Neurotrauma & Critical Care NEWS

American Association of Neurological Surgeons

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AANS/CNS Section on Neurotrauma & Critical Care

Editor: Shelly D. Timmons, MD, PhD, FACS

In This Issue...

From the Chair

P. David Adelson, MD, FACS

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Each day in the newspaper one reads another article that highlights the constant barrage sustained not only by organized medicine but also by neurosurgery as a small specialty. Whether the issues are of medical liability, reimbursement, quality performance measures, or others, many practitioners have become quite frustrated in their attempts to provide quality care for their patients. What has become even more frustrating and disappointing is that some of these issues have arisen internally from within organized medicine, pitting specialties against one another.

For example, despite fierce opposition by organized neurosurgery, the recent move by trauma surgeons to create an acute care surgery specialty is particularly frustrating to all of us who have been and continue to be involved in neurosurgical emergencies and critical care, including neurotrauma. To believe that a "fellowship" consisting of a few months of training is ample qualification for handling neurosurgical emergencies is absurd considering that neurosurgical residency, fellowships, and practice add up to countless hours in the OR and in the ICU and years of managing patients with neurosurgical emergencies. The development of acute care surgery specialists who, with a few months of neurosurgical training, perform craniotomies and place ICP monitors and burr holes makes little sense when there is a wide range of nontrauma neurosurgical emergencies that require acute care evaluation and management, stabilization and transfer.

Presently, the patient with a subarachnoid hemorrhage due to a basilar tip aneurysm is neither going to be coiled nor clipped at the local community hospital in a rural setting, even by the neurosurgeon located there. This type of neurosurgical emergency is evaluated, stabilized and transferred to a center with a neurovascular neurosurgeon and/or endovascular neurosurgeon and a neuro-ICU specialist, all of whom are attuned to the management of these patients. We should not expect any less for trauma patients, who deserve the highest level of care that their injuries require.

The general feeling among neurosurgeons is that the development of an acute care surgery specialty is frankly insulting. Similar feelings are found among our orthopedic colleagues since acute care surgery specialists will care for orthopedic emergencies as well. Despite a number of face-to-face meetings and the exchange of alternative solutions, the acute care surgery train moves steadily forward as is evidenced by the recent announcement of plans for new "accredited" fellowship training programs. What better way to further fracture the coalition of organized medicine than to have its members at odds and not working together in a collaborative way for novel and optimal solutions.

The Institute of Medicine report on emergency care cited a number of recommendations that have been endorsed by neurosurgery. These include regionalization, protection from medical liability and additional funding for emergency care. These are all viable solutions that would enhance and encourage the type of care patients receive without disenfranchising any group of medical practitioners or specialists.

Take, for example, regionalization. Who does regionalization affect in a negative manner? It creates an integrated system of neurotrauma care that defines levels of expertise and promotes rapid

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International Neurotrauma

Rani Nasser and Jack Jallo, MD, PhD, FACS

The range of neurotraumatic injuries and the capabilities of neurosurgeons to manage them effectively vary across the globe. According to the World Directory of Neurological Surgeons, there are 23,940 neurosurgeons in a world with a population of more than six billion people, resulting in an international ratio of approximately 1 neurosurgeon to 230,000 people, though, in reality, 60 percent of neurosurgeons take care of 14 percent of the world population in developed nations. Furthermore, in underdeveloped countries, only 6 percent of neurosurgeons take care of 34 percent of the world population.

There is a tremendous disparity in resources and training in developing nations. This rift is partially due to scarcity of resources, but it is also due to intrinsic factors specific to certain parts of the world. This article will address such factors and some feasible solutions that could help improve outcomes for neurosurgical patients internationally.

Africa The continent of Africa is among the hardest hit in terms of neurosurgical disparity and scarcity of resources. For example, 18 countries have no CT scanners, and 13 countries have just one CT scanner each. Furthermore, the entire continent of Africa has 565 neurosurgeons, most of whom are concentrated in North Africa and in South Africa. There are only 79 neurosurgeons for all of sub-Saharan Africa, a ratio 1 neurosurgeon for 3.6 million people, with the most destitute of regions having only 1 neurosurgeon for 9 million people. In addition, injured Africans face a median distance of 60 km (37 miles) to a hospital and a corresponding nine-hour delay in reaching such care. Throughout the continent medical services and equipment are unevenly distributed, and the majority of the population does not have access to these amenities due to poor economic resources and the lack of medical insurance.

Parallels that African neurotrauma shares with the West are that males are disproportionately affected and that traffic accidents are the predominant mechanism of injury. Moreover, as in North America traumatic brain injury, TBI, is the most common cause of traumatic death for young Africans. There is a high incidence of mortality and morbidity across the continent resulting from relatively manageable neurosurgical interventions (by Western standards) such as posttraumatic hematomas, brain abscesses, hydrocephalus, and benign tumors. Furthermore, the development and progression of neurosurgery as a field in Africa is stifled and institutionally insufficient for managing the incidences of neurotrauma presented in its population, partially due to fiscal constraints but also due to other public health concerns that take priority.

Latin America Latin America has a population of 305.7 million people and has 2,489 neurosurgeons, with a ratio of 1 neurosurgeon to 123,003 people. The trend in traffic-related accidents as the primary contributing factor for TBI is maintained in Latin America. Moreover, 50 percent of fatalities and injuries involve persons with an average age of 25. This is also in accordance with international statistics regarding neurotrauma. Although socialized healthcare provides some level of care, patients often need to have substantial financial resources or be willing to participate in experimental cognitive rehabilitation treatments to receive needed rehabilitation services. In Uruguay for example, rehabilitation efforts for people with TBI during acute care and sub-acute care are limited to one or two private clinics and a few research studies.

Asia Asia has an extensive range of neurotrauma care and levels of care throughout the 47 nations which comprise the continent. There are 9,618 neurosurgeons for 3.253 billion people, providing an overall ratio of 1 neurosurgeon per 336,000 people. However, the level of neurosurgical care is far from uniform throughout the continent and can be strongly contrasted with the levels of care in such nations as Japan and Thailand. For example, the paying capacity of patients and the subsidizing power of the government are very limited in a nation like Thailand, whereas Japan has the highest ratio of neurosurgeons to population and the most cutting-edge technology in all of Asia. In Thailand, the leading cause of TBI is traffic accidents. Furthermore, there is overwhelming noncompliance regarding helmet usage throughout Thailand. This is particularly significant in a nation like Thailand where motorcycle and moped travel is widespread; a motorcycle driver or passenger constitutes 91.6 percent of the injured and 89.9 percent of the deceased.. To further illustrate the magnitude of such noncompliance, 89.3 percent of the injured and 95.4 percent of the killed motorcyclists wore no helmet. In addition, alcohol consumption was involved in 42 percent of traffic accident cases.

Japan, with a population of 120 million people, boasts 7,987 neurosurgeons, 373 training hospitals, and 844 attached hospitals, in contrast to 95 training sites in the United States, which has twice the population of Japan. Japan has a ratio of 1 neurosurgeon for every 22,000 people and intends to increase its present number of neurosurgeons by three-fold. This may be due to the fact that Japanese neurosurgeons often subspecialize into various fields in which U.S. neurosurgeons do not operate as frequently, such as neuropathology and neuroradiology. Japan's successful patient outcomes may be attributed to sophisticated imaging modalities and well-funded research institutions. For example, 50 percent of all Gamma Knife technology in Asia is installed in Japan. Additionally, Japan has the greatest number of CT units per person and is second only to the United States in the number of MRI units per person. In addition to advanced technology, Japan's research initiatives may also play a central role in raising the standard of care. Out of the minimum six-year neurosurgical residency, two years must be spent in academic research. Furthermore, Japan's research institutions are well-funded government institutions with hefty private endowments.

India has a population of 1.12 billion people and a ratio of 1 neurosurgeon for every 1,400,000 people. India's 800 neurosurgeons are charged with the hefty task of managing the 2,130,141 cases of TBI every year, nearly 60 percent of which are caused by road traffic injury.

North America In North America there are 4,583 neurosurgeons for 370.8 million people, a rate of 1 neurosurgeon for every 81,000 people. Approximately one million Americans are treated and released from hospital emergency departments annually as a result of TBI. Of the one million releases, 80,000 people are estimated to be discharged from the hospital with some TBI-related disability, and 50,000 die. These numbers were so alarming that in 1986 the National Head Injury Foundation described head trauma as a "silent epidemic." By 1998, the NHIF indicated that the number of TBI cases had increased dramatically from 1.5 million to two million per year. Of these individuals, 70,000 to 90,000 experienced long-term loss of functioning. TBI continues to be the leading cause of death and disability in the U.S. for persons up to age 44.

European Union The European Union has 6,594 neurosurgeons for 799 million people, a rate of 1 neurosurgeon for every 121,000 persons. Brain injury accounts for one million hospital admissions per year within the EU, and motor vehicle accidents account for 50 percent of all TBI cases. These figures include automobiles, trucks, motorcycles, bicycles, and pedestrians hit by vehicles. Furthermore, winter sports such as skiing and ice-skating account for nearly 20,000 brain injuries.

Australia Australia has 103 neurosurgeons for 21.1 million people, a rate of 1 neurosurgeon for every 205,000 persons. A total of 338,700 Australians (1.9 percent of the Australian population) has sustained a disability related to brain injury. Australia has higher rates of alcohol-related brain injury than other Western countries. An alarming 68 percent of brain-injured people had a history of substance misuse and 14 percent developed an alcohol- or other drug-related problems after head injury.

International Neurosurgical Community: A Call for Collaboration In today's global village there is much that the international neurosurgical community can do to help raise the standard of care and decrease the disparities described herein. Despite the intrinsic regional challenges that developing nations may face, there is potential to overcome some of these hurdles via collaboration with developed nations. For instance, developed nations could increase the number of positions available to visiting fellows from underserved regions. More specifically, upgrading the observer status of many visiting fellows to a more involved one within the training program could provide the hands-on training needed to help establish proficiency in cutting-edge techniques. Training of nurses and paramedical staff also could serve to provide necessary support for an already depleted neurosurgical population in developing nations. For example, the Department of Health at Fujita Health University in Japan is offering three-month fellowships for training neurosurgeons, nurses, and paramedical

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International Distribution of Neurosurgeons

	World	Africa	Sub-Sahara Africa	Latin America	Mexico	Asia	Japan	India	North America	European Union	Australia
Population	6+ Billion	700 Million	600 Million	305.7 Million	107 Million	3.253 Billion	120 Million	1.12 Billion	370.8 Million	799 Million	21.1 Million
Number of Neuro-surgeons	23,940	565	79	2,489	280	9,618	7,987	800	4,583	6,594	103
Ratio of Neuro-surgeons to People	1:230,000	1:238,000	1:3,600,000	1:123,003	1:377,000	1:336,000	1:22,000	1:1,400,000	1:81,000	1:121,000	1:205,000

International Injury Induced Mortality

	Nigeria	South Africa	Uruguay	Mexico	Thailand	Japan	India	Qatar	USA	Norway	Australia
Injuries	4,495	3,686	1,978	2,009	2,548	1,048	3,626	1,299	1,439	1,061	1,107
Unintentional injuries	**3,222**	**1,962**	**1,203**	**1,451**	**965**	**626**	**2,913**	**1,140**	**997**	**752**	**804**
Road traffic accidents	961	906	354	445	149	200	599	682	455	262	264
Poisonings	215	31	21	25	18	12	150	2	106	28	117
Falls	174	102	90	138	154	116	372	110	106	150	112
Fires	246	164	27	25	29	18	467	23	33	25	14
Drowning	490	85	97	72	30	38	166	67	39	22	35
Other unintentional injuries	1,137	674	613	745	585	241	1,159	257	260	266	263
Intentional injuries	**1,273**	**1,724**	**776**	**558**	**1,583**	**423**	**713**	**159**	**442**	**309**	**304**
Self-inflicted injuries	150	268	320	102	150	399	504	86	227	269	260
Violence	960	1,342	453	454	154	24	174	62	211	40	43
War	163	114	2	2	1,276	N/A	23	12	0	0	N/A

Age-standardized disability-adjusted life years, DALYs, per 100,000 by cause, and member state, 2002. World Health Organization (Organisation Mondiale de la Santé) Department of Measurement and Health Information, December 2004.

Regionalization: Lessons From Santa Clara County

Kenneth S. Blumenfeld, MD

It is Dec. 4, 2004. A handful of doctors, nurses and technicians stand outside San Jose Medical Center as it closes it doors. Amidst angry sentiment there is legitimate concern for the well-being of the community. What would happen now? The hospital had been a busy level II trauma center that had provided exemplary trauma and neurosurgical services for more than 14 years. To make matters worse, the hospital had closed to trauma with only 90 days notice, leaving only two other facilities to deal with the heavy patient load.

For better or for worse the Santa Clara County EMS, servicing one of California's most heavily populated regions, faced a daunting task. In the process of reconstructing trauma services, the politically charged question of regionalization would need to be addressed. The challenges that followed offer insight into the process.

First to be tackled was the redirection of patients to remaining trauma centers. Simple as this may seem, it raised immediate concern over transit times and closure rates. EMS dispatch, service regions and triage criteria had to be reexamined. Nontrauma neurosurgical emergency care went into crisis mode as patients with aneurysmal subarachnoid hemorrhage, central nervous system tumors, hemorrhagic strokes, hydrocephalus and nontraumatic subdural hematomas were displaced to surrounding, less well-equipped emergency departments.

As finger-pointing began it became evident that these problems were more than transitional pains. Physical limitations like time and distance to centers were significant. Though staffing, emergency department and intensive care unit capacity could be increased, time and physical plant constraints seemed overwhelming. These problems exacted a cost, both financially and politically.

So a basic question was asked: Would Santa Clara County be better served by two or three geographically separated trauma centers? This question was contentious, as the owner of both San Jose Medical Center and Regional Medical Center San Jose, HCA Inc., had petitioned the county to "transfer" or develop a trauma program at RMCSJ following the closure of SJMC. This petition was initially rejected partly out of contempt for the closure but also based on the expectation that the county would be better served by two upgraded trauma centers, a sort of "regionalized system."

Trying to assess the trauma center needs of a community is not simple. Sources of information included EMS field data, trauma registry records, and reports by the Abaris Group trauma consultants. Inherently, the process is only as good as the data. In the case of Santa Clara County there were notable discrepancies in the data.

At some point, common sense prevailed. Consideration was given to population density and geography. Traffic patterns, existing infrastructure, urban sprawl, potential vulnerability to natural disasters, reliance of surrounding counties for trauma care were added to the mix. Then it became clear. If Santa Clara County could have three trauma centers with demonstrable competency, verification by the American College of Surgeons Committee on Trauma, and willingness to participate in concurrent review, why would it only want two? The arguments that followed were more about institutional profit, marketing and politics than patient care. Once consensus was reached, the work of "moving" a trauma center was begun. This too proved difficult and remains a work in progress, but trauma services and the community have benefited.

As a cautionary note, distinction needs to be made regarding the difference between regionalization of neurotorauma and the regionalization of nontrauma emergency neurosurgical care. The latter is yet to be reconciled. Santa Clara County is representative of the situation in which many communities find themselves. Though there are only three hospitals designated or willing to care for trauma patients, seven facilities want to primarily manage patients with subarachnoid hemorrhage, intracerebral hemorrhage, brain tumors, and nontraumatic subdural hematoma. The evolution of primary stroke centers has intensified this situation further because there are not enough neurosurgeons to cover all of those emergency departments without combining call schedules. To compound the problem, hospital administrators and medical staffs resist any attempts at regionalization or development of centers of excellence. Their goal seems to be maintenance of market share and development of centers of mediocrity. Nontrauma emergency neurosurgical care requires much of the same infrastructure and staff support as does trauma services. This may be readily available at academic institutions and large regionalized centers but not at smaller community hospitals. Unfortunately, we have yet to tackle this issue in a cooperative manner.

Ultimately, the feasibility of regionalization of trauma and neurosurgical care will depend greatly on the needs of the communities being served. It will require input from the neurosurgical community, coordination with local EMS, and an honest assessment of capabilities of participating hospitals. What works in New York City may not work in rural regions. Similarly, areas of suburban development may require yet another solution. A cookbook approach is unlikely to be successful. ■

International Neurotrauma *continued from page 3*

staff. Additionally, both the American Association of Neurological Surgeons and the Congress of Neurological Surgeons offer traveling fellowships for neurosurgical training.

Further progress could be made by holding more international conferences, thus providing a fruitful venue for program directors to build affiliations. Such affiliations could yield a teleconference network in which fast and efficient advice and collaboration with neurosurgical contemporaries can be shared from around the globe. One such link has been functioning since 1999 between the department of neurosurgery at Hokkaido University in Japan and Malaysia. Lastly, the donation of equipment and instruments to developing nations could also be facilitated through international conferences and could also serve as a tax exemption. The advent of high speed telecommunications has opened many pathways for us as an international community to build professional cohesion, and it is the collective hope and anticipation of neurosurgeons globally that the rift in neurotrauma outcome in the developing world will be curtailed. ■

Trauma Highlights at the 2007 CNS Annual Meeting

The 2007 Congress of Neurological Surgeons Annual Meeting offers engaging speakers, original science and novel educational formats designed to help you better assimilate the information presented into your practice. This year's theme, Navigating Change: Integrating Discovery and Innovation Into Practice" explores the dynamic field of neurosurgery to help attendees adapt their practice to technological advances, new medical challenges and changing societal demands.

Saturday, September 15, 2007

8:00 AM – 5:00 PM

Traumatic Brain Injury
Raj K. Narayan and Lori Anne Shutter, Course Directors

1:00 AM – 5:00 PM

Practical Neurosurgical ICU Management: The Basics (for MDs in Training, RNs, APRNs, and PAs)
Joshua B. Bederson and Owen Samuels, Course Directors

Sunday, September 16, 2007

8:00 AM – 12:00 PM

Adult and Pediatric Spinal Trauma Surgery
James S. Harrop, Director

1:00 AM – 5:00 PM

Advanced Concepts in Neuro-Critical Care
E. Sander Connolly Jr. and Michael DeGeorgia, Course Directors

Monday, September 17, 2007

2:30 – 2:40 PM

Optimal Timing of Surgery for Traumatic Central Cord Syndrome
Alexander K. Powers; John A. Wilson Jr.; Charles L. Branch Jr.

2:00 PM – 4:00 PM

CNS Neurosurgical Forum—Section on Neurotrauma and Critical Care

2:00 – 2:10 PM

Synthes Award for Resident Research on Brain and Craniofacial Injury

2:10 – 2:20 PM

Synthes Award for Resident Research on Spinal Cord and Spinal Column Injury

2:20 – 2:30 PM

Novo Nordisk Award

2:30 – 2:40 PM

Treatment of Severe Diffuse Axonal Injury in Rats With an Acute Intravenous Dose of Polyethylene Glycol Dramatically Reduces Cytotoxic Edema Formation at One Week on Diffusion-Weighted Imaging

2:40 – 2:50 PM

The Impact of Neurosurgical Coverage and Trauma Center Status on Patient Outcome

2:50 – 3:00 PM

Treatment of Traumatic Brain Injury in Mice With Erythropoietin

3:00 – 3:10 PM

Hippocampal Changes in the Lateral Controlled Cortical Impact Traumatic Brain Injury Model in Mice

3:10 – 3:20 PM

Monitoring of Cerebral Metabolism: Non-ischemic Impairment of Oxidative Metabolism Following Severe Traumatic Brain Injury

3:20 – 3:30 PM

Early Hemispheric Blood Flow Asymmetry Is Associated With the Onset of Vasospasm

3:30 – 3:40 PM

MRI Fails to Identify Instable Cervical Spine Injuries Missed by CT in Patients Without Neurological Deficit: The Four-Year Experience of a Level I Trauma Center

3:40 – 3:50 PM

The Use of Biodegradable Poly (e-caprolactone) Scaffolds in a Rat Spinal Cord Injury Model

3:50 – 4:00

Transplantation of Bone Marrow Derived Mesenchymal Stromal Cells as a Scaffold for Adult Neural Stem/Progenitor Cells in the Injury Adult Rat Spinal Cord

2:00 PM – 4:00 PM

Special Course—Advances in the Management of Spinal Cord Injury
David O. Okonkwo, Michael P. Steinmetz, Michael G. Fehlings

Tuesday, September 18, 2007

Luncheon Seminar 12:30 – 2:00 PM

Traumatic Brain Injury: Lessons Learned and Future Directions
Peter D. LeRoux

2:00 – 3:30 PM

Section on Neurotrauma and Critical Care I-Surgical Treatment of Head Injury
P. David Adelson, Moderator

2:00 – 2:25 PM

Integra Lecture: Surgery for Cerebral Contusion
Yoichi Katayama

2:25 – 2:30 PM

Interactive Question and Answer Session

Symposium: Decompressive Craniectomy: Revisiting an Old Concept

2:30 – 2:45 PM

Decompressive Craniectomy in the 1970s: Fade In/Fade Out
Lawrence Pitts

2:45 – 3:00 PM

Everything Old Is New Again: Results in the Present Day
Dilantha B. Ellegala

3:00 – 3:15 PM

RESCUEicp: A New Randomized Multicenter Trial
Peter J. Hutchinson

3:15 – 3:30 PM

Section on Neurotrauma and Critical Care I Interactive Panel Discussion

Wednesday, September 19, 2007

Luncheon Seminar 12:30 – 2:00 PM

Spine Trauma and Spinal Cord Injury: Advances in Medical and Surgical Management
Mark N. Hadley, Moderator
Barth A. Green, Michael G. Fehlings, R. John Hurlbert

Practical Management of Peripheral Nerve and Brachial Plexus Injury
David G. Kline, Moderator
Eric L. Zager, Allan J. Belzberg, Lynda J. Yang

Section Session 4:00 – 5:30 PM

Section on Neurotrauma and Critical Care II-Surgical Treatment of Head Injury

4:00 – 4:15 PM

Evolution of Neurocritical Care
William M. Coplin, Moderator

Point/Counterpoint: To Transfuse or Not To Transfuse

4:15 – 4:30 PM

Restricted Transfusion Strategy in Severe TBI
Lori A. Shutter

4:30 – 4:45 PM

Liberal Transfusion Strategy in Severe TBI
Shelly D. Timmons

TBI Monitoring: Management Brain Tissue PO2

4:45 – 5:00 PM

Indications and Management Protocols
Roland A. Torres

5:00 – 5:15 PM

Efficacy of Hyperoxygen Therapy
Peter Leroux

5:15 – 5:30 PM

Interactive Panel Discussion

Thursday, September 20, 2007

Interactive Case Discussion 7:00 – 8:20 AM

Navigating Change in Practice: Managing the Present and Working Towards the Future

Neurotrama and Critical Care
Lawrence F. Marshall and Shelly D. Timmons, Moderators

From the Chair *continued from front page*

patient transport to the most appropriate and well-equipped centers for the management of acute emergencies. With advances in technology and telemedicine and up-to-date algorithms for treatment and availability of experts, a highly integrated system could give even rural and community medical centers the highest quality and ability for the patient's stabilization and acute care prior to transport, as necessary. The creation of a highly efficient and integrated system for the evaluation and management of patients with neurosurgical emergencies would allow for adequate call coverage, scheduling of staff and appropriate ancillary specialists with an appropriate investment in the resources necessary to provide the optimal care.

The question that arises, then, is what is the cost? As with any change, regionalization likely would require significant investment. An initial step would be to identify such systems that now exist, study their strengths and weaknesses, and begin to develop individualized, community-specific solutions. While the move toward an integrated network would require funding for such things as technology, we must not forget the need for available individuals with "emergency" expertise who would review the patients at the outlying hospitals within the regionalized system of care. These individuals would require at least some level of compensation for time and liability, particularly for those physicians making decisions for either continued local management or transport to the regionalized higher-level centers. One could easily envision the neurosurgeon at the high-level center taking calls, evaluating scans, and making decisions for transfer and transport through this integrated regionalized network, delivering optimal care and appropriately allocating resources. For example, the patient with a Glascow coma score of 13 with a negative CT could be observed at the local hospital rather than being sent by helicopter to the regional trauma center. This would help to alleviate the coverage needs that many neurosurgeons are faced with at the present time and would support the appropriate transfer of patients who truly need high-level care.

Where is the resistance to regionalization coming from at the present time? Hospitals with "trauma centers" wish to maintain that designation so that they can continue to have neurosurgical coverage, not just for the emergency cases but also for the elective cases; the goal obviously is to maintain market share. Loss of market share potentially would lead to a decrease in revenue generated by neurosurgery within those hospitals. Additionally, if one were to provide protection from medical liability for those physicians covering neurosurgical emergencies, then many so-called patient advocacy groups and medical liability advocates within the legal profession would protest in the name of patient safety. These are all problems that can be overcome with leadership and recognition of the urgent need to address these situations.

In the short term, the availability of funding for projects that evaluate the regionalized or networked centers that are presently functioning will begin the process. To move the concept of regionalization forward, it becomes important that each specialty begins to define the algorithms for stabilization, management, triage and transfer of patients for optimal and appropriate care.

Neurosurgery needs to continue advocate for the patient with a strong voice. Optimal and appropriate care, the best allocation of resources, medical liability protection, adequate funding for emergency coverage and involvement in the development of these regionalized systems are the issues on which we must focus. ■

Multiple Casualty Incidents: The Israeli Experience

Guy Rosenthal, MD

Multiple casualty incidents that are due to terrorist attacks and military conflict are common in Israel. Because MCIs by definition involve the need to treat a large number of casualties in a brief time frame, they create particular challenges for any medical system. Between 2000 and 2004 Israel experienced many MCIs. A recent study using the Israeli National Trauma Registry found 1,155 patients over a two-year period (2000–2002) were injured in terror-related violence (4). A majority of these patients (54 percent) were injured in explosions that often were attributable to suicide bombers. The bombs utilized contain a variety of objects, such as nails, ball bearings, metal bolts, hexagonal nuts, and segments of metal rods, all of which are intended to maximize damage to civilians (Figure 1).

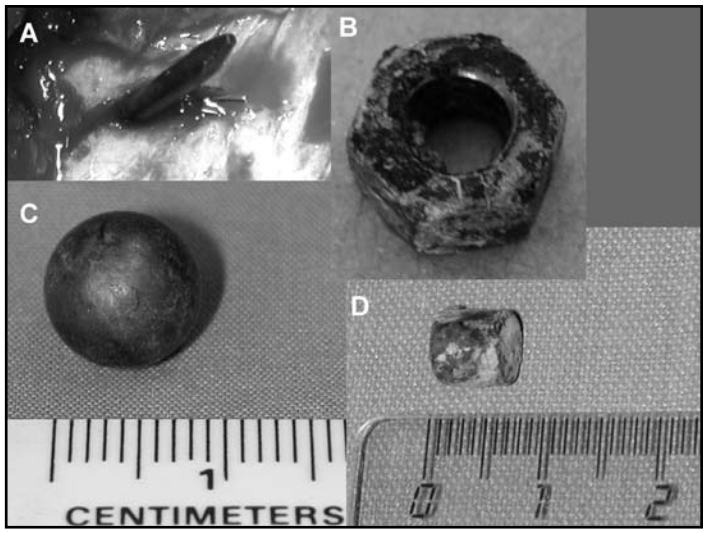

Figure 1 — Objects placed in terrorist bombs include (A) nails (pictured here embedded in the inner table of the skull), (B) hexagonal nuts, (C) ball bearings, and (D) pieces of metal rods.

Preparedness

Preparedness for managing MCIs is crucial. All Israeli hospitals have contingency plans for an MCI and hold practice drills, usually on an annual basis. The protocols for managing a sudden surge of patients are established, and all hospital staff practice their assigned roles in an MCI. Actual "patients" are usually provided by the Israeli army, which will assign an appropriate number of soldiers with predetermined injuries taped to a card on a wristband to act as patients. These drills, although they may seem tedious at the time, help prepare the hospital and staff for the real event.

Managing the Surge—Practical Considerations

Because Israel is small geographically and MCIs usually occur in an urban setting, casualties arrive quickly to the emergency department. The emergency medical services, known in Israel as the Magen David Adom or Red Star of David, have personnel who are trained to deal to with MCIs and who are well-practiced in triaging and treating casualties in the field. The result is that casualties usually arrive to the ED soon after an event. In a recent study by Einav and colleagues, one third of patients arrived within 10 minutes of the arrival of the first patient, and 65 percent of patients arrived within 30 minutes (2). Therefore, the hospital and the ED have very little time to prepare for the arrival of casualties. Any hospital near an MCI will be immediately notified of its occurrence, location, and mechanism. Immediately upon notification, the hospital's contingency deployment plan is put into effect and all medical, nursing, and ancillary personnel report to their specific predetermined locations and assume their roles (2).

One of the main challenges at the onset of an event is providing an adequate number of hospital beds at a moment's notice to allow unidirectional flow through the ED. A busy emergency department needs to be emptied of patients as quickly as possible to make room for arriving casualties. Routine patients already in the ED are triaged by the senior ED physician and are transferred to any available hospital bed. Nonsurgical staff physicians are mobilized to admit and care for these patients, preferably on medical rather than on surgical services. If needed, a contingency ED can be opened up in most facilities. ICU bed availability is one of the foremost concerns in the hospital deployment plan (2). Patients in general or surgical ICUs can often be transferred to alternative ICUs (cardiac care, internal medicine) if additional ICU beds are needed for surgical patients. In addition, the postanesthesia care unit is often mobilized to serve as an expanded ICU.

Triage in the ED

Initial triage for an MCI in Israel usually occurs at the entrance to the ED where patients are separated into critically injured, potentially unstable, and stable patients and funneled to appropriate sections of the ED. A recent study found that patients injured in bombings have a bimodal distribution of injuries, with a large proportion of both critical injuries and minor injuries (4). About one third of patients (34 percent) present with an injury severity score, ISS, greater than 162. A relatively large proportion of patients (18 percent) injured in explosions suffer a moderate or severe traumatic brain injury (4). In a review of the Israeli experience, nearly 40 percent of admitted patients following an MCI were sent to the CT scanner directly from the ED, creating the first "bottleneck" in the flow of patients from the ED to definitive treatment (2). Patients with TBI should have the highest priority for CT scan as they may require immediate, lifesaving operations.

Surgery and ICU

The Israeli experience indicates that operative procedures were performed on 60 percent of admitted patients and that 36 percent of admitted patients were triaged directly from the ED to the oper-

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ating theater (2). The majority of patients entering surgery within the first two hours were severely injured (ISS > 16) and multisystem injuries were common (2). Priority should be given to patients with immediate life- or limb-threatening injuries such as TBI and abdominal, thoracic, or vascular injuries. One third of admitted patients were admitted to the ICU, placing tremendous demands on the hospital's critical care system (2). Overall the median length of stay for all admitted patients was seven days, but for those admitted to the ICU the median length of stay was 17 days, reflecting the severity of injuries encountered from these bombs (2). In the review by Einav and colleagues, the overall in-hospital mortality was 8 percent.

Neurosurgical Perspectives

The neurosurgeon's role in MCIs begins in the planning stages. It is important to have a departmental plan of action established ahead of time so that neurosurgical team members all can be reached and can know their expected roles in a mass casualty incident. It is critical to recruit adequate neurosurgical staff for an MCI from the moment of notification, as it will take time for personnel to reach the hospital. Since each severe TBI patient will likely require operative intervention or ICU care, several neurosurgical teams should be on hand. All available personnel are called in via pager or phone and a quick assessment of the number of neurosurgical teams available is made.

At Hadassah-Hebrew University Hospital in Jerusalem, we have made it our practice to designate one neurosurgeon to help triage casualties in the ED, deciding which patients will require CT scanning and in what order. This is especially important since, as noted previously, the first "bottleneck" in patient management occurs at the CT scanner (1,3). We also have made it our practice to assign a senior neurosurgeon to triage patients at the CT scanner itself. Here decisions are made as to which patients go directly to the operating theater or to the ICU. A neurosurgical team is then assigned to individual patients to continue managing their care. We have found that such a system helps to centralize decision-making and to minimize loss of information in the initial stages of an MCI, when the hospital can be overwhelmed by the influx of patients in rapid succession.

A "second wave" of casualties should be anticipated, as some patients may have been inappropriately triaged in the field to hospitals without neurosurgical facilities. The explosive devices used in bombings combine blast effect with penetrating injuries from shrapnel. The large-mass objects placed in these bombs tend to frequently penetrate the skull and injure the brain parenchyma and vasculature (Figure 2). Patients with blast injury to the lung in addition to TBI present especially difficult management issues. Hospital and ICU stays for these patients are often lengthy. Neurosurgical complications associated with penetrating brain injuries, including pseudoaneurysms, infection, and even migration of large-mass objects through the brain occur with these injuries and should be anticipated (5).

Figure 2 — CT scan of patient injured in a bombing inside a university cafeteria. A bihemispheric injury from a large metallic object entering in the left frontal region and lodged on the right is seen.

The need to deal with terror attacks unfortunately has become reality in many parts of the world. When they occur, these incidents place tremendous strains on medical resources. Planning and practice can best help us prepare for mass casualty scenarios whether from terror, natural disaster or large-scale accidents. Neurosurgeons will always have an active role in treating victims of these disasters, and we should also take an active role in preparing our local medical systems to deal with these events. ■

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AANS Online Case Studies Project

Do you have a difficult case to manage? A great teaching case you'd like to share? Log on at www.MyAANS.org to browse through interesting cases or to post your case online. Click the "Online Case Studies" link at the left and follow the step-by-step directions to submit your material.

Posted cases will be reviewed by a neurosurgeon with expertise in the relevant field. You may seek input from colleagues, and other neurosurgeons may learn from your experience. The AANS Online Case Studies also are a great way to review for boards or MOC.

Frequently Asked Questions Regarding Case Studies:

What is the AANS Case Studies project?
The Case Studies project is an online repository of patient case material at MyAANS.org. It contains case vignettes, technical points, intraoperative video and audio descriptors. It is a resource for practicing neurosurgeons preparing for boards, MOC, and use in their own practice. The Case Studies are searchable by area of neurosurgery (for example, functional, spine, vascular)

Who can submit cases?
AANS neurosurgeons, residents, or medical students who have a MyAANS.org account can submit cases. Medical students are asked to name a clinical mentor (resident or attending) with whom they have reviewed the case when they submit.

Can I collaborate with someone such as a resident or medical student to submit a case?
Absolutely. The best way is to review and prepare the materials in your preferred software, such as PowerPoint (PPT), Acrobat (PDF), Word (DOC), or others, and then have one person submit the case.

How can a medical student gain access to the Case Studies?
By registering at www.aans.org/medical_students/SubmitMStudies.aspx, you will be granted full access to the AANS Case Studies and you will be able to submit a case with a clinical mentor (resident or attending).

Who reviews the cases and what is the purpose of the review?
A group of board-certified reviewers in the specialty for that case will look the case over for completeness and may ask for some additional information, edit the case briefly or embed a reviewer's comment. They will then "publish" the case, and it will be accessible to other neurosurgeons at MyAANS.org.

How can I embed very large video on the site?
Right now the site is able to accept 10 MB uploads through the browser. If you have a large video, this may be best submitted via a link to Google video or YouTube. For technical details on embedded video, please contact Bob Carter, MD.

Why is it that when I submit a comment it does not show up right away?
The comments are moderated, but they are usually posted within a few hours.

What is the best way to produce a Case Studies webcast?
A variety of software products allows you to annotate slideshows or video with audio for the purpose of a webcast. If you need help with products or methods of producing a webcast, please contact Bob Carter, MD, at bcarter@partners.org. ■

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Join the Section or Renew Your Membership Online

An online application process for membership in the AANS/CNS Section on Neurotrauma and Critical Care recently became available, rendering the form that had been printed in previous newsletters obsolete. The new streamlined process decreases the time from application to membership, expediting the extension of Trauma Section benefits to new members.

Applying is this easy:

1) Go to www.MyAANS.org.
2) Login using e-mail address and password, or register by entering name and e-mail address and chosen password.
3) Select: Member Applications from the left-hand tool bar.
4) Select: Create a New Application.
5) Select: AANS/CNS Section on Neurotrauma and Critical Care.
6) Complete and submit the application following the online instructions.

Questions may be directed to AANS/CNS Section Services, sjm@aans.org or (888) 566-2267.

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