

**PRE-CONGRESS SEMINARS  
AND WORKSHOPS**

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## MILD BRAIN INJURY TASK FORCE - AN UPDATE

*Hans von Holst*, MD, PhD, Karolinska Sjukhuset, Stockholm, Sweden

The majority of patients with mild brain injury are relatively recovered within a couple of days to months. However, there is a number of people who report long term severe symptoms that are not correlated to the severity of the injury. The mild head injury has a substantial impact on both the patient as well as its relatives. Also, the social ramifications of minor head injury are reflections of the overall disruption caused by these common injuries. Not to forget is that mild head injuries make substantial demands on the health care system since they form a considerable part of the work of emergency departments. Another point to be considered is the lack of gold standard guidelines for the treatment of mild head injury. Therefore, the WorldHealth Organisation Collaborating Center at Karolinska Institute in Sweden has, together with the Alberta University in Canada, taken the initiative to the Task Force on Mild Brain Injury. The Task Force methodology is to perform an overview of the literature in an effort to present guidelines recommendations based on a screening and synthesis of the literature. The objectives of the Task Force is to perform a best evidence synthesis of epidemiology, diagnosis, treatment and economic costs of mild brain injury. The presentation of the Task Force is an update of the ongoing work so far.



## PROGNOSTIC INDICATORS IN SEVERELY HEAD INJURED PATIENTS

*Franco Servadei*, WHO Neurotrauma Collaborating Centre, Ospedale M. Bufalini, Cesena, Italy

The uncertainty that exists about the outcome after traumatic brain injury is still well reported by Hippocrates “No head injury is so serious that it should be despaired nor so trivial that it can be ignored”.

The advances in prognosis reflect the establishment of methods for categorizing outcomes (GOS) and early injury severity (GCS). The Brain Trauma Foundation (BTF) has recently supported a study on early indicators of prognosis in severe traumatic brain injury.

The methodology (as for the guidelines for management) included a literature search and paper classification.

The following parameters were found relevant to increase the probability of poor/good outcomes in severely head injured patients.

**Age:** Most literature supports children faring better than adults. The influence of age on outcomes is not explained by the increasing frequency of systemic complications or intracerebral haematomas.

Furthermore, age is a strong independent factor in prognosis with a significant increase in poor outcomes above 60 years of age.

**GCS:** The initial GCS has a linear relationship with outcomes (mortality from 65% with GCS 3, to 24% with GCS 6 and to 10% with GCS 9-13)<sup>1</sup>. Many studies<sup>2</sup> have shown that very often the initial clinical assessment is obscured by prehospital medication and intubation thus altering the precision for prediction of a good outcome.

**Pupillary** diameter and the pupilloconstrictor light reflex are two parameters that have been related to prognosis in different papers. Patients with bilateral unreactive pupils have less than 5% chances of a good outcome<sup>3</sup>.

**Hypotension:** SBP < 90 mmHg at any time from injury has been found<sup>4</sup> to be one of the five most powerful predictors of bad outcomes.

**CT parameters:** Presence of abnormalities on initial CT examinations, CT classification according to Marshall<sup>5</sup>, type of intracranial lesion, basal cisterns status and presence of traumatic subarachnoid hemorrhage are all parameters linked to patient's prognosis.

### References:

1. *Fearnside et al, Br J Neurosurg, 1988*



2. *Murray et al, Acta Neurochir, 1999*
3. *Jennett et al, Lancet, 1976*
4. *Chesnut et al, J Trauma, 1993*
5. *Marshall et al, J Neurosurg, 1991*

**SPEAKERS**



**NEUROBEHAVIORAL CONSEQUENCES OF TBI EVIDENCE BASED WORKSHOP**

*Deborah L. Warden*, MD, Chief of the Traumatic Brain Injury Program, Departments of Neurology and Neurosurgery, Walter Reed Army Medical Center, Washington DC, USA

Individuals with TBI may experience neurobehavioral difficulties (cognitive problems, depression, irritability, anxiety, decreased motivation, mood lability, aggression, and psychosis) during their recovery. This presentation will discuss the progress to date of the Neurobehavioral Consequences of TBI Guideline Workgroup, a group convened by the International Brain Injury Association in January 2000 and co-directed by Dr. Deborah Warden and Dr. George Zitnay. This presentation will include a discussion of the methodology of creating an Evidence Based Guidelines Task Force, as well as a presentation of first-draft guidelines based on all Class I and Class II articles identified to date.



## THE MANAGEMENT OF PATIENTS WITH SEVERE TRAUMATIC BRAIN INJURY. RESULTS OF A NATIONAL CONSENSUS CONFERENCE

*Mariangela Taricco*, MD, Italy, on behalf of Committee of the National Consensus Conference

A Consensus Conference (CC) on the rehabilitation of the traumatic brain injury (TBI) persons has been held in June, 2000 in Modena, Italy. The aim of the Conference was to provide recommendations about the rehabilitation management during the acute phase of TBI patients and to define clinical guidelines on referral and transfer from the ICU units to the rehabilitation facilities. Clinicians, patients and families, providers and policy makers were involved in the CC process. In this paper, a summary of the results of the CC will be presented.

**SYNOPSIS** - On the basis of the scientific data presented during the Conference the Jury come to formulate the following recommendations:

- Improving epidemiological data on traumatic brain injury is an essential need in order to quantify the services required as well as the most appropriate timing and levels of care during the different phases of the disease.
- Although scientific uncertainty still exists on the real efficacy of early and/or intensive interventions, the Jury recommends that rehabilitation procedures be activated as early as possible during the acute phase of head trauma to prevent complications, minimize impairment and facilitate recovery and interaction with the environment.
- Based on the published scientific literature the use of intensive multi-sensory stimulation is not recommended.
- The Jury believes that the following are to be considered minimum requirements for rehabilitation of TBI patients during the acute stage:
  - repeated postural changes during the day as well as passive mobilization
  - structured monitoring of patients responsiveness
  - respiratory rehabilitation including facilitation of bronchial drainage, progressive weaning off from controlled ventilation and switching to assisted or spontaneous ventilation
  - uniformity and consistency of information given by the medical team to patient's families as well as psychological and organizational (social, home, etc) support
- The Jury also defined criteria of good clinical practice for patient transfer from intensive care units or neurosurgical wards to rehabilitative units. These criteria have been divided into two subsets: a) medical stabilization and b) neurosurgical stabilization. Presence of a tracheostomy tube, central venous catheter, nasogastric tube, gastrostomy tube (i.e. PEG) or seizures not completely controlled by drug



therapy should not be considered contraindications to the transfer to a rehabilitative facility.

- Three separate typologies of TBI patients can be identified on the basis of their level of consciousness, general medical conditions, type and severity of medical complications and expected possibility of recovery. Each group of patients will require a different therapeutic approach.
- Patient's family must be informed and involved in the therapeutic program. Adequate and appropriate information sharing is the cornerstone of good quality care. Thus, medical teams need to be organized to maximize their ability to provide family support and involvement during all the different phases of the disease.
- Although empirical data are lacking on the real efficacy of different organizational models, the Jury recommends a model based on "an integrated network with differential levels of responsibility". This model relies on the identification of primary and secondary levels which apply to both Acute Units and Medical Rehabilitation Units
- The Jury believes it is urgent to inform local and regional health Authorities about the usefulness of setting up adequate monitoring mechanisms aimed at improving knowledge and skills for the care of TBI patients.
- The Jury identified areas of clinical-epidemiological research with highest priority for funding.
- The Jury finally urged Conferences' Organizers to seek the most effective ways to promote discussion, dissemination and implementation of the recommendations that have emerged.



## EVIDENCE-BASED COGNITIVE REHABILITATION: RECOMMENDATIONS FOR CLINICAL PRACTICE

**Keith D. Cicerone**, PhD, ABPP, Brain Injury-Interdisciplinary Special Interest Group, American Congress of Rehabilitation Medicine

Impairments of cognitive functioning are a significant cause of disability after traumatic brain injury (TBI) and stroke, and interventions to reduce cognitive disability are a common component of brain injury rehabilitation. However, there is a need to establish the effectiveness of cognitive rehabilitation and provide standards of practice. The Brain Injury-Interdisciplinary Interest Group of the American Congress of Rehabilitation Medicine has recently developed clinical recommendations for the practice of cognitive rehabilitation, based upon an evidence-based methodology. The process of developing evidence-based recommendations involved the review, analysis and classification of the existing research, and development of practice parameters based upon the strength of available evidence. From an initial review of 655 published articles, 171 studies were fully evaluated and classified according to the level of evidence: (1) well designed, prospective, randomized controlled trials (RCTs) [Class I], prospective, non-randomized cohort studies; retrospective case-control studies; or clinical series with well-designed controls [Class II], and (3) clinical series without concurrent controls, or well-designed studies which utilized appropriate single-subject methodology [Class III]. Of the 171 studies evaluated, 29 were Class I, 35 Class II, and 107 Class III. Of the 29 Class I studies, 20 clearly support cognitive rehabilitation acquired TBI or stroke and several demonstrate an advantage over conventional forms of rehabilitation. No controlled study demonstrated that cognitive rehabilitation was *less effective* than an alternative treatment.

On the basis of evidence from the 20 Class I studies, several *Practice Standards* were established. These included visuospatial remediation of impairments of visual scanning resulting from right hemisphere stroke, and language remediation following left hemisphere stroke. *Practice Standards* for the cognitive remediation for persons with TBI include compensatory memory strategy training for persons with mild memory impairments, and specific interventions for functional communication deficits, including pragmatic conversational skills. *Practice Guidelines* include the remediation of attention deficits for persons with TBI or stroke during the post-acute period of rehabilitation; interventions for specific areas of language impairment, such as reading comprehension and language formulation, after left hemisphere stroke or TBI; programmatic interventions for problem solving deficits for persons with stroke or TBI during the post-acute period of rehabilitation; and the use of comprehensive-neuropsychological rehabilitation to reduce cognitive and functional disability following TBI. A *negative* recommendation was made concerning the isolated use of computers for cognitive remediation. Additional *Practice Options* included the use of assistive technology and compensations directed at facilitating the acquisition of specific skills and knowledge with direct application to functional activities in the

treatment of persons with moderate to severe memory impairments following TBI; and interventions that promote internalization of self-regulation strategies for the remediation of deficits in executive functioning following TBI, including the reduction of problem behaviors in everyday situations. Within the context of a comprehensive-holistic neuropsychological rehabilitation program, it was recommended that improvements in functioning may be achieved by providing an integrated treatment of both individualized cognitive and interpersonal therapies. Unlike many medical interventions, which attempt to reverse pathology, the rehabilitation of persons with acquired brain injury is primarily concerned with reducing levels of disability and handicap, and cognitive rehabilitation should always be directed towards improvements in everyday functioning. In practice, cognitive rehabilitation typically relies upon individually tailored interventions to provide the best available treatment within a clinical setting. The evidence-based review of cognitive rehabilitation provides at least preliminary support for the effectiveness of several forms of this intervention for persons with acquired brain injury due to stroke and TBI. Specific recommendations resulting from this review may help to establish parameters of effective treatment, which should be of assistance to practicing clinicians and suggest additional avenues of clinical research.

#### **Practice Standards**

1. Visuospatial rehabilitation is recommended for persons with visuospatial deficits associated with visual neglect following right hemisphere stroke.
2. Cognitive-linguistic therapies are recommended for the treatment of persons with language deficits secondary to left hemisphere stroke during both acute and post-acute periods of rehabilitation.
3. Specific interventions for functional communication deficits, including pragmatic conversational skills, are recommended for persons with TBI.
4. Compensatory memory strategy training is recommended for persons with mild memory impairments due to TBI.

#### **Practice Guidelines**

1. Remediation of attention deficits which includes varied stimulus modalities, levels of complexity, and response demands is recommended for persons with TBI or stroke during the post-acute period of rehabilitation. There is insufficient evidence to distinguish the effects of specific attention training from spontaneous recovery or more general cognitive interventions for persons with moderate and severe TBI during the acute period of recovery and rehabilitation.
2. For persons with severe visuospatial impairment that includes visual neglect following right hemisphere stroke, scanning training is an important, if not critical, element of the intervention. Visuospatial interventions intended to directly increase visual fields without the development of compensatory visual scanning are not recommended.
3. Cognitive interventions for specific areas of language impairment, such as reading comprehension and language formulation, are recommended after left hemisphere stroke or TBI.
4. Programmatic interventions for problem solving deficits, through the training of



formal problem solving strategies and their application to everyday situations and functional activities, are recommended for persons with stroke or TBI during the post-acute period of rehabilitation.

5. Comprehensive-holistic neuropsychological rehabilitation is recommended to reduce cognitive and functional disability following TBI.
6. Treatment of unilateral left behavioral inattention through the isolated use of microcomputer-based exercises does not appear effective and is not recommended.

### Practice Options

1. Specific interventions directed at facilitating the acquisition of specific skills and knowledge, including the use of memory notebooks or other external aids, may be considered in the treatment of persons with moderate to severe memory impairments following TBI. These interventions should have direct application to functional activities, rather than attempting to improve memory functioning, per se.
2. Persons with visual perceptual deficits, but without visual neglect, after right hemisphere stroke may benefit from systematic training of visuo-spatial and organizational skills as part of their acute rehabilitation. There is not consistent evidence to support the specific effectiveness of visuospatial remediation for persons with left hemisphere stroke or TBI who do not exhibit unilateral spatial inattention, and this intervention cannot be recommended in these cases.
3. Cognitive interventions that promote internalization of self-regulation strategies through the use of verbal self-instruction, self-questioning, and self-monitoring may be considered for the remediation of deficits in executive functioning following TBI, including the reduction of problem behaviors in everyday situations. Such interventions should incorporate detailed neuropsychological and clinical assessment data to identify relevant behaviors for intervention and to make modifications in treatment interventions on the basis of individual patterns of strengths and limitations.
4. Within the context of a comprehensive-holistic neuropsychological rehabilitation program, improvements in functioning may be achieved by providing an integrated treatment of both individualized cognitive and interpersonal therapies.
5. Computer-based interventions may be utilized as part of a multi-modal intervention for cognitive deficits, which includes active therapist involvement in order to foster insight into cognitive strengths and weaknesses, develop compensatory strategies, and facilitate the transfer of skills from the treatment tasks to real life situations. Rehabilitation for cognitive deficits that relies solely on repeated exposure and practice on computer-based treatment tasks without extensive involvement and intervention by a therapist is not recommended.

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## MANAGEMENT OF MODERATE AND SEVERE HEAD INJURY

**Ignacio J. Previgliano**, Asc. Prof. of Medicine - Maimonides University School of Medicine, Chairman Neurotrauma Committee - Medical and Surgical Trauma Argentine Association

Neurotrauma, the so called “silent epidemic”, is the main cause of mortality and disability in the population under 40 years old. It is also the leading cause of years of productive life loss.

Neurotrauma has predilection for young working males between 15 and 30 years old and a notorious inverse relationship with family incomes.

In 1998, in Buenos Aires, Argentina, Previgliano and Ferrari studied the incidence of Head Injury in the Emergency Department of the Fernandez county Hospital. Out of 15300 patients, two percent of the visits (310) were due to Head Injury and out of that, 92% were minor, 4% were mild, and 3.5% were severe, according to Rimel’s classification. Sixty-four percent were male and the average age was  $35 \pm 16$ yo.

This rate of males to females was constant in all different publications.

Even though some studies showed a higher rate of head injury in blacks, we suppose that this finding is related to the poor economic conditions. According to Cooper (8), the rate of injury was inversely correlated to family income. Rates were highest in the lowest income strata and were more often caused by motor vehicles and assaults.

Regarding mortality Torner, in 1996, stated that it was near 1% for minor injury, 18% for mild, and 48% for severe head injury. As regards severe head injury, mortality has been changing since that report.

Which are the factors that lead to that change?

First of all the widespread of the American College of Surgeons ATLS® Courses that improved the initial management of trauma victims. This approach is based on the identification of the sequential variables that could cause the victim’s death:

- A: airway with cervical spine control
- B: breathing (hemo or neumothorax)
- C: circulation (maintenance of blood pressure, control of hemorrhage)
- D: disability (Glasgow Coma Scale)
- E: exposure (examination from head to toe)
- S: secondary evaluation

The GCS will allow to classified head injury victims:

- 13 - 15: Minor
- 9 - 12: Moderate
- 3 - 8: Severe

Severe head injury management have been outlined in different Guidelines (Brain Trauma Foundation and European Brain Injury Consortium). A comprehensive



summary with the results of our experience in 52 patients is outlined in figures 1 and 2. Moderate head injury is an object of controversies. The Italian Society of Neurosurgery excluded GCS 13 patients from minor head injury. A prospective research of our group reveal that there are significant differences in the CT findings between GCS 13 and 14-15 patients, so we included these patients in the moderate group.

Our approach to moderate head injury is based on the clinical status and the CT findings. According to the severity patients are hospitalized in the general ward, in an Intermediate Care Unit or in the Intensive Care Unit.

There are some alternative treatments that have lead to similar morbidity and mortality rates (Cerebral Perfusion Pressure Management, Controlled Hyperventilation, Lund Therapy, Hypothermia).

In spite of all these consideration the best way to treat moderate and severe head injury lays on a simple but complex alternative: PREVENTION.

Figure 1 - Brain oriented resuscitation.

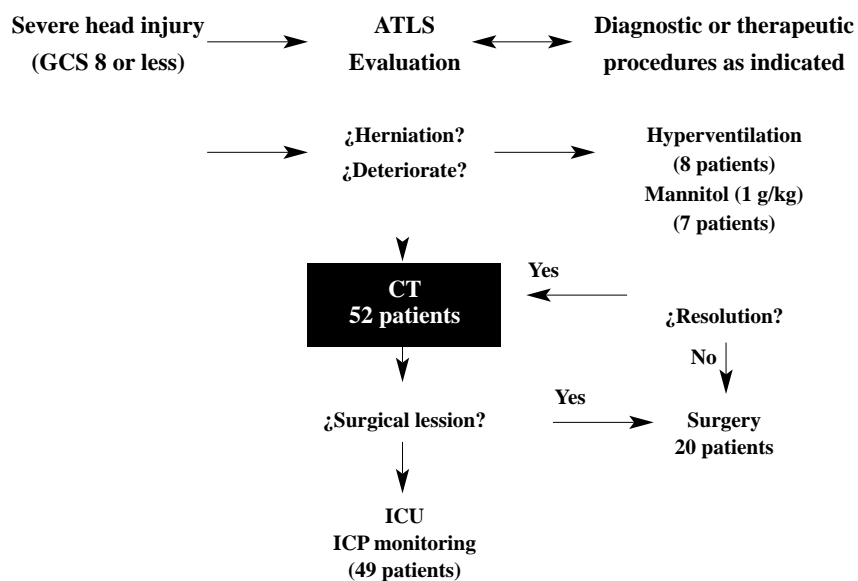
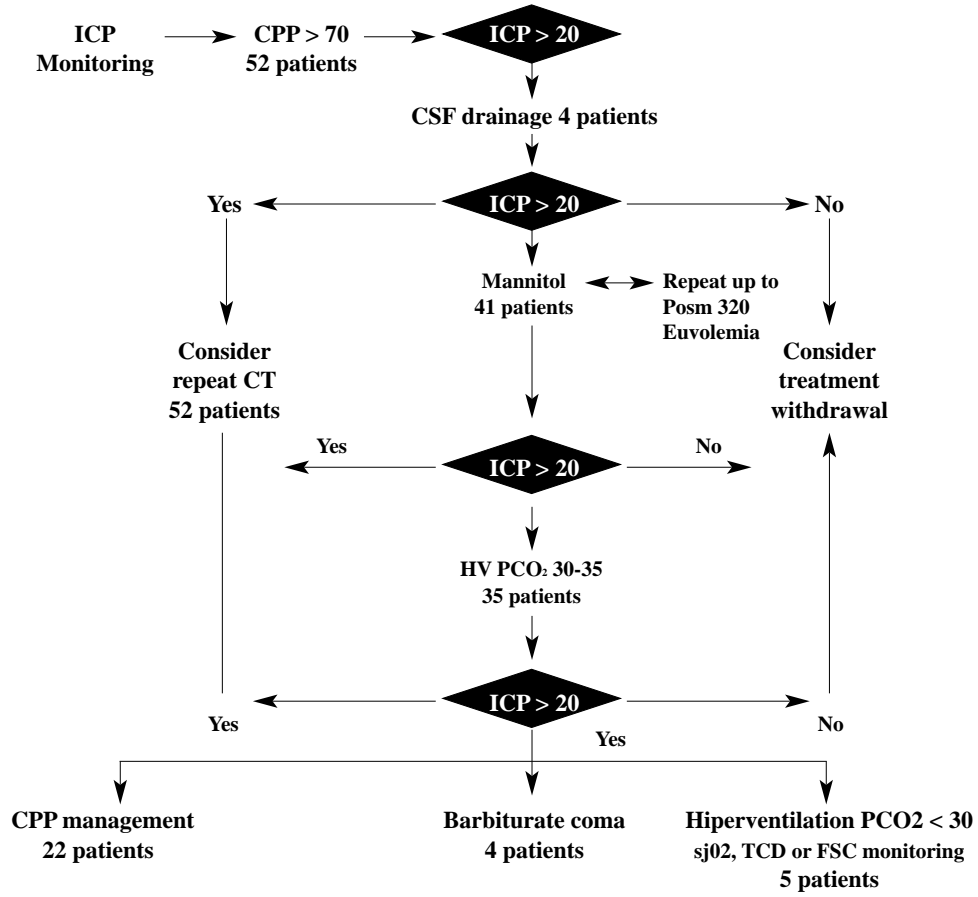


Figure 2 - Algorithm for established intracranial hypertension



**BOTULINUM TOXIN: PRACTICE TRENDS AND CLINICAL OUTCOMES**

**Gerard E. Francisco**, MD, Assistant Professor, Physical Medicine and Rehabilitation, University of Texas Health Sciences Center and, Baylor College of Medicine, Houston, Texas, USA

Associate Director, Brain Injury Program, The Institute for Rehabilitation and Research, Houston, Texas, USA

Botulinum toxin has revolutionized the management of spasticity resulting from cerebral and spinal cord diseases. It has been an attractive treatment option, especially in individuals with brain disorders, who do not tolerate the sedative and cognitive effects of the more traditional oral pharmacologic agents. Over the years, clinical experience and numerous studies have proven its efficacy and safety. The challenge facing clinicians now is to find ways to deliver botulinum toxin therapy in a more effective and cost-efficient manner. This challenge can be met in different ways: 1) improving patient selection; 2) refining injection techniques; 3) enhancing therapeutic effects of the toxin; and 4) providing toxin therapy at the appropriate time. Proper patient selection is important, since therapeutic success depends on how much of the problem is due to spasticity. The decision as to which muscles need to be injected is also critical, and relies on the clinician's knowledge of functional anatomy. Injection technique can be improved by using electromyography or electrical stimulation for more precision, modifying muscle injection site, and possibly, by manipulating the volume of toxin solution injected. The clinical effects of botulinum toxin therapy may be augmented by adjunctive therapies, including electrical stimulation, physical modalities, and exercise. Lastly, delivering toxin therapy at the appropriate time is important for long-term success. It is believed that early intervention results in improvement in functional performance and, perhaps, enhancement in cortical recovery.



**EXPANDING APPLICATIONS OF INTRATHECAL BACLOFEN THERAPY**

**Gerard E. Francisco**, MD, Assistant Professor, Physical Medicine and Rehabilitation, University of Texas Health Sciences Center and, Baylor College of Medicine, Houston, Texas, USA

Associate Director, Brain Injury Program, The Institute for Rehabilitation and Research, Houston, Texas, USA

Intrathecal baclofen therapy (ITB) is an effective and safe treatment of severe, multi-limb spasticity. While it is commonly used in those with traumatic brain and spinal injuries, and in children with cerebral palsy, its efficacy in other conditions is only recently being recognized widely. Individuals with spastic hemiplegia from stroke also benefit from ITB, in terms of reduction in tone, spasms, and pain. Preliminary results of an ongoing study in stroke survivors demonstrate a significant decrease in tone without impairing tone and strength on the uninvolved side. Moreover, ITB can enhance gait speed and pattern. Post-traumatic movement disorders, including dystonia and hemiballismus, can also be helped by ITB by reducing the abnormal movement patterns. Adults with cerebral palsy can also benefit from ITB in spite of earlier interventions, including oral medications, neurolytic procedures, and orthopedic surgeries. Although ITB therapy in brain injury survivors is common, using it in acute (within one year of the onset of brain injury) and chronic (more than ten years after the onset of brain injury) situations is also gaining notice among clinicians. Early use has resulted in decreased signs of dysautonomia and, possibly, enhanced recovery. Initial data showed that early use of ITB did not appear to inhibit recovery from brain injury. Cases to illustrate these claims will be discussed and shown on video.



## PATHOPHYSIOLOGY OF SPASTICITY IN ACQUIRED BRAIN INJURY

**John S. Hong**, MD, MS, Diplomat of Internal Medicine, John Jane Brain Injury Center in Charlottesville, Virginia, USA

Objectives:

1. To understand the basic physiology of the reflex arc.
2. To understand the pathophysiology of spasticity in acquired brain injury (ABI).

Context: Spasticity is a characteristic of the Upper Motoneuron Syndrome. [1] Generally, spasticity occurs in muscles that are over-sensitized to contract when stretched. This hyper-reflexia appears to be velocity dependent. [2-4]

In normal physiology, the segmental reflex arc consists of muscle receptors, the afferent nerve to the spinal cord, and the motoneuron which returns to the muscle. Primary afferent Ia fibers surround intrafusal fibers of the muscle spindle. When the muscle stretches, the spindles are excited and send an impulse up the Ia nerve to the spinal cord. At the spinal cord, the alpha motoneuron stimulates the stretched muscle and its synergistic muscles while the inhibitory interneuron stops the alpha motoneuron to the antagonistic muscles. [2, 5] So the stretched muscle begins to oppose the stretch by contracting itself to create a reflex response. In ABI, there are abnormal proprioceptive reflexes. The increased stretch reflex may be from hyper-excitability of the alpha motoneuron pool at the segmental level possibly due to an imbalance between inhibitory and excitatory inputs and/or motoneurons firing below normal threshold. From the ABI, normal inhibition at the primary afferent nerve terminals may be reduced, such as in the reticulospinal pathway. Another theory is that the motoneurons may be more excited from an increase in depolarization from a supraspinal pathway, such as the lateral vestibulospinal pathway. [2, 6, 7]

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## TREATMENT OF SUPRASPINAL SPASTICITY WITH INTRATHECAL BACLOFEN

*Leopold Saltuari*, MD, Department of Neurorehabilitation Hochzirl, Austria

Supraspinal spasticity occurs as the result of a mismatch of descending facilitation and inhibition secondary to damaged or disconnected cerebral structures. The spinal cord is disinhibited as a consequence of interrupted cortical excitatory input to the medullary reticular formation, the output of which via the lateral reticular spinal tract inhibits spinal reflexes and promotes voluntary movements. Spasticity as one symptom of upper motor neuron lesion responds satisfactorily in less than 50% of these cases to oral antispastic treatment. A new and more effective means of treatment is intrathecal application of baclofen via an implanted drug delivery system.

Our experience in treatment of supraspinal spasticity with intrathecal Baclofen is based on 59 cases, including brain injury, hypoxia, cerebral palsy, degenerative diseases and stroke. The essential criterion for a successful treatment with intrathecal Baclofen is a meticulous evaluation of the patient, taking into consideration not only the reduction of spasticity, but also the consequent change in motor control.

The application of Baclofen during the evaluation phase by external intrathecal catheter allows for observation of the patient over several days. A team consisting of physicians, nurses, therapists, the patient himself and his family thus has time to observe the reactions to the reduction of muscle tone and its effect on therapy.

Other parameters must be taken into consideration, for example bladder control, bowel motility and the risk of seizures.

Intrathecal Baclofen can be an excellent tool for reduction of supraspinal spasticity. However, since spasticity also can contribute to the patient's autonomy, the success of intrathecal Baclofen depends greatly on the experience of the evaluation team, and can only achieve its full potential when combined with an adequate rehabilitation program.



## CONSERVATIVE TREATMENT OF SPASTICITY

1. **Rebecca R. Schock**, MPT
2. **Mary J. Bridle**, MA, OTR/L

John Jane Brain Injury Center, Charlottesville, Virginia, USA

### Objectives:

1. Review conservative measures in the management of spasticity.
2. Discuss spasticity management in the context of client goals.
3. Describe therapist - physician collaboration in spasticity management.

Spasticity is a clinical problem that therapists have struggled with since therapy began. It is a complex problem with both positive and negative characteristics, and the art of good therapy is to maximize the positive while minimizing the negative. It is difficult to understand how the somatosensory, vestibular, and motor systems interact to produce normal movement, and therefore abnormal movement is even more difficult to understand (Fisher & Yakura, 1993). The therapists must treat the client with all of these systems in mind to maximize the functional outcomes. The advent of invasive spasticity management approaches such as dorsal rhizotomy, botox injections, and baclofen pumps demand a good working relationship between physicians and therapists, along with total body movement analysis to ensure optimal functional outcome.

Based on the client - centered evaluation previously described, we focus on the clients' stated priorities using appropriate conservative means to ameliorate their spasticity while maximizing their function. Modalities such as weight-bearing (Chakerian & Larson, 1993; Farber 1982, Stockmeyer, 1980), positioning (Carr & Kennedy, 1992; Fisher & Yakura, 1993), strengthening, range of motion (Sharp & Brouwer, 1997), splinting and casting (Booth, Doyle, & Montgomery, 1983; Cruickshank & O'Neill, 1990; Langlois, Pederson, & Mackinnon, 1991; Yasukawa, 1989) and electrical stimulation (Carmick, 1993; Katz, 1996; King, 1996) are all valid and effective treatment tools that must not be overlooked. In fact, they should be thoroughly explored prior to any invasive procedure.

Traditionally a good therapist - physician relationship is one in which the therapist relays observations from treatment and functional activities to the physician to guide decision - making in regards to invasive procedures. At JJBIC the therapists and physician work closely with the client in clinical decisions regarding spasticity management.

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## SPASTICITY: CLINICAL FEATURES AND ASSESSMENT

1. **Mary J. Bridle**, MA, OTR/L
2. **Rebecca R. Schock**, MPT

John Jane Brain Injury Center, Charlottesville, Virginia, USA

### Objectives:

1. To present an evaluation tool.
2. Discuss the components of the tool.
3. Discuss the inter-relationship between spasticity, positioning, and function.

Spasticity has been variously defined as "...a velocity-dependent response of a muscle to passive stretching" (Lance, 1980 p. 485; Jones and Mulley, 1982 p187) and "...a state of increased of muscle tone with exaggeration of the tendon reflexes" (Basmajain, et al. 1982 p. 1382). There is a paucity of information regarding outcome measures that assess functional changes relative to the changes in spasticity (Hinderer& Gupta, 1996). At the John Jane Brain Injury Center (JJBIC), we have assembled a variety of measures to evaluate the effect of spasticity on function in the context of a client-centered approach. The instrument includes a problem list from the client's perspective, percent of function rated by the client (Brin, 1997), the Modified Ashworth Scale (Bohannon & Smith, 1987), active and passive range of motion, gait, balance, sensory, and activities of daily living assessment. The inter-relationship between spasticity, positioning and function will be briefly discussed with an emphasis on identifying true spasticity from tone variations due to posture or position. The importance of a good working relationship between therapists and physician is emphasized particularly regarding decisions for invasive treatment modalities.

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## CASE REPORT: FUNCTIONAL SURGERY AND GAIT RECOVERY IN BILATERAL EQUINOVARUS FOOT AFTER TRAUMATIC BRAIN INJURY

1. **Franco Molteni**, MD, H. Valduce Rehab. Center "Villa Beretta" Costamasnaga, Lc, Italy
2. **Giulio Gasperini**, MD, H. Valduce Rehab. Center "Villa Beretta" Costamasnaga, Lc, Italy
3. **Antonio De Tanti**, MD, H. Valduce Rehab. Center "Villa Beretta" Costamasnaga, Lc, Italy
4. **Villiam Dallolio**, MD, Neurosurgery Unit H., Lecco, Lc, Italy

### Objectives:

1. Gait recovery.
2. Surgical planning.

## INTRODUCTION

Spastic equinovarus foot is one of the commonest sequelae of traumatic brain injury and causes functional deficits as standing, transfers and walking inability. This case report illustrates the usefulness of functional surgery as therapeutic option for recovery of walking in a brain injured patient with bilateral equinovarus foot.

## METHODS

A 16-year-old boy sustained severe TBI 2 years previously.

Clinical examination revealed spastic diplegia; bilateral equinovarus foot deformity; deambulation for 5 metres with anterior double support (motor FIM:8/35).

Dynamic EMG documented reduced activity of tibialis anterior muscle, bilaterally increased activity of gastrocnemius, soleus, tibialis posterior and flexor digitorum longus muscle.

Surgical treatment: Selective neurothomy of tibialis posterior nerve. Percutaneous lengthening of the Achilles tendon. Flexor digitorum tendon transfer pro ankle dorsiflexion.

## RESULTS

After specific gait training the patient achieved walking ability with cane and assistance less than 25% (motor FIM 20/35; 2 years follow up).

## DISCUSSION

Biomechanical modification at lower limbs after surgery allowed the patient to achieve new motor abilities and specific gait training possibilities. Selective neurothomy of tibialis posterior nerve was preferred to the tibialis posterior lengthening because of the risk of heel valgus; motor branch neurothomy directed to the gastrocnemius and



soleus muscle was performed to reduce the risk of equinovarus foot relapse. Flexor digitorum tendon transfer allowed orthosis free ambulation.

### CONCLUSION

Rehabilitation programs should consider surgical therapeutic options in severe disability due to equinovarus foot. Cognitive functioning, family assistance and the presence of residual hip and knee control are positive prognostic factors for walking recovery.

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## POST TRAUMATIC EPILEPSY PATHOGENESIS

*Andres M. Salazar*, MD, Washington DC, USA

In our search for clues to the pathogenesis of symptomatic epilepsy, traumatic brain injury (TBI) is one etiology which may offer particularly valuable insights. The incidence of post-traumatic epilepsy (PTE) is high: from 5% overall to 25-30% for severe closed head injury, and 51% or more after penetrating head injury (PHI). In addition, PTE usually occurs in otherwise healthy young adults and can be directly linked to their injury, thus eliminating multiple genetic and early life variables. PTE develops over time, suggesting a period of "maturation of the focus" over which certain pathologic processes are presumably evolving in the injured brain. Among injury risk factors which have been associated with PTE are large brain volume losses, hematoma or retained blood, penetrating brain injury, retained (ferric) metal fragments, frontal or temporal location of injury, and certain associated neurologic deficits. Family history does not appear to play a significant role. Other clues to pathogenesis include the failure of prophylactic strategies (using phenytoin, carbamazepine, and phenobarbital) which were largely based on the kindling model of epilepsy. While the kindling model may still yield valuable insights, other relevant pathologic processes occurring in the injured brain include excitotoxic neuronal injury with cellular energy failure, apoptosis, aberrant regeneration, and free radical mediated injury with lipid peroxidation. The latter may be particularly interesting in light of known animal models of iron induced epilepsy and the apparent toxicity of free blood in the injured brain.

Future prophylactic strategies for PTE should focus on understanding and preventing the evolution of these basic pathologic processes induced by TBI, rather than simply suppressing clinical or subclinical epileptogenic activity.



## THE PHARMACOLOGICAL PROPHYLAXIS OF POST-TRAUMATIC EPILEPSY

*F. Monaco*, Department of Neurology, Università del Piemonte Orientale "Amedeo Avogadro", Novara, Italy

Before facing the problem of prophylaxis and treatment of human post-traumatic epilepsy, we must refer to experimental data.

In rats, phenobarbital prophylactically (i.e., before the onset of epilepsy) prevents the occurrence of audiogenic seizures (Servit, 1960), and in guinea pigs with alumina gel epilepsy, "mirror" foci are prevented in a similar manner (Morrell & Baker, 1961). Rapport and Ojemann (1975) suggested that the prophylactic administration of phenytoin might prevent the maturation of the epileptogenic focus in cobalt-induced epilepsy. Animal studies regarding kindling mechanism have also suggested that there may be experimental evidence to support a preventive rationale for anticonvulsivant prophylaxis (McNamara et al, 1989; Wada et al, 1976).

So, encouraged by animal experimentation, retrospective and non-randomized open trials in humans were conducted during the past 30 years with somewhat favorable results (Yablon, 1993), but decidedly less impressive results were observed among randomized controlled perspective investigations. Double-blind, placebo-controlled perspective studies on the efficacy of anti-epileptic drug as prophylaxis of post-traumatic epilepsy failed to substantiate evidence of efficacy for anti-epileptic drugs prophylaxis in late post-traumatic seizures (Penry, White, & Brackett, 1979; Temkin et al., 1990). Most studies used phenytoin as prophylaxis, though similar results were also observed in one trial primarily administering carbamazepine (Glozner et al., 1983). (Table).

**Table:** Summary of Double-Blind, Placebo-Controlled Prospective Studies of the Efficacy of Anti-Epileptic Drugs as Prophylaxis of Post-Traumatic Epilepsy.

Percent Developing Epilepsy			
Authors	Drugs	Control %	Treated %
Penry et al., 1979	Phenytoin	13.0	23.0
Phenobarbital			
Young et al., 1983	Phenytoin	10.8	12.9
Temkin et al.,	Phenytoin	21.1	27.5

Other anti-epileptic drugs, such as valproic acid (VPA), vigabatrin (GVG), or lamotrigine (LTG) might prove prophylactically useful in the future (Anderson et al., 1991).



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## POST-TRAUMATIC EPILEPSY: CLINICAL, NEUROBEHAVIORAL AND RADIOLOGIC ASSESSMENT

1. **Letizia Mazzini**, Dept. of Neurology, San Giovanni Bosco Hospital, Torino, Italy
2. **Elisabetta Angelino**, Psychologist, Fondazione "S. Maugeri" IRCCS, Veruno, Italy
3. **Ilaria Pastore**, MD, University "Amedeo Avogadro", Novara, Italy
4. **Francesco Monaco**, MD, University "Amedeo Avogadro", Novara, Italy

### Objectives:

1. To detect the clinical and radiological characteristics of patients with PTE.
2. To determine the frequency and the characteristics of neurobehavioural and neuropsychological disorders.
3. To define the prognostic value for late clinical and functional outcome.

Post-traumatic epilepsy (PTE) is a relatively common complication of head injury and it has been found to influence the clinical and functional outcome. One hundred and forty patients with severe traumatic brain injury were consecutively recruited. Patients were examined by:

- (1) cognitive and behavioural evaluation which included a clinical interview and psychometric tests performed by an expert clinical psychologist;
- (2) SPECT and NMR;
- (3) functional evaluation including the Glasgow Outcome Scale (GOS) and the Functional Independence Measure (FIM).

Twenty eight patients (20%) developed seizures after a mean time from trauma of 11.5÷8.9 months (Range:1-39). Eight of them were treated with fenobarbital to prevent seizures from the acute phase. The occurrence of PTE was significantly correlated with the degree of hydrocephalus ( $P<.04$ ) and of hypoperfusion in temporal lobes ( $P<0.004$ ), with operative head- injury ( $P<.001$ ), personality ( $P<.0002$ ) and attentive ( $P<.01$ ) disorders, GOS ( $P<.04$ ) and FIM ( $P<.01$ ). The first seizure was generalized in the 75% of patients while focal temporal seizures were more frequent in the recurrence. Status epilepticus complicated the first seizure in 10% of patients. The commonest cognitive and neurobehavioural detected disorders were: disinhibited behaviour (72%), personality disorders (82%), irritability (73%), attentive disturbances (72%) and socialization problems (71%). NMR showed a high incidence of temporal lesions (72% of patients) and with a lower extent of frontal lesions (46%). Right hemisphere was more frequently affected (80%) than the left (40%). In 60% of subjects a severe post-traumatic hydrocephalus was evident. SPECT detected temporal lobe hypoperfusion in 94% of patients.

Our data show that PTE influences the neurobehavioural outcome and the social reintegration after severe traumatic brain injury. Hydrocephalus and temporal right lobe hypoperfusion represent important prognostic factors for post-traumatic epilepsy.



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## POST-TRAUMATIC EPILEPSY IN SEVERE BRAIN-INJURED PATIENTS: PREVENTIVE THERAPY, EEG ABNORMALITIES AND NEW ANTI-EPILEPTIC DRUGS

*R. Formisano, F. Spanedda, V. Vinicola, F. Penta and M.G. Marciani\**

Rehabilitation Hospital, I.R.C.C.S. Santa Lucia, Roma, Italy

\* Neurological Institute, University "Tor Vergata", Roma, Italy

Since many controlled studies have demonstrated the lack of efficacy of prophylactic treatment, the most recent guidelines challenged the utility of preventive anti-epileptic therapy after traumatic brain injury.

Some authors have recommended the utilisation of anti-epileptic drugs, on account of the paroxysmal increase in intracranial pressure during post-traumatic coma, which is postulated to be associated with subclinical seizures (Marianne et al., 1979). Moreover, it is common clinical practice to use phenobarbital for post-traumatic epilepsy (PTE), despite the fact that the focal nature of such epilepsy is well known. The aim of this study conducted on a population of severe traumatic brain-injured patients, was to retrospectively and prospectively assess the incidence of PTE depending on whether patients have or have not received preventive treatment. In the first phase we retrospectively studied 55 patients suffering from very severe brain injury (43 M, 12 F) with a duration of coma lasting longer than 2 weeks. Eight out of the 55 patients retrospectively studied (14.5%) suffered from late PTE, defined as epileptic seizures occurring during the first week after trauma. The incidence of late epilepsy, in a follow-up of at least 2 years after the brain injury, was lower in patients not given prophylactic treatment than in patients treated with preventive antiepileptic therapy (29% versus 13%), though the difference between the 2 groups was not statistically significant. In the second phase of the study we prospectively analyzed, in a population of 82 severe brain-injured patients, the incidence of late PTE, which was present in 27 out of the 82 patients (32.9%). Electroencephalographic (EEG) paroxysmal abnormalities were found in 17 out of the 27 patients with PTE (62.9%). Sixty-nine patients out of the 82 were admitted to our Hospital with prophylactic treatment (84%), with an incidence of late PTE, evaluated 2 years after trauma, of 39.2% (27 out of the 69 patients). In the 13 patients without preventive treatment no patient suffered from PTE 2 years after trauma. In patients without PTE the majority of the patients (76.3%) were treated with preventive therapy but specific EEG abnormalities were present in a higher incidence with respect to not treated patients (30.9% versus 15.3%). In 5 patients, since the traditional anti-epileptic drugs (dintoina and carbamazepine) were not able to control PTE or caused side effects, the new anti-epileptic drugs (lamotrigine and topiramate) led to reach a seizure-free condition in the majority of the patients, with very few side effects and with lower dosage than in idiopathic epilepsy.

Since anti-epileptic drugs may reduce vigilance and cognition, confirmation of these data in larger series of patients may be of considerable interest.



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