. Initially the mean leakage flow rate was 11.2 drops per minute and after ten attempts it averaged 3.6 drops per minute. In this case, there was a more linear improvement noted with experience and a noticeable plateau was not noted, although the poor repairs with high leakages were eliminated after six attempts.

DISCUSSION

The dural repair model using an easily measurable hydrostatic test was initially developed to compare different repair techniques. We noted a distinct learning curve from the use of this model and modified it to be used as a surgical simulation exercise. Dural repair is a difficult task requiring water tight closure on the initial attempt. Failure or poor performance can lead to prolonged bed rest and hospitalization with potential for fistula formation. Because of this requirement, many students get little practice in the closure of inadvertent dural tears. This made the model an excellent exercise to be practiced by inexperienced surgeons.

An important characteristic of a simulation model is validity, that is the ability of the model to represent the real clinical situation (the degree of realism). This has also been termed its fidelity. Further, the skills learned should be transferable from the laboratory to operating room. Low fidelity simulators generally teach individual skills using low cost commercial materials and easily applied assessments tools. Transfer of skills to cadaver surgery and to the operating room appears excellent. (7) High fidelity simulators have high face validity and represent the clinical situation in anatomy, feel of tissues, and complexity. These are more costly but are expected to have greater transferable skills to the operating room.

Our residents reported that the calf spine model had excellent fidelity and closely simulated the human condition except that the dura was thicker more like cervical than lumbar spine. Using real surgical instruments, loupe magnification, and fine suture added to the experience. The equipment cost is small and the specimen cost was approximately $25 per specimen which could be used 3-4 times. Additionally, the students needed to do multi-level laminectomies which further added to the learning experience.

Our results were typical of other surgical stimulations. Students improved with repetition with decreased operative time and improvement in quality. The surgical time decreased by 40 percent and the quality of the hydrostatic seal by over 2 times. Further the extremely poor results with large leakages were eliminated.

In summary a dural repair in a calf spine tested using a hydrostatic test is a high fidelity simulation where improvement in surgical time and quality is easily measurable. The model is low cost and easily adoptable to most laboratories or teaching programs.

References:

Simulation in Surgical Training

In the era of duty hour restrictions and increasing medico-legal pressures, surgical simulation offers a viable alternative to bridge the gap in experience and knowledge of residents. The value of simulation for the re-creation of invasive procedures has a rich history in cadaveric dissection and animal experimentation. While these exposures provide a valuable experience and do not require sophisticated technological support, cadavers and laboratory animals are a scarce and expensive resource. Three years ago, we established a ‘fundamental skills laboratory’ funded by educational grant support. The course was run by our faculty and senior level residents and provided an educational experience to the junior level residents. The course involved intensive hands-on exercises designed to familiarize the trainees with fundamental bedside procedures and operative skills such as external ventricular drain and intracranial pressure bolt placement, suturing, drilling and turning a craniotomy flap. This course was extremely successful and was the forerunner to the SNS Boot Camp that will be offered for its second consecutive year in July 2011 for all incoming post-graduate year 1 (PGY1) neurosurgery residents.

Technological advancements have made possible the transition from these laboratory experiences to a ‘clean’ environment that relies entirely on technology and no preserved tissue specimens. Simulation in this setting is now widely accepted for enhancing the resident training experience in other specialties including surgical training of laparoscopic procedures, endoscopy, colonoscopy, thorascopy, cataract surgery, peripheral vascular endovascular interventions and airway management. These simulation systems replicate procedures that involve two-dimensional visualization. The application of simulation in the realm of neurosurgical training and education has lagged somewhat compared to other specialties, likely

Figure 1: Residents and fellows perform an endovascular coil embolization of a posterior communicating artery aneurysm on the Simbionix simulator (Simbionix USA Corp, Cleveland OH). Simbionix provides an interactive and realistic biplanar fluoroscopy to perform both diagnostic and interventional procedures on a number of ‘patient’ case scenarios with unique vasculatures. A broad selection of groin sheaths, diagnostic catheters and guidewires may be selected and the software incorporates the unique mechanical properties of each. Patient vital signs are continuously monitored during the session.

Figure 2: A) Trainees advance a 5F diagnostic catheter over an 0.035” guidewire to cross the arch and then selectively catheterize the right internal carotid artery (RICA). B) A selective RICA angiogram is then performed as shown in this fluoroscopic view.
due to the challenge inherent in replicating a complex three-dimensional reality with a sharp contrast between neural elements and their surrounding skeletal support system.

However, improvements in computer processing power, volume rendering, graphics and haptics have facilitated the creation of sophisticated, albeit limited simulation, systems for neurosurgical applications. Some centers have adapted resources for three-dimensional volume rendering intended for diagnostic and intraoperative navigation purposes towards simulation and educational efforts. The benefit of this strategy is that it utilizes specific patient’s imaging data. There is evidence that employing computed tomography angiography (CTA), magnetic resonance angiography (MRA), 3-D stereoscopic imaging and other virtual reality systems to interact and familiarize one’s self with a particular patient’s anatomy can be beneficial towards surgical planning. This method can aid in establishing a good surgical strategy, enhancing intra-operative spatial orientation and increasing the surgeon’s confidence in a wide range of surgical scenarios. The drawback of this strategy is that it does not provide feedback to the trainee.

Endovascular Simulation
A high fidelity simulation system equipped with haptic feedback is available for angiography-based procedures that is based on a more simplified two-dimensional visualization than open neurosurgery. Angiography and the growing field of neurointervention are playing a rapidly evolving role in the care of neurosurgical patients. Neurointervention requires a very unique skill set that is not transferable from open domains taught in neurosurgical training programs. An unintended consequence of the rapid evolution and adaptation of endovascular techniques is that residents are currently not completing training programs with a sufficient endovascular experience to practice that specific skill set beyond. As a result, present-day neurosurgery resident graduates lack the comprehensive capacity of prior generations of neurosurgeons. In an attempt to begin to close that gap we strongly encourage the active participation in the angiography suite by residents and are exploring new and safe methods for our trainees to acquire endovascular skills. With this purpose in mind, we studied the feasibility and utility of simulated diagnostic cerebral angiography among neurosurgical residents and fellows using an endovascular biplane angiography simulator.

We recruited trainees into a pilot study approved by the institutional review board of the Cleveland Clinic. Neurosurgical residents in their post-graduate years one through five (PGY 1-5) and first and second year endovascular neurosurgery fellows were recruited into a standardized training protocol consisting of a didactic, demonstration and hands-on learning environment. A pre- and post-task survey was performed; designed to assess a participant’s baseline knowledge, attitudes and beliefs regarding the educational merit of the training curriculum.

The Simbionix simulator (Simbionix USA Corp, Cleveland OH), was employed. Simbionix provides an interactive biplanar fluoroscopic display to perform both diagnostic and interventional procedures on a number of ‘patient’ case scenarios with unique vasculatures. A broad selection of groin sheaths, diagnostic catheters and glidewires may be selected and the software incorporates the unique mechanical properties of each. While the behavior of the catheter in the vessel is simulated, actual catheter and wire manipulations are incorporated by motion tracking sensing capabilities in the hardware component of the simulator. Information such as angulation, friction and forward-loading are all incorporated into the algorithm to produce haptic feedback and allow the catheters to navigate in a realistic fashion. Contrast can be administered during both simulated real time fluoroscopy and digital subtraction angiography. Roadmap assistance for navigation can also be simulated.

The potential benefit of learning this invasive procedure that requires fluoroscopy and cumulative radiation doses on a simulator is that it involves a no-risk environment for both the patient and the trainee. The simulator was
Simulation in Residency Training: Moving Forward

Simulation of surgical procedures such as laparoscopy has been fully incorporated into the training of general surgery residents. In fact, general surgery training programs are required under the Accreditation Council for Graduate Medical Education to provide a simulation and skills laboratory for trainees. The role of simulation in neurosurgical education is yet to be defined. There are two main components to a procedure that simulation can reinforce. First, the order of steps required to successfully perform any given procedure can be rehearsed under different scenarios. For example, one can perform A then B then C and await the outcome of this management algorithm. After the outcome is identified by the simulation system (adverse or desired), another treatment algorithm can be employed in a reiterative manner. This learning environment could be very beneficial and efficient, particularly for relatively rare yet vital occurrences in real-world patient encounters, such as critical resuscitation. There is evidence that simulation of cardiopulmonary resuscitative efforts, for example, can improve performance and subjective perceptions of self competence among trainees. An intensive, curriculum-based simulation module can be as beneficial as six months of clinical ward experience.

Secondly, simulation of technical procedures can also be of benefit by providing a no-risk environment for rehearsal of mechanical skills required. These findings reflect a transfer of skills acquired from the simulator to an actual patient encounter. It would be expected that the closer a simulation can mimic an actual procedure, the more readily the skills can be transferred. Strategies employing simulation into training must also incorporate periodic retraining of skills to avoid deterioration over time.

Conclusions

Surgical simulation provides a zero-risk setting in which skills can be acquired through repetition. Advanced anatomically and technically accurate simulation systems that provide haptic feedback can further aid the trainee in developing and refining the mechanical skills required for the procedure. In addition, exposure of trainees to long and complex procedures could help to develop the mental preparedness to withstand their real-life counterparts. Ultimately, the best metric for determining simulator effectiveness is an objective assessment of the efficacy of skill acquisition derived from simulation usage and the transfer of this information to actual real-life procedures.

The role of simulation in neurosurgical residency training will be established by a handful of leading programs that are committed to providing a rich environment for their trainees and outlining protocols and curricula with objective outcomes to track an individual’s performance over time. To this aim, we should demand and drive future technological advances towards this worthwhile endeavor.

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Reference:
Experience promotes quality and improves outcomes. How then, can neurosurgical trainees gain experience without compromising the quality of patient care? This question has taken on new significance since United States neurosurgical residencies incorporated the first postgraduate (PGY1) year of training in 2009.

Teaching brand new learners is a very special skill, as every piano, tennis, or driving instructor knows. Previously, the preliminary training year (PGY1) in general surgery taught fundamental surgical skills, oriented new residents to the hospital environment and surgical team, and provided knowledge related to professionalism, communications, and patient safety. These duties now fall to the neurological surgery residency program directors and faculty.

Neurosurgery faculty take on the task of training new medical school graduates at a tremendously challenging time, during which the public, regulators and government agencies are focused on promoting both the competency of trainees and patient safety in training environments. Medical and surgical educators are being asked to achieve better outcomes, using diminishing financial resources, and with less time to train residents because of new ACGME duty hours regulations.

Two strategies may promote success, despite these obstacles. First, neurosurgery should create an organized and systematic curriculum that provides fundamental knowledge and skills, sets expectations, and identifies goals for PGY1 residents. Second, we can teach basic procedural skills first in a simulated environment before residents perform them under supervision on the clinical service. These strategies, while proven effective in many settings, can be intimidating to organize and difficult to fund.

To assist residency program directors in implementing successful educational strategies at the inception of residency training, and to provide some of the additional needed infrastructure, the Society of Neurological Surgeons (SNS) organized six regional boot camp courses for incoming neurosurgery PGY1 residents in July 2010. These boot camps were based on a successful pilot boot camp course held in the Western region in 2009.

At the boot camps, first year neurosurgical trainees were introduced to various fundamental cognitive and practical skills. Each course comprised nine didactic lectures on clinical and non-clinical competency topics, nine hands-on procedural skills stations, and six operative skills stations. Ninety-four percent of United States neurosurgical PGY1 residents and 75 neurosurgical faculty from 36 residency programs participated in the inaugural SNS boot camp courses.

A key component of each course was simulated experience of basic procedural and operative skills. ‘Surgical simulation’ frequently implies the use of complex and technologically demanding, computer-based, haptic devices with multi-million dollar price tags. This need not, however, always be the case. In fact, the boot camp courses have demonstrated that simple and generally inexpensive simulated experience is particularly valuable for new surgical learners.

Many simulators for PGY1 level skills are well established, using manikin-based models for central venous catheter insertion (Figure 1).
lumbar drain placement, or ICP monitor introduction. Existing and commonly available surgical navigation technology may be adapted to learn the appropriate angle for ventricular drain placement (Figure 2). Relatively inexpensive, non-cadaver based surgical skill simulation is possible utilizing freeze dried beef scapulae for drilling (Figure 3), artificial skin and dura for sewing, etc. The bootcamp course utilized these and various other simulated learning tools to teach residents basic skills and pitfalls in a safe, non-patient care environment.

In addition to technical skills, simulators are also useful for teaching situational, clinical decision making. During the 2010 boot camp courses, the Western region course piloted use of a wireless, computer controlled manikin to simulate a challenging clinical scenario. The scenario involved an awake, talking patient who arrived in the emergency department and then deteriorated due to an expanding epidural hematoma. The commercially available simulator, used on most medical school campuses, was able to answer questions, change respiratory pattern and vital signs, blow a pupil, and otherwise provide a convincing set of clinical data requiring timely decision making and action by the treating resident (Figure 4). The PGY1 trainees at the course thus experienced their first emergent clinical ‘crisis’ in a no-lose, simulated environment. Clinical decision making simulators will be part of the curriculum of all six bootcamp courses in July 2011.

Data collected from faculty and trainees before and after the 2010 bootcamp courses reflect the success and tremendous value of this approach for new trainees (and have been submitted for peer review and full report in the neurosurgical literature). The Accreditation Council for Graduate Medical Education (ACGME) has taken interest in neurosurgery’s efforts to advance educational practices for surgical PGY1 training, which may be applicable to other procedural specialties.

Since the founding of our field, neurosurgeons have been intensely interested in promoting the highest quality outcomes for our patients and have pioneered ways to both track and improve such outcomes. Now that new learners, directly from medical school, are a part of our profession, it makes sense to extend that tradition to their very first steps in training.

References
It is noble to teach oneself, but still nobler to teach others - and less trouble.

-Mark Twain (Doctor Van Dyke speech, 1906)

Self Assessment in Neurological Surgery (SANS) is the leading online educational tool in neurosurgery. More than 25 years ago, SANS started as a set of printed questions designed to help meet the educational needs of fellow neurosurgeons. With the explosion of the internet and the development of multimedia devices to facilitate learning, SANS evolved to an online version. The latest version of SANS Lifelong Learning allows for the incorporation of high resolution images and video as well as links to educational material both inside and outside of the Congress of Neurological Surgeons’ web site (Figure 1).

Currently, SANS offers five modules, all of which confer continuing medical education (CME) credit and three of which have been integrated into the maintenance of certification (MOC) process. These educational offerings include the following: (1) SANS General Examination (CME and MOC); (2) SANS: Spine (CME and MOC); (3) SANS: Pediatrics (CME and MOC); (4) SANS Competencies (CME); and (5) SANS Neurotrauma (CME).

SANS relies on a diverse network of support to ensure its success. The AANS/CNS sections have lent support to SANS, each having appointed SANS liaisons to help coordinate contributions of new material on an annual basis. In addition, there are more than two dozen SANS section editors and contributors that are essential to the creation and annual revision of SANS questions. One cannot extend enough gratitude and recognition to SANS contributors, who come from all over the United States and the world.

Each SANS question undergoes extensive vetting for accuracy, bias, relevance, and format by SANS senior editors. Once a question is deemed acceptable for publication, the question is categorized and deployed. Questions may then undergo further revision based on feedback from SANS users. Through this painstaking process, SANS has accumulated a library of over 1,000 questions. This library and the continued contributions ensure that at least 25% of the questions of each SANS module are updated on an annual basis. In addition, a select number of questions are recommended to the American Board of Neurological Surgeons (ABNS) for inclusion in the written primary or MOC examinations.

As part of the commitment to lifelong learning, SANS has evolved to meet the needs of neurosurgeons-in-training, international neurosurgeons, and other surgical subspecialties. Numerous residency programs take advantage of institutional subscriptions to integrate SANS into resident teaching, self-assessment, and evaluation. Also, international neurosurgeons and clinicians with similar practices (e.g. orthopedic spine surgeons) have utilized SANS for lifelong learning. Future initiatives will ensure that SANS stays ahead of the curve with respect to both education and technology. The future of SANS is a bright one. New products including SANS Fundamentals geared towards topics for residents and mobile SANS are on the horizon. SANS will also evolve to assess learning gaps and to provide learning opportunities tailored to the individual user.

It has been interesting to see how SANS has evolved over the past decade. Mark Twain’s autobiography recently was published 100 years after his death in 1910. Like Twain’s continued impact on the literary world, we expect SANS to continue to have an impact on neurosurgical education for many years to come.

References
Noteworthy News from the CNS

The 2011 Congress of Neurological Surgeons Annual Meeting, October 1-6 in Washington, DC, will provide neurosurgeons from across the country and around the world with the tools and resources necessary to stay ahead in the rapidly advancing field of neurosurgery while enhancing health and improving lives worldwide through the advancement of education and scientific exchange. Registration is available online at www.cns.org!

Sixth Annual CNS 3-D Surgical Anatomy Course for Senior Residents Application Deadline: June 10!

Attention Senior Residents: Mark your calendar for the Sixth Annual CNS 3-D Surgical Anatomy Course being held August 25-28, 2011 at the Spine Education & Research Center in Chicago (Burr Ridge), IL. Led by Michael T. Lawton, MD, this all expense paid opportunity is available to up to 65 Senior Residents. Submit your application by June 10!

CNS University Presents A New Trauma Webinar in June!

Tuesday, June 21, 2011
7:00 PM EST
Trauma Case Vignettes: Open Discussion with the Masters
Moderator: Craig H. Rabb
Faculty: Rocco Armonda, Lori A. Shutter, Alex B. Valadka

Dinner Seminars Return to the CNS Annual Meeting!
Brush up on the latest in clinical management strategies while dining at DC’s finest restaurants! Space is limited – register online at www.cns.org!

Tuesday, October
• Low-Grade Glioma at the Source.
• Controversies in the Treatment of Cervical Spondylotic Myelopathy at Occidental Grill & Seafood

Wednesday, October 6
• Current Management Strategies for Metastatic Spine Tumors at 1789
• Cervical and Lumbar Arthroplasty at Charlie Palmer Steak

The Art of Managing Complex Cranial Cases: A 3-D Video Presentation.
On Monday, October 3, join expert faculty, Drs. Aaron Cohen-Gadol, William Couldwell and Duke Sampson, as they examine, The Art of Managing Complex Cranial Cases: A 3-D Video Presentation, live from the General Scientific Session stage. This dynamic presentation, included in your registration fee, provides participants with complication avoidance and surgical treatment strategies for complex cranial cases.
When physicians from different minimally invasive vascular disciplines interact in a collaborative fashion, interesting synergies arise and problem solving is enhanced; patient care is improved. When appropriate translational research scientists (engineers, physicists, cell biologists etc) interact with specialists in vascular intervention (Cardiologists, Vascular Surgeons, Radiologists and Neurointerventionalists) in the operating room, clinic and at conferences and casual meetings, interesting insights into better methods of treatment arise. These insights lead to better understanding of disease management. They also lead to innovative concepts in the technology we use to treat vascular disease ... which leads to opportunities for entrepreneurship.

When physicians are put in charge of the delivery of medical care and held accountable, quality improves, costs are contained, and patient and physician satisfaction skyrockets, e.g. Cleveland and Mayo Clinics and other specialty hospitals.

The Global Vascular Center (GVI) Concept based on the preceding facts and observations creates a complex partnership among hospital, university physicians and scientists, private practice physicians, industry and the community at large to focus on Vascular disease in a global sense, i.e. all vascular systems.

Los Angeles architect Mehrdad Yazdani worked with a group of thought leaders in all the vascular interventional specialties (Cardiology, Vascular Surgery, Radiology and Neurointerventionalists) to design a free standing Vascular center, where all the vascular disciplines work virtually side by side with all cath labs on one large floor in a circular array and all vascular surgery suites in a similar pattern one floor below. Yazdani’s observation after several meetings with the physicians was “you guys want collisions...all vascular physicians and scientists bumping into each other all day.” The unique $300 million dollar building design with outside design features reflecting inside functions has already been recognized with several architectural awards (Figure 1).

The vascular center is attached to the main hospital by a short bridge facilitating transfer and interaction. The Clinical and Translational Research Center (CTRC), i.e. floors 5-8, houses all the vascular related scientists and sits on top of the vascular center with full research imaging and surgery/interventional capabilities.

The fifth floor is primarily leased space and will be occupied by the Jacobs Institute(JI), a not-for-profit institute founded by the Jacobs family of Buffalo, devoted to a philanthropic venture to enhance vascular disease management with a lasting memorial to DR Lawrence Jacobs, a world famous Neurologist and inventor. JI functions will include management of the complex hospital, university and private practice physician partnership along with serving as a catalyst for excellence in clinical care, academics, and clinical research. The JI will also feature a Center for Innovation in Medicine (CIM), designed as a “proof of concept” center to help harvest, vet and mature the innovative ideas generated from this unique amalgamation of clinicians and scientists toward the creation of products, companies and jobs in the WNY region. The JI and CIM will serve as a center for ethical collaboration among industry, physicians and scientists – a powerful source of innovation in medicine. The JI space is reflected by the “ribbon” on the outside of the building.

The Vascular and translational research center concept initiated and shepherded by the JI is a unique and complex undertaking which will require disparate groups working together toward a common goal of improving health care and our community.
SECTION NEWS

SPINE SECTION UPDATE

Daniel M. Sciuabba, MD

The 27th Annual Meeting of the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves was held in Phoenix, Arizona in March 2011 with great participation and success. The theme of the meeting was: “Evidence-Based Spine Surgery in the Real World.” Given the current political climate mandating evidence-based care and reimbursement based on such care, presenters focused heavily on educating the participants in evidence evaluation, implementation, and assessing cost for value.

The meeting began with a scientific session completely dedicated to the overall concepts and fundamentals of an evidence-based approach to spinal care. Speakers spent time reviewing how literature is evaluated, and how practical, real-world guidelines are created from such literature. In addition, they showed the weaknesses of the current literature and the need for prospective outcome measures to be recorded for all patients. In the process, comparative effectiveness research (CER) was introduced. In short, CER is the direct comparison of existing health care interventions (e.g., fusion versus epidural injections for low back pain) to determine which works best for various types of patients, and which pose the greatest benefits and harms. Although effectiveness is of paramount importance, concepts relating to cost were also discussed at length as it is now becoming incumbent for all providers not only to show clinical effectiveness of specific treatments, but also to show cost-effectiveness of conducting such treatments. Toward this end, quality-adjusted life year (QALY) was introduced, which is a measure of disease burden, including both the quality and quantity of life lived. This measure will be more consistently used academically and economically when deciding which interventions provide the most value to a given group of patients per unit of cost.

Dr. Ziya Gokaslan, this year’s chairman, provided an inspirational kickoff to the meeting with his Presidential Address entitled, “Evolution in Surgical Treatment of Spinal Tumors.” Given his vast experience as a spinal oncology expert, he presented a series of landmark papers, many of which he co-authored, showing how the approach to spinal oncology has changed in just two decades. Specifically, he illustrated how radical resection of primary tumors of the spine, such as chordoma, has led to substantial improvements in local control and overall survival for patients.

In addition, an entire scientific session was then led by Dr. Gokaslan entitled, “Evolution in the Treatment of Metastatic Disease.” Within this session, speakers discussed the evidence as it relates to surgery, radiosurgery and vertebroplasty in the treatment of metastatic lesion. Specifically, time was spent reviewing the landmark manuscript authored by Roy Patchell et al., in which surgery plus radiation therapy was shown to be superior to radiation therapy alone for spinal metastases involving epidural spinal cord compression. This study represents one of the few prospective, randomized trials in our field, and thus it has had an enormous impact on management of such patients. Also within the session, speakers reviewed cost effectiveness of treating patients with spinal metastases and outlined current and future translational research strategies to improve patient outcomes.

Dr. Paul Cooper received the Meritorious Service Award for his significant contributions to the field, specifically in the area of cervical spine surgery. Within his award presentation, he followed the overall theme of the meeting and presented literature reviews on both posterior cervical decompression (laminectomy alone versus laminoplasty versus laminectomy and fusion) and use of intraoperative monitoring in cervical spine surgery. He combined an in-depth analysis of the literature with his own extensive experience to provide the audience with a practical approach to caring for patients with cervical spine disease.

The section hosted a record number of oral and poster presentations, educating the participants on the latest results from clinical and laboratory investigations. Turkey served as the host nation and conducted an entire pre-meeting special course on the current status of spine surgery in Turkey. In addition, two special courses were held in conjunction with other societies as part of an ongoing effort to link together the various spine health organizations. Specifically, the Pediatric Craniocervical Society presented on the management of complex pediatric craniospinal disorders, led by Dr. Douglas Brockmeyer and a number of his pediatric neurosurgery colleagues. The cervical spine research society (CSRS) also conducted a special course on cervical myelopathy with multiple orthopaedic surgeon and neurosurgeon members of the CSRS.

Finally, the meeting served to educate participants on the change that has occurred within our own specialty. Large sections of the meeting were dedicated to novel minimally invasive techniques and to the management of spinal deformity. Regarding the latter, numerous orthopaedic surgeons attended and presented at the meeting, providing insights from the field of orthopaedics and its long tradition of managing pediatric and adult scoliosis.

In terms of funding, this AANS/CNS section was extremely successful in its ability to provide research grants and clinical fellowship awards to 7 individuals, including the newly granted Outcomes Committee Award. This high number of awards has increased over the last several years despite recent economic pressures, and such success can be attributed to Section leadership and sponsorship from member and corporate donations. All members of the AANS and CNS are encouraged to review the application details and apply online at www.spinesection.org.
Doctors

Doctors are by nature individualistic and independent. It is hard for us to work in groups because our education encourages us to think independently. Most of the problems we face require more judgment than fact. Such situations lead us to disagree over treatment plans. For example, in spine surgery there are many ways to approach a spine problem when there is conflicting evidence. We can even disagree on whether anything needs to be done at all. In the business and political world there is one boss with whom no one disagrees. So, in a negotiating situation when doctors face business people, doctors are at a disadvantage, as they appear to differ among themselves. The opposite side looks at this division as a weakness. Doctors need to understand these dynamics and to organize and develop a strategy to gain POWER in the healthcare debate.

Politics

Also doctors are not educated as politicians or marketers. Doctors are very intelligent, but these are fields in which they have no training. With some education and common sense, doctors can be highly successful in the political and business arenas. Lyle French, my mentor at the University of Minnesota told me when he went from being Head of Neurosurgery to Vice Chancellor of the university, “Jim. You have to be happy with half-victories and keep coming back for the rest later.” Neurosurgeons are not accustomed to this thinking as they are trained to get what they want when they want it. In the political arena, decisions are not life or death, but are long, complex and hierarchical. Once you realize this fact, you will begin to win. You are smarter than your opponent, experienced in making decisions and good at it. You make more business-like decisions every day with higher stakes than business people ever make.

Who really has the POWER?

Next, without doctors bringing patients for inpatient care, hospitals would close, and administrators would be out of a job. Do not forget that fact. You control the business although the administrators do not want you to understand that fact. They need you. That is also true of Medicare and government programs. Without you, the government-sponsored insurance fails, and they know it. But they do not want you to know that. What happens every year when the 21% cut in doctor compensation is considered by Medicare and the politicians? Nothing. Why? Because the politicians fear that doctors will refuse to take care of Medicare patients, which would be a political disaster for them.

Marketing for POWER

Lastly, how do the others gain control of doctors in this grab for POWER in healthcare? By criticizing and denigrating doctors. There is a stream of publications about doctors, all of which are NOT complimentary. WHY? The goal is to put doctors on the defensive so that politicians can gain control of healthcare. They say that you are greedy, drive fancy cars, spend little time with patients, make too much money, make errors that kill 100,000 - 200,000 people, and the USA has a high cost of healthcare with poor quality, there are 47 million uninsured, etc. Most of these statements are totally false or misstatements of the real facts. But, you must realize that this publicity is an orchestrated attempt to gain control of you, the patient, and the healthcare dollar. Unfortunately some of our own doctors contribute to this criticism. On the converse, remember politicians want to suppress criticism of themselves using legislation and other means to prevent the criticism. Did you know that doctors perform over 32 million operations a year saving lives with minimal risks? Why don’t you read that? They do not want that information publicized. A recent Gallup poll found that the public trusts doctors, nurses, and pharmacists by 40-50 percentage points over politicians, business people, “banksters”, and lawyers. You have what they do not have: The Public Trust! Use it! Do what is right for the patient. That is why I say, “POWER for the PATIENT”. The others want POWER for themselves.

The Reason for the Desire for POWER

In healthcare today insurers, biomedical companies, politicians have all demanded and
received a spot at the healthcare table. Why? Because they want part of the $2 trillion dollars (going on $4 trillion) that makes up 1/6 of the GDP in the USA or > 16% of the economy. None of these providers really care about the patient. They want the money and control. A businessman defensively argued with me about that statement. I asked if he would give his product away to a customer for free or even at 80% reduction in charges if the customer had little or no money to pay for it. He would not and won’t. We do. Argument over. We do it because we are interested in helping people; they do it for money.

The Future
The last factor to know is that there will be less money available for doctors and hospitals in the future. Why? The USA is bankrupt. It will need to find money to pay its debts. That means lower fees for doctors, more restrictions on spine surgery, and low payment for hospitals. That also means “bundling of payments” where the hospital is paid one lump sum for patient care, and then the administrators distribute the fees to the doctors. Now that is a losing scenario for doctors if I ever knew one.

The Solution
Here is what you need to do. You need POWER. You need POWER to counteract those who have corrupted democracy to develop a socialist government controlled power center. That means you need to get the doctors in your community or state to work as a group. Yes, I know you cannot stand the other neurosurgeons, etc., etc. But the other neurosurgeon is not your problem. The government and all the other stakeholders at the table are. You need to organize to get POWER for the PATIENT. Why? Because you are the only ones who really care about the patient.

As an example, I have helped a group of practicing neurosurgeons organize, and then work with a health system to invest in building a neuroscience center. They partnered with a health system because both gained from the partnership. Then, the group, which became the most powerful in the community, expanded to include others around the state. Now they had POWER to bargain with insurers. They doubled their reimbursement from the insurers. Remember insurance companies are in business to make profits for their stockholders. The neurosurgeons also attracted new neurosurgeons to join their group when that was impossible before in individual practice. Then neurologists, physiatrists and others wanted to be part of this group. It began to grow tremendously. It had POWER. The key here is that the doctors decided that they had more POWER as a group than they had individually. Now anyone who wants neuroscience care has to go through them. That is the POWER you want. It does not matter what happens in healthcare because you have POWER.

This is how to get POWER. It is easy to do if you realize the fundamentals I outlined above and the will to do it. ☑️
The 61st Annual Meeting of the Congress of Neurological Surgeons (CNS) will be held in Washington, DC, October 1-6, 2011 at the Walter E. Washington Convention Center. The CNS is proud to co-host the meeting with our international partner, the Spanish Neuro-surgical Society (SENEC). Apropos the setting, the theme of this year’s meeting, *E Pluribus Unum* (Out of many, one), engenders a spirit of cohesion and unity among our international specialty members. The 2011 Annual Meeting program will bring together meeting attendees to explore the latest advances in the various facets of neurological surgery.

**Practical Courses**

Twenty-eight Practical Courses were developed by Co-Chairs, Ashok Asthagiri, MD, and Vinay Deshmukh, MD, in conjunction with the Practical Course Directors. These courses, from the popular 3-D Anatomy courses led by Dr. Albert Rhoton, Jr., MD, to the new simulation and NINDS workshop courses for residents, cover each neurosurgical subspecialty, research, education and emerging technologies.

**General Scientific Sessions (GSS)**

GSS Co-Chairs, George Jallo, MD, and Michael Wang, MD, have crafted a series of spectacular scientific sessions, throughout the week each featuring presentations by luminaries in neurosurgery on the latest scientific breakthroughs in their respective fields. The Annual Meeting kicks off with the Sunday afternoon Opening Session (4:30 to 6:00 PM), setting the stage for the week-day GSSs. The Opening Session features a presentation by Albert Rhoton, Jr., MD, on *Striving To Optimize Outcome: The Anatomic Foundation of Neurological Surgery*, Special Lecturer Gerald Imber, MD, author of *Genius on the Edge: The Bizarre Double Life of William Halsted*, and a presentation by the John Thompson History of Medicine Lecturer, General (Retired) Stanley McChrystal, on *Maintaining Expertise in a Complex and Changing Environment*.

The Monday session features talks by CNS President, Christopher Getch, MD and a
NINDS Workshop

Because of the many challenges associated with balancing a research career and clinical neurosurgery, the National Institute for Neurological Disorders and Stroke (NINDS) has partnered with the Congress of Neurological Surgeons (CNS) to provide a Workshop on Grant Writing and Career Development (PC01). This practical course will remain complementary and is being co-directed by E. Antonio Chiocca, MD, Professor and Chairman at Ohio State University Department of Neurosurgery and Stephen Korn, PhD, Director of Training and Career Development for NIH/NINDS. Course faculty will include seasoned neurosurgery and neurology researchers, new neurosurgery and neurology investigators who have successfully transitioned to career development grants and beyond, and senior NINDS staff. The workshop will focus on how to obtain funds for your research career and how to successfully navigate a dual career as both clinician and researcher. The morning program will be limited by invitation to NINDS R25 grantees and selected Neurosurgery residents. The afternoon program, which includes both didactic sessions and small group discussion/mentoring sessions, is open to all interested residents, fellows and junior faculty (established faculty are also welcome, but the program is directed at junior investigators). There will also be opportunity for networking and individual discussion. Participants are encouraged to bring their own grants-in-progress to this session. Faculty who have successfully obtained funding from the National Institutes of Health (NIH) at different stages of their careers and NIH study section reviewers will review these grants and provide individual instruction. At the conclusion of this session, participants will have gained significant insight into how to write successful grant applications, and how to structure a career to succeed in combining clinical and research efforts. A reception for all participants and faculty will immediately follow the grant writing workshop.

3-D presentation by Honored Guest, H. Hunt Batjer, MD, entitled, Red Cerebral Veins: the Science and Art of Arteriovenous Malformation Management. The 2011 Dandy Orator, Jon Meacham, a Pulitzer Prize winning author and former editor of Newsweek, will speak on Leadership in a Time of Crisis.

Tuesday morning features talks by world-class neurosurgeons, including SENEC President, Miguel Manrique, and for the first time ever, a live surgical demonstration (carotid stenting) will be included in the GSS. Honored Guest, H. Hunt Batjer, MD, will deliver a 3-D presentation on surgical complications entitled, We Ain’t Treatin’ the Measles: Our Decisions Count. An exciting Music and the Mind Symposium (10:30 to 11:30 AM) includes a talk by head and neck surgeon and musician, Charles Limb, MD, on music’s effect on the mind, followed by an interview and performance by Jeffrey Kahane, world-renowned musician, composer and music director of the LA Chamber Orchestra and Colorado Symphony Orchestra.

The Wednesday session offers a variety of lectures by leading neurosurgeons, neurologists and neuroscientists. Special Lecturer Lee Hochberg, MD, PhD, lead investigator of two clinical trials for BrainGate, will discuss Seeking to Restore Function: Human-Robotic Interface. Special Lecturer Colonel Geoffrey Ling, MD, PhD, an expert on battlefield head injury and prosthetic development, presents...
the latest developments in managing injury and rehabilitation for our soldiers returning from war. Honored Guest H. Hunt Batjer addresses emerging issues in resident training with The Future of Neurosurgical Education: What Will Your New Partners and Personal Physicians Look Like?. The session also features Julian T. Hoff Lecturer, Frank Deford, a world-renowned sports writer whose work has been featured on HBO’s Real Sports with Bryant Gumbel, National Public Radio (NPR) and Sports Illustrated.

Thursday offers two new sessions on controversial topics in tumor and spine surgery. The first focuses on the advantages and disadvantages of maximizing surgical resection for high-grade gliomas, and the use of surgical adjuncts, such as intraoperative MRI and fluorescence-guided resection, to aid in surgical resection. The second evaluates the utility of arthroplasty for the treatment of cervical spine disease.

Luncheon Seminars
Co-Chairs, Costas Hadjipanayis, MD, and Odette Harris, MD have developed a tremendous lineup of Luncheon Seminars with the essential input of expert moderators and faculty, and feedback from prior attendees. These seminars cover emerging advances from Contemporary Management of Traumatic Spine & Spinal Cord Injury to Hematology and Coagulation for Neurosurgeons: Dangers and Solutions.

Original Science Program
The Original Science Program, featuring the “Neurosurgical Forum” and “Oral Presentation” sessions, has been expanded for 2011 under the direction of Co-Chairs, James Harrop, MD, and Jason Sheehan, MD. With more oral presentations than ever, Oral Presentations from each subspecialty and the Council of State Neurosurgical Societies (CSNS) will be presented on Monday afternoon, followed by a new multidisciplinary session on Wednesday.

Consensus Sessions
Co-Chairs, John Boockvar, MD, and Elad Levy, MD, have designed two interactive Consensus Sessions for the meeting. As always, these sessions allow audience members to weigh in, via hand-held devices, on timely and controversial topics that confront all neurosurgeons. Consensus Session I, Treatment of Metastatic Brain Tumors: What is the Standard of Care?, on Monday afternoon covers the roles of radiosurgery and surgery in metastatic disease. Consensus Session II, Management of Low Back Pain: What is the Standard of Care?, on Wednesday afternoon covers the utility of various medical and surgical management strategies for low back pain.

Special Courses
Special Course Co-Chairs, Aviva Abosch, MD, and Bernard Bendok, MD, have worked with course directors and faculty to develop two outstanding Special Courses. Special Course I, Concussion: A Perfect Storm and the Role of the National Football League, focuses on sports-related concussion with experts Margot Putukian, MD, Mitchell S. Berger, MD, H. Hunt Batjer, MD, and Richard G. Ellenberger, MD. Special Course II, Guidelines and Clinical Evidence Update, presents the latest evidence-based data to direct care for various clinical scenarios in functional, spine, vascular and tumor neurosurgery.

Dinner Seminars
Based on the overwhelming success and positive feedback from last year’s Dinner Seminars, we have expanded our offering.

Co-Chairs, James Liu, MD, Zohr Ghogawala, MD, James Harrop, MD, and Ashwini Sharan, MD, have designed four Dinner Seminars on Tuesday and Wednesday evenings covering Low-Grade Gliomas, Controversies in the Treatment of Cervical Spondylotic Myelopathy, Current Management Strategies for Metastatic Spine Tumors and Cervical and Lumbar Arthroplasty. The Dinner Seminars will take place at four of DC’s finest restaurants with world-class experts discussing various viewpoints related to these timely and critical issues.

Operative Technique Symposia
To further enhance the technique focused sessions from past meetings, the CNS will debut a new live surgery offering and two new surgical technique video symposia. Our live surgery debut during the Tuesday GSS features a live carotid stenting procedure by Elad I. Levy, MD, and L. Nick Hopkins, III, MD. Monday afternoon features a new high-definition 3-D video demonstration of surgical management of complex intracranial aneurysm cases, by Aaron Cohen-Gadol, MD, William T. Coulwell, MD, and Duke Samson, MD On Tuesday afternoon, we are honored to have Nelson Oyesiku, MD, Editor-in-Chief, NEUROSURGERY®, kick off Operative NEUROSURGERY®, a session featuring select operative technique videos presented by authors that published a description of their technique in Operative Neurosurgery during the past year.

See You at the 2011 CNS Annual Meeting!
While we are certain that the scientific offerings will be of interest to the members, we also want attendees to enjoy the locale. Washington, DC, offers a unique opportunity for the whole family, boasting some of the most important monuments and museums in the United States. We have purposefully left ample time, particularly on Tuesday and Wednesday afternoons for attendees to take in the sights. We look forward to seeing you in Washington, DC, this fall!
Given the pre-eminent role and mission of education as a guiding principle of the CNS, our Fellowships Committee seeks to encourage the academic pursuits of young neurosurgeons worldwide through career-enhancing fellowship awards. These awards encompass all disciplines of our field and include projects ranging from basic science research to clinical outcomes initiatives to socio-economic concerns, and even to mentoring opportunities with leaders in neurosurgery. Applicants were asked to address critical knowledge gaps and to build a project aimed at answering these important questions with an evidence-based paradigm.

The CNS is pleased to announce that we were able to offer over $215,000 in fellowship awards in 2011. We had an exceptionally high number of applicants this year—over seventy—for 14 awards, including the CNS Penfield Clinical Translational Research Fellowship, the CNS Cushing Fellowship, the CNS Dandy Fellowship, the CNS Socioeconomic Fellowship as well as the CNS specialty fellowships in Spine, Tumor, Vascular and Functional Neurosurgery. A nineteen-member panel comprised of the CNS members spent weeks evaluating each application, eventually arriving at the extremely difficult task of awarding just a few fellowships from a large pool of very worthy candidates.

This year also marks the first awards cycle of our new “InSITE,” or Industry Sponsored Initiatives for Teaching and Education, fund for the CNS Fellowship Awards. InSITE is a repository for pooled funds donated by multiple industry partners, in strict compliance with new Accreditation Council for Graduate Medical Education (ACGME) guidelines, from which multiple, educationally high priority, mission-directed and CNS-selected Fellowship Awards can be distributed.

Interested neurosurgeons are encouraged to check the CNS web site for 2013 fellowship applications beginning in late August, 2011. A description of the winning projects along with this year’s very deserving fellowship award recipients can also be found in the CNS University/Fellowships section of the web site, or by linking to http://w3.cns.org/fellowship.asp.

Congratulations to all our winners on these prestigious awards!

CNS Wilder Penfield Clinical Translational Research Fellowship
Shawn Hervey-Jumper, MD
Arthur P. Chou, MD, PhD

CNS Cushing Fellowship
Andrea J. Chamczuk, MSc, MD

CNS Dandy Fellowship
Kimon Bekelis, MD

CNS Functional Fellowship
Vassilios G. Dimopoulos, MD
Jonathan D. Choi, MD

CNS Spine Fellowship
Victor Chang, MD
Monique J. Vanaman, MD
Zachary A. Smith, MD

CNS Tumor Fellowship
Katharine M. Cronk, MD, PhD
James K. Liu, MD

CNS Vascular Fellowship
Peter Kan, MD
Ali K. Ozturk, MD

CNS Socioeconomic Fellowship
Timothy R. Smith, MD

Steven N. Kalkanis, MD
A 26 yo patient with Sickle Cell presented with progressive HAs after a syncopal episode. He underwent a far lateral approach for resection of an epidermoid tumor that contrast enhanced (they never contrast enhance...) and wrapped his basilar and vertebral arteries as well as cranial nerves IX, X, XI, and XII.

Submitted by:
Costas G. Hadjipanayis, MD, PhD
Emory University School of Medicine
Presenting the Best Clinical and Basic Science at the 2011 CNS Annual Meeting Original Science Program!

The 2011 Congress of Neurological Surgeons Annual Meeting continually presents the best clinical and basic science during the expanded ORIGINAL SCIENCE PROGRAM, featuring more Oral Presentations than ever before on Monday and Wednesday afternoon!

- **ORAL PLATFORM PRESENTATIONS** will deliver the highest-ranked abstracts in eight-minute presentations from each neurosurgical subspecialty on Monday afternoon, as well as a **NEW Multidisciplinary Session** on Wednesday afternoon!

- **NEUROSURGICAL FORUM** authors will make dynamic oral presentations to small groups in this interdisciplinary session immediately following the Oral Platform Presentations on Monday.

Join your colleagues to hear the latest research in each subspecialty in this neurosurgical marketplace of ideas.

*Registration is available online at www.cns.org!*