MANAGEMENT AND REHABILITATION OF TRAUMATIC BRAIN INJURY IN CHILDREN

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ABSTRACT

Traumatic brain injury is described as a blow to the head or a penetrating head damage which disturb the normal function of the brain. Traumatic brain injuries, in children are common and sometimes are powerful in threatening the life and are leading causes of acquired disability and death. Traumatic brain injury is responsible for nearly 1.4 million injuries and 52 000 deaths annually in the United States. Therefore, in this paper we reviewed the new and recent advances about the management and neuromonitoring in pediatric traumatic brain injury. And to provide a summary of the empirical research on management and rehabilitation in pediatric traumatic brain injury (TBI). Studies of the effectiveness of interventions with children with TBI are hampered by difficulty with combining subjects with various levels of TBI, problems with random assignment to treatment groups, and varying age levels at injury. While these are areas of concern, there are emerging studies that indicate both applied behavioral analysis (ABA) and positive behavioral interventions are helpful to many children. For some children, ABA is not successful, and a shift to positive behavioral interventions has been found to be helpful. Transitions to home and school can be difficult particularly if there are family issues that predated the injury. This review provides additional information for the pediatric neuropsychologist to assist with transition to school and home. Studies utilizing the Internet for family interventions have revealed promising results.

Conclusion: Neuromonitoring technology is still at an early stage in pediatric TBI. These improvements have provided the possibility of true multimodal monitoring for useful treatments. But, using clinical functional neuromonitoring would help clinicians to evaluate the managements in hospitals. Studies have indicated that children with severe TBI show significant difficulties with emotional and behavioral adjustment that pose more challenges for intervention and reentry to home and school compared with cognitive and physical issues.

Key words: Children, TBI, management, rehabilitation,

INTRODUCTION

Traumatic brain injury (TBI) is a leading cause of death and disability around the globe and presents a major worldwide social, economic, and health problem. It is the number one cause of coma. And is the leading cause of brain damage in children and young adults. About 2% of all emergency department visits are due to head injury. It is the leading cause of death among people less than 24 years of age. [١]

Also traumatic brain injury (TBI) is the leading cause of death and disability in children. Statistical analyses shows that almost half of patients with a TBI each year in the United Kingdom are children under 16 years, and approximately one third of the patients with cranial trauma per year in the United States are children aged between 0 and 14 years old. [2]

The most common causes of TBI in children: falls, child abuse, motor vehicle accidents sport accidents, assaults, and instrumental delivery. Regarding age distribution of TBI, there are two risk groups: the first group aged between 0 and 4 years old, and the second 15-19 years old. Boys seem to be affected twice the rate of girls. [٣]

Traumatic pathology during the first 3 years of life is completely different when compared with adults. Langlois emphasized the differentials between children and adults' pathology: "children are not young adults". [2]

In developed countries, pediatric trauma mortality still represents more than half of all childhood fatalities: 18 times more common than brain tumors**.** However, many aspects of pediatric neurotrauma still remain unclear as the literature focusing on the pediatric population is very limited. In fact, guidelines for management of pediatric TBI were mainly derived from adult guidelines. [٤]

Difficulties are frequently seen in cognition, achievement, language, attention, executive functioning, and behavior following TBI particularly in severe cases each of these areas is particularly important for a comprehensive neuropsychological evaluation to determine the strengths and weaknesses of the patient as well as to plan for intervention. The purpose of this article is to provide a brief overview of the research involving rehabilitation following pediatric TBI as well as to present information about transitions from hospital to home and then reentry to school. [٥]

Hence, in this article we studied the previous and new advanced methods of pediatric traumatic brain injury managements and rehabilitation.

Management

It is important to begin emergency treatment within the so-called (golden hours) following the injury. [٦]

A- Minor head injuries: After taking the history and performing the initial examination of patients with minor head injuries (i.e. GCS or PGCS score >14 or LOC 30 minutes), assess whether a skull radiograph is indicated. Indications for CT brain are as follows:

1. History of loss of consciousness or amnesia. 2. Scalp laceration (to bone or > 5 cm). 3. Violent mechanism of injury. 4. Persisting headache and/or vomiting. 5. Significant maxillofacial injuries. [٦]

If the radiographic findings are unremarkable, the patient can be discharged home with head injury instructions. However, the patient should be admitted if any difficulties in assessment occur, as in the following:1. Possible drug or alcohol use. 2. Epilepsy. 3. Attempted suicide. 4. Preexisting neurological conditions (e. g. Parkinson disease, Alzheimer disease). 5. Patient treated with warfarin or who has coagulation disorder. 6. Lack of responsible adult to supervise.7. Any uncertainty in diagnosis. [٦]

B- Mderate head injuries: All patients with moderate head injury (GCS or PGCS score 9-13, PTA (post traumatic amnesia) >1 to <7 days, or LOC >30 minutes to <24 hours) should undergo CT scan of the head and should be admitted to the hospital. If the CT scan findings reveal CNS injury, referral to the neurosurgical unit is imperative. If the CT scan findings are unremarkable, the patient must be admitted for observation. [٦]

A patient with a moderate head injury and normal CT scan findings should improve within hours of admission. If no improvement is noticed, the CT scan should be repeated.

When admitting patients with minor or moderate head injuries without intracranial pathology, the following guidelines apply:

a. Neurological observations should be performed every 2 hours. The patient should take is nothing by mouth until alert.

b. Mild analgesics (e.g. paracetamol, codeine phosphate) and antiemetic can be prescribed if necessary. Avoid phenothiazines because they can lower the seizure threshold. [٦]

C- Severe head injuries (GCS or PGCS 8)*:* The guidelines of treatment of severe head injury proposed by the Brain Trauma Foundation (BTF) [٦] are as in the next table:

Table (1) BTF Guidelines

Recommendation	Level 1	Level 2	Level 3
I. Blood pressure and oxygenation	-	+	-
II. Hyperosmolar therapy	-	+	-
III. Prophylactic hypothermia	-	-	+
IV. infection prophylaxis	-	-	+
V. DVT prophylaxis	-	-	+
VI. Indication of ICP monitoring	-	+	+
VII. ICP monitoring technology	-	-	-
VIII. ICP thresholds	-	+	-
IX. Cerebral perfusion threshold	-	+	-
X. Brain oxygen monitoring and threshold	-	-	+
XI. Anaesthetic, Analgesics and sedative	-	+	-
XII. Nutrition	-	+	-
XIII. Antiseizure prophylaxis	-	+	-
XIV. Hyperventilation	-	-	+
XV. Steroids	+	-	-

- An airway should be established, by the most appropriate means available, in patients who have severe TBI (GCS8) with inability to maintain an adequate airway, or hypoxemia not corrected by supplemental oxygen. Level of evidence 3. [7]

- Early airway management involves providing proper airway position and clearance of debris while keeping C-spine precautions in place until the C-spine has been evaluated and cleared. Appropriate bag-mask ventilation and Endo-tracheal intubation should be used as needed. [8]

- Oxygenation should be monitored and hypoxia (PaO_2 60 mm Hg or saturation 90 %) avoided. level of evidence 2. [7]

- Hypercapnia and hypoxia are both potent cerebral blood flow and volume and, potentially, increased ICP; thus, they must be avoided. Orotracheal intubation allows for airway protection in patients who are severely obtunded and allows for better control of oxygenation and ventilation. [8]

- In the initial resuscitation period, efforts should be made to maintain eucapnia at the low end of the reference range ($PaCO_2$ of 35- 40 mm Hg) and prevent hypoxia (PaO_2 < 60 mm Hg) to prevent or to limit secondary brain injury. Nasotracheal intubation should be avoided because of the risk of direct intracranial injury, especially in patients with basilar skull fractures. [8]

- Special neuroprotective considerations must be given to the choice of medications used to facilitate endotracheal intubation (prevent elevated ICP, minimize cerebral metabolic rate or oxygen consumption, and avoid hypotension). Common medications used in the intubation of patients with traumatic brain injury include etomidate, thiopental, and potentially lidocaine as an added agent. Ketamine is commonly avoided because of its potential for elevating ICP. [9]

- Blood pressure should be monitored and hypotension (systolic BP 90 mm Hg) avoided. Level of evidence 2. [10]

- Aggressive fluid resuscitation with isotonic fluids until euvolemia is achieved. Level of evidence 3. Isolated traumatic brain injury rarely leads to severe hypotension. Other possible injuries (eg, spinal cord trauma), ongoing occult blood loss, and reasons for cardiac tamponade, including hemothorax or pneumothorax, should be identified and quickly treated. [8]

- Manipulation of the head of the bed to optimal levels to decrease venous obstruction may help to control ICP. Traditionally, 30° elevations of the head in midline position are thought to be optimal, although this has not been confirmed by pediatric studies. [9]

- Fever (ie, temperature >38°C or 100.4°F) or hyperthermia is not uncommon following traumatic brain injury. Temperature control through the treatment of fever can aid in decreasing systemic and cerebral metabolic requirements. Fever also decreases the seizure threshold. Efforts should be made to avoid hyperthermia using medications and cooling devices). [10]

- Sedation and analgesia are also important adjuncts to minimize increases in ICP. However, sedatives and analgesics must be judiciously chosen to prevent unwanted side effects (eg, hypotension). Short-acting and reversible medications, such as fentanyl, are commonly used. Short-acting benzodiazepines, such as midazolam, are also commonly used and have the added benefit of increasing the seizure threshold. [11]

- Steroids: in patients with moderate to severe TBI, high dose methyleprednisolone is associated with increased mortality and is contraindicated level of evidence 1

- Head CT scanning should be performed after initial resuscitation in patients with TBI to establish a baseline and assess initial damage. Neurosurgeons evaluate the potential need for surgical intervention, such as evacuation of a hematoma that may lead to intracranial h) hypertension and herniation. Repeat CT scanning should be considered whenever neurologic deterioration or increased ICP persists despite interventions. [11]

D- General lines for TBI management

1- ICP monitoring**:** ICP should be monitored in all salvageable patients with a severe traumatic brain injury (GCS 3-8 after resuscitation) and an abnormal CT scan. Level of evidence 2. [8]

2- Indications for ICP monitoring: All patients with severe head injury (GCS or PGCS< 9) and those patients with moderate head injury (GCS or PGCS 9-12) at increased risk (see below) or who cannot be followed with serial neurological examination (e.g. anaesthetized for other procedure) . [9]

Table (2) Indications for ICP monitoring

Indications for ICP monitoring	**Risk of raised ICP**
Severe head injury (GCS or PGCS 3-8)	
- Abnormal CT scan	50-60%
- Normal CT scan age >40or BP <90mmHg or abnormal motor posturing	50-60%
- Normal CT scan no risk factors	13%
Moderate head injury (GCS or PGCS 9-12) - If anaesthetized/ sedated - Abnormal CT scan	Approx. 10-20% will deteriorate to severe head injury
Mild head injury (GCS or PGCS 13-15) Few indications for ICP measurements	around 3% will deteriorate

a. ICP monitoring is indicated in patients with severe TBI and normal CT scan if two or more of the following features are noted at admission: age over 40 years, unilateral or bilateral motor posturing, or systolic BP 90 mmHg. [8]

b. Continuous ICP monitoring is predominantly used to help target therapies to maintain adequate cerebral perfusion pressure (CPP). Continuous ICP monitoring is also used to minimize intracranial hypertension and to monitor trends in ICP. The exact upper limit of pathological ICP for a given age has not been established, but the general consensus is that treatment efforts should, at a minimum, attempt to keep ICP less than 20 mmHg. [8]

c. Ventricular devices have the added benefit of cerebrospinal fluid (CSF) drainage. [8]

3- CSF drainage: Ventricular drains have long been used for the drainage of CSF in patients with hydrocephalus. With the advent of ventricular ICP monitoring, ventricular drainage for patients with increased ICP has also been commonly used. [9]

4- Hyperosmolar therapy: Mannitol is effective for control of raised ICP at doses of 0.25 g/kg to 1 g/kg body weight. Hypotension (systolic BP 90 mm Hg) should be avoided. Level of evidence. [9]

Mannitol has long been successfully used to treat increased ICP, especially following traumatic brain injury in adults. Mannitol is an osmolar agent with rapid onset of action via 2 distinct mechanisms. [9] Initial effects of mannitol result from reduction of blood viscosity and a reflex decrease in vessel diameter to maintain cerebral blood flow through autoregulation. This decrease in vessel diameter contributes to decreasing total cerebral fluid volume and pressure. This mechanism of action is transient (lasting about *75* mm) and requires repeated dosing for prolonged effect. Mannitol exhibits its second mechanism action through osmotic effects. It increases serum osmolality; thus, water is shifted from intracellular compartments to the intravascular space, and cellular edema is decreased. Although slower in onset, this mechanism lasts up to 6 hours in duration. [9]

Pitfalls of mannitol include its potential to accumulate in regions of cerebral vascular interruption and cause a reverse osmotic shift, therefore increasing brain edema and increasing ICP; this risk is reported with continuous infusions. For this reason, intermittent mannitol boluses are recommended. Also, mannitol has been linked to acute tubular necrosis and renal failure at serum osmolality levels greater than 320 mOsm/L. [9]

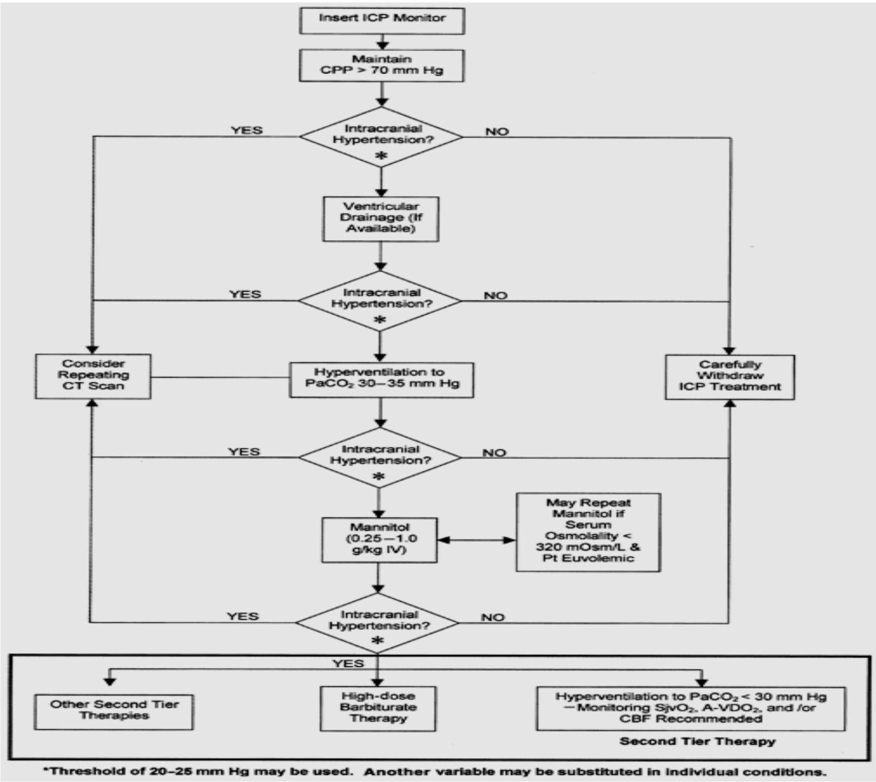

Fig. (1) Critical pathway for the treatment of established intracranial hypertension in traumatic brain injury, according to the Society of Critical Care Medicine guidelines. GCS = Glasgow Coma Scale; ICP = Intracranial Pressure; CPP = Cerebral perfusion pressure; HOB = Head of bed; CSF Cerebrospinal fluid; PRN = as needed. [9]

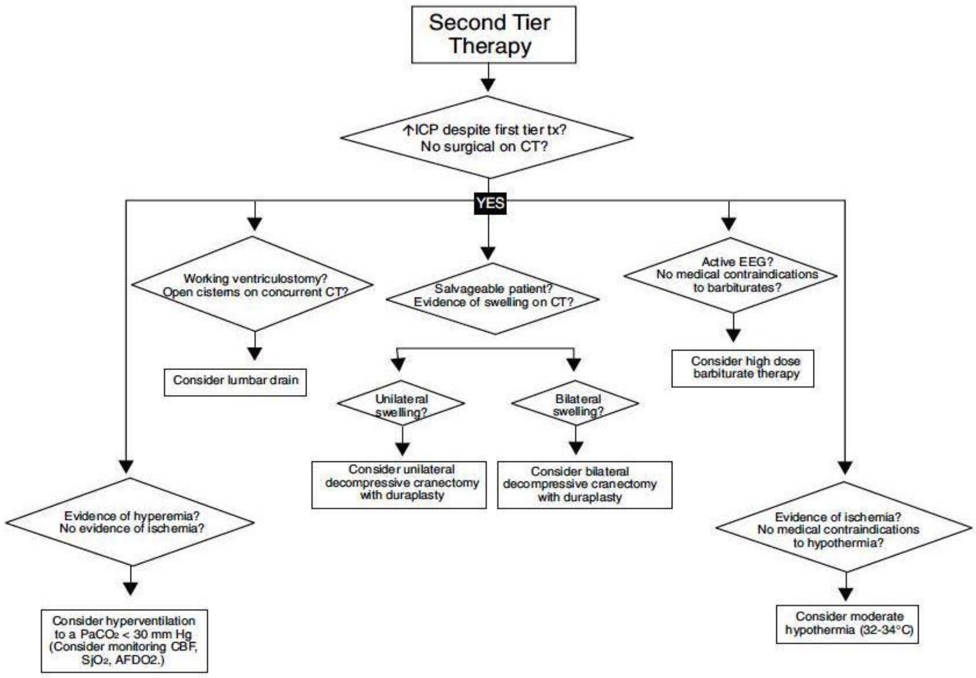

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Fig. (2) Second tier therapy for the treatment of established intracranial hypertension in traumatic brain injury according to the Society of Critical Care Medicine guidelines. ICP = Intracranial pressure; CBF = Cerebral blood flow; Sj2 Jugular venous oxygen saturation; AJDO2 = Arterial-jugular venous difference in oxygen content. [8]

More recently, hypertonic saline has been shown to be an effective therapy for intracranial hypertension following pediatric traumatic brain injury. Hypertonic saline, typically 3% saline, has an osmolar mechanism of action similar to that of mannitol, without the diuretic effects.42 Added theoretical benefits of hypertonic saline include improved vasoregulation, cardiac output, immune modulation, and plasma volume expansion. [10]

Patients using hypertonic saline have tolerated serum osmolalities of as much as 360 mOsm/L. However, in the author's institution, reversible renal insufficiency has been noted with the use of hypertonic saline when serum osmolality approached 320 mOsm/L, thus, caution should be used. [10]

Risks of hypertonic saline administration include rebound intracranial hypertension after withdrawal of therapy, central pontine myelinolysis with rapidly increasing serum sodium levels, subarachnoid hemorrhage due to rapid shrinkage of the cerebrum and tearing of bridging veins, and renal failure. [10]

<u>5- Hyperventilation</u>: Although ventilation at the lower end of eucapnia may be beneficial in decreasing ICP hyperventilation has the potential to reduce ICP via reflex vasoconstriction leads to decreased cerebral blood flow, decreased overall cerebral fluid volume, and, therefore, decreased ICP. [12]

In cases of refractory intracranial hypertension, mild hyperventilation (PaCO2 of 30-3 5 mm Hg) may be beneficial in decreasing ICP. Level of evidence 3. [12]

Excessive hypocapnia may lead to ischemia secondary to insufficient cerebral blood flow Ensuing respiratory alkalosis also shifts the hemoglobin-oxygenation dissociation curve to the left, making release of oxygen to tissues more difficult. [8]

Although aggressive hyperventilation (PaCO2 <30 mm Hg) may be necessary in emergency situations such as impending herniation in a patient with Cushing's triad (hypertension, bradycardia, and irregular respirations), it is not commonly used as a prolonged therapy for the reduction of ICP due to its association with worse long term neurologic outcomes. [8]

6- Barbiturates: High-dose barbiturate administration is recommended to control elevated ICP refractory to maximum standard medical and surgical treatment. Heamodynamic stability is essential during barbiturate therapy. Level of evidence 2. [11]

The use of high-dose barbiturate therapy, such as pentobarbital, has been successful in the management of increased ICP. This class of medication suppresses cerebral metabolism, thus decreasing oxygen demand. Barbiturates also have the added benefit of neuroprotection through mechanisms such as inhibition of free radical lipid peroxidation and neuronal membrane disruption. It showed be noted that barbiturate therapy in the patient with TBI requires continuous FEG monitoring. With EEG monitoring, barbiturate infusions may be titrated to achieve burst suppression. [11]

Despite the potential benefits of barbiturates, their adverse affects on the cardiovascular system limit their use to refractory intracranial hypertension Barbiturates may cause both myocardial depression and hypotension that requires fluid resuscitation and inotropic support; ability to perform neurological examination is also lost when barbiturates are used to control ICP. Additionally, barbiturate therapy may result in immune suppression, leading to sepsis and ileus with subsequent feeding intolerance. [11]

7- Hypothermia: Hyperthermia has long been correlated with poor outcome in patients with traumatic brain injury, and control of fever is an important initial intervention to limit secondary brain injury. More recently, induced moderate hypothermia (32-34°C, 89.6-93.2°F) has emerged as a potentially useful strategy. A recent phase II clinical trial demonstrated that 48 hours of moderate hypothermia initiated within 6-24 hours of acute traumatic brain injury reduces ICP and was "safe," although a higher incidence of arrhythmias (reversed with fluid administration or rewarming) and rebound ICP elevation after rewarming were reported. Until further clinical studies are performed, moderate hypothermia is reserved for patients with persistent intracranial hypertension refractory to other medical interventions. Problems associated with hypothermia include increased bleeding risk, arrhythmias, and increased susceptibility to infection and sepsis. [11]

8- Decompressive craniectomy: When medical therapies for treatment of intracranial hypertention remain refractory, decompressive craniectomy is a surgical option. Patients typically undergo this procedure within the first 48 hours of initial injury. [11]

9- DVT prophylaxis: Graduated compression stockings or intermittent pneumatic compression (IPC) stockings are recommended, unless lower extremity injuries prevent their use, use should be continued until patients are ambulatory. Level of evidence 3. [8]

10- Antiseizure prophylaxis: Anticonvulsants are indicated to decrease the incidence of early post-traumatic seizures (within 7 days of injury). Level of evidence Prophylactic use of phenytoin or valproate is not recommended for preventing late post-traumatic seizures. Level of evidence 2. [13]

11- Nutrition: Patients should be fed to attain full caloric replacement by day 7 post-injury. Level of evidence 2. [14]

The use of steroids is not recommended for improving outcome or reducing ICP in patients with TBI. Level of evidence 1. [10]

12- Prognosis: The prognosis for pediatric head injuries differs from adult patients due to the child's skull flexibility and pliability, reduced subarachnoidn space, different metabolic responses to injury, differences in fluid and edema removal rates, and long term effects from axonal injury. Pediatric skulls are more flexible and so provide less protection to underlying brain, resulting in more brain injury for the same amount of force applied, as compared to an adult skull. The reduced pediatric subarachnoid space allows the brain to move more freely within the skull. Additionally, young children have a larger head-to-body ratio and less neck control/ musculature than do adults. Therefore, it is more likely for a child to suffer a more severe head injury than an adult given the same mechanism and forces. [15]

Children generally have a better prognosis than adults do after the same injury, although prognosis is probably age and injury-dependent. Notably, inflicted brain injuries have worse outcomes and are the most common cause of head injury deaths. [16]

Prognosis worsens with the severity of injury.46 Permanent disability is thought to occur in 10% of mild injuries, 66% of moderate injuries, and 100% of severe injuries.47 Prognosis differs depending on the lesion type. Subarachnoid hemorrhage approximately doubles mortality. [17]

Subdural hematoma is associated with worse outcome and increased mortality, while people with epidural hematoma are expected to have a good outcome if they receive surgery quickly. [18] Diffuse axonal injury is often associated with coma and poor outcome. [19]

Pediatric Traumatic Brain Injury Rehabilitation and Transition to Home and School

RECOVERY VARIABLES

Research on the outcome of TBI has found difficulties with disinhibition, irritability, aggression, anger dyscontrol, social deficits and withdrawal, and depression to be commonly associated with poorer outcome following TBI. [20]

It has been estimated that a sizable majority of children with severe TBI experience difficulties following head injury, not present before injury, that persist at least 2 years post-injury**.** Most importantly, these difficulties have been found to interfere with quality of life into adulthood more than cognitive or physical disabilities. [21]

For children with mild head injury, difficulty with irritability has been seen to persist 12 months after injury in one-third of cases. Aggression has also been found to be present in 33% of children with TBI and appears to be independent of level of injury. [22] A review of intervention articles following TBI suggests that children (and adults) show more externalizing behaviors following TBI in general. [20] Age at injury, however, appears related to a higher incidence of internalizing symptoms when the child is injured before the age of 6, with externalizing behaviors increasing in this population with age. [23]

INTERVENTIONS

There are very few studies of intervention outcome solely for children and adolescents. Most of the intervention studies available are completed with adults and yield varying results. A National Institutes of Health panel studied the cognitive rehabilitation literature as to the effectiveness of various treatments. Findings indicated that the understanding of cognitive rehabilitation outcomes was complicated by the heterogeneity of participants, interventions used, and diversity of outcome measures. Recent systematic reviews have suggested that direct attention training, specific treatments of visuospatial deficits, long-term cognitive therapy, and learning of compensatory techniques have been found to be successful interventions for adults. [24]

Interventions can be divided into two classes:
(1) Direct intervention to retrain cognitive processes.(2) Teaching of compensatory skills.

In the first approach, direct intervention is given to individual cognitive processes, while the second approach involves reteaching and training based on cognitive skills that are intact. In the first approach, it is hypothesized that damaged neural networks can be retrained if partially spared from injury. These interventions are frequently used immediately following recovery from the injury. The second approach teaches skills to manage tasks that are present in everyday life, such as driving, balancing a checkbook, and using a computer, and assumes that functional brain reorganization will occur with this training. [25]

Two large reviews of the literature on head injury concluded that, for adults, empirically valid interventions are present for treatment for attention, executive functioning, and functional language impairments following TBI as well as for teaching of memory strategies. [26]

Although an updated meta-analysis from these authors combining both child and adult studies also found empirical evidence for attention training following TBI, the effect size was significant but small for attention improvement. [27]

The effectiveness of direct training in memory strategies was not found in this third meta-analysis. A meta-analysis of behavioral interventions following TBI utilized both adult and child studies. [20]

Approximately one-third of the 65 studies reviewed involved children or adolescents, and out of these studies, more than half were case studies. Thus, the conclusions from this review need to be viewed cautiously. Findings indicated that traditional applied behavioral analysis (ABA) and positive behavior support are helpful and empirically valid approaches. These approaches, although evidence-based treatment options, also suffered from significant methodological concerns making the findings somewhat tentative. Difficulties with definitions of the sample employed, varying outcome measures, and lack of random assignment to treatment groups were some of the methodological concerns. Within the traditional ABA approach, the focus was on specific behaviors with emphasis on increasing the frequency of positive behaviors and decreasing negative behaviors with additional emphasis on a consistent application of consequences for behaviors. [20]

Most commonly used interventions included reinforcement of positive behaviors, token economies, time out, and ignoring of negative behaviors. In addition, extrinsic reinforcers were used to support and increase targeted behaviors. Desired behavioral changes were set up in a sequential manner building on strengths and previously mastered skills and moving toward transfer of the behavior to new environments.

Most of these interventions were provided by specialists within classrooms, residential treatment settings, or clinics. In contrast to the ABA treatments, the positive behavior intervention focused on lifestyle changes that are important to the client and caregivers with secondary focus on target behaviors. [20]

While the focus for ABA was on external control, the focus for positive behavior intervention was on internal control. It was also frequently combined with training in executive functioning. In addition to evaluating the person's behavior, positive behavioral intervention also evaluates the environment of the person and lifestyle variables. Moreover, there is focus on structuring the environment to be as positive as possible and to increase choice and control for the client as progress is made. These interventions are most often provided in community settings with the caregivers providing much of the intervention supported by specialists. [20]

Ylvisaker et al. (2007) found that both ABA and positive intervention strategies can be effective for treatment. What is not obvious from the comparison is which treatment is appropriate for which individual or for which specific brain injury. Further study on type of individual, time from injury, and type of behavior problem is needed to determine appropriate interventions. In addition to these concerns, it is likely that interventions that are appropriate for older adolescents or young adults may not be as appropriate or helpful for younger subjects. This concern was not evaluated in the Ylvisaker et al. (2007) review of the existing literature. Support for this conclusion comes from studies finding that a contingency technique may not be helpful for a particular individual who may, in turn, respond well to a positive behavioral intervention. [20]

Ylvisaker (2001) found that using cognitive behavioral interventions that are coupled with positive behavior supports were successful with two young children with severe TBI and increasingly challenging behaviors. Such a combination of positive behavior intervention and ABA is likely appropriate for many children and adolescents. Although there is emerging evidence that this combination may be efficacious for children and adults with TBI, additional empirical study is needed. One aspect that requires additional study, similarly to the intervention issue, is transition from hospital to home, family intervention, and support during this process as well as family support during transition to school. A survey of researchers and professionals involved in the care of children and adolescents with TBI identified these transitions as understudied. [28]

Such transitions to home can be difficult particularly if there are challenges the family is facing beyond the TBI. The following section discusses issues in the transition to home from the hospital. One aspect that requires additional study, similarly to the intervention issue, is transition from hospital to home, family intervention, and support during this process as well as family support during transition to school. A survey of researchers and professionals involved in the care of children and adolescents with TBI identified these transitions as understudied. [28]

TRANSITION TO HOME

It is very important to recognize that there are significant stressors on the family unit following TBI, particularly when the injury has been severe. Families of a child with severe TBI who have a history of significant discord and stress prior to the accident are at highest risk for experiencing additional difficulty following the injury. Conversely, families with a history of good communication and cohesiveness generally have a more favorable outcome. Research is emerging that the main predictor for a good outcome may not be the injury itself but rather the child's environment following such injury. [29]

Similar to the finding those premorbid behavioral and personality disturbances are predictive of similar problems after the injury; family discord prior to an injury is highly predictive of divorce, social isolation, and substance abuse following the TBI. [30]

It has been suggested that there are two burdens that families experience during the recovery of their child which are objective and subjective. Objective burdens include the child's neuropsychological and cognitive deficits, while subjective burdens are those that concern the level of distress experienced by family members. The mother of the child with TBI often experiences the subjective burden more than other members of the family, and this emotional toll often is more predictive of family distress compared with the objective burden. The outward expression of these subjective burdens includes frustration, anger, liability, depression, and overprotection. The subjective burdens increase throughout time, with eventual outcomes including divorce, substance abuse, and social isolation. Interventions that families report to be most helpful include information about the child's health, educational programs available to the child, and community agencies available for assistance. Understandable information about the child's injury and nature of deficits was also deemed important. This information may need to be repeated frequently with additional details and depth provided as the child recovers. Too many details or too much information at one time may serve only to confuse rather than provide assistance. (31)

It is important to inform parents that recovery is not an all-or-none process. Some skills will recover fairly quickly while others may require several months to reappear. Another area that is important to evaluate is whether the parent needs a respite from the child's and encouragement to look after their own emotional health. Parents of children with severe TBI are at high risk for developing affective disorders as well as marital discord and even divorce. It is also important for the parent to recognize that the child may resist some of the assistance provided and may confront the parent in ways that are uncomfortable and difficult to manage. (32)

Studies of interventions that involve self-guided Web-based materials as well as videoconferencing with families are emerging. These interventions are unusual as they include random assignment to treatment. In one study, families were randomly assigned to an online family problem-solving group while others received Internet resources. (33)

Findings revealed less global distress particularly in depressive symptoms and in anxiety at follow-up in the children in the family problem-solving group compared with the resources group. In addition, children in the family problem-solving group showed improvement in problem-solving skills. Similarly, another study conducted by the same authors compared an online family problem-solving group to an Internet resources comparison group for families with a child with moderate-to-severe TBI. (33)

The family problem solving group showed more improvement in child self management and compliance with adult directions at follow-up compared with the resources group. The greatest improvement was found for children who were older or who came from a lower socio-economic status (SES) An area of importance for working with families as the child transitions from hospital to home to school is to develop a home-school partnership. Success with the transition to school is dependent on the ability of the school and parent to reach a common understanding, to be flexible in adjusting to changing demands from the child, and to find appropriate supports within the school and community. (5)

The ability to utilize home-school partnerships is particularly important for a smooth transition to the school setting and for the adjustment of the educational plan as needed. The use of conjoint consultation to assist with problem resolution is particularly important and has been found helpful. The child's needs are dynamic and ever changing, and such a partnership allows for the adjustment of techniques that may not be optimal. These partnerships evolve throughout time and with care and nurturing and provide a safety net for the child as well as direction for future requirements. (5)

PROMOTING REENTRY INTO THE SCHOOL SETTING

Successful reentry into the school during the recovery process requires the coordination of all systems in the child's life: home, school, and medical. The past emphasis in rehabilitation has basically centered on restoring physical functioning to the neglect of social-emotional and behavioral recovery. It is estimated that 70% of children with severe head injuries and 40% of those with moderate injuries will require some special education services due to residual disability. Based on the literature, approximately 20% of children with history of a head injury had special education needs that predated the injury. (34)

Placements can range from residential treatment, to homebound instruction, to school entry with modified day. For most children, a stepwise transition to school is very helpful beginning with a half-day placement with time in school increasing during recovery. Aspects that have been found to be predictive of successful school reintegration include: (1) Ability to attend to classroom instruction(2) Ability to understand and retain information (3) Ability to reason and express ideas (4) Ability to problem-solve (5) Ability to plan and monitor one's own performance (6) Self-control. (35)

For successful reentry into school, early planning is required among professionals in the hospital setting and those in the school. Information that is most helpful includes what types of tasks the child=adolescent is currently able to complete as well as those that may develop at a later time. The individual education plan (IEP) developed for discharge needs to include the levels of performance, goals, and objectives (short and long term), need for related services (occupational therapy [OT], physical therapy [PT], speech and language therapy), the anticipated duration of services, and methods for evaluation of the child's progress. Additional information may include whether there is a recommendations for a half or full day of school; medications and their side effects; therapy required; emotional and behavioral functioning; physical plant accommodations that may be needed; and methods that have been successful in working with the child. In addition, a plan needs to be made to provide for additional communications among the team members. [35]

Systems Issues in School Reentry

One of the main predictors for good outcome from TBI is the recognition of possible difficulties in the system that may impede the child's progress. Particular areas of systems concern include the school environment, teacher flexibility, and number and quality of peer interactions that occur. [36]

Learning environments have also been found to be the key in assisting the child with the transition to the school. Aspects of the classroom that have been found to be important include whether the classroom is structured or unstructured, whether the work is mainly independent or teacher led, and the use of classroom materials in related services such as OT, PT, and speech and language therapy. [37]

CONCLUSION

Neuromonitoring technology is still at an early stage in pediatric TBI. These improvements have provided the possibility of true multimodal monitoring for useful treatments. In this regard, more investigations are required to determine whether these modalities and procedures in technology with noninvasive monitors will allow early and reliable diagnosis of reversible secondary brain insults. But, using clinical functional neuromonitoring would help clinicians to evaluate the managements in hospitals.

In summary, studies have indicated that children with severe TBI show significant difficulties with emotional and behavioral adjustment that pose more challenges for intervention and reentry to home and school compared with cognitive and physical issues. Improvements with intervention have been found in the areas of attention, in the teaching of memory strategies, and in the improvement of visual-spatial skills. Short-term memory and language skills continue to be difficult to remediate. In addition, irritability, aggression, and social isolation have been found in children and adolescents with TBI and appear to increase with time possibly due to increased frustration as skills do not return to normal for the child. Difficulties with mood liability, aggression, and social isolation interfere with emotional development. Such problems often extend into adulthood and negatively impact vocational and personal adjustment. There is a significant lack of controlled studies to inform what interventions are appropriate for which types of disabilities.

Areas of future research include continuing use of the Internet to provide support to families and individuals. In addition, controlled studies of empirically validated interventions need a great deal of expansion. Support

of families as well as school personnel may prove crucial for assisting in the recovery from TBI. Many schools are utilizing neuropsychological services to educate teachers and school psychologists in TBI and to modify curriculum to meet the child's needs. Pediatric neuropsychologists can assist and expand their practices, through consultation with schools and partnering with schools for assessment and treatment of children with TBI. The findings from intervention studies and those from studies on reentry of children=adolescents with TBI also indicate the need for training of pediatric neuropsychologists in family work and in school consultation. These are exciting avenues that a neuropsychologist may take to expand practice and research endeavors.

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خطوات العلاج وأعاده التأهيل فى اصابات المخ عند الاطفال

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مقدمه: اصابات الدماغ عند الاطفال هى السبب الرئيسى للوفاه والعجز بعد صدمه عصبيه حاده فى هذه الايام، وطريقه الاصابه من الناحيه الباثولوجيه عند الاطفال مختلفه تماما فى اول ٣ سنوات عن البالغون ومازالت الكثير من جوانب علم الاصابات العصبيه غير واضحه حتى الان ولذا ركزنا فى هذا المقال على الطرق الجديده للتعامل مع اصابات المخ عند الاطفال واساليب العلاج الحديثه فى اعاده تاهيل المصاب خاصه فى المراحل المختلفه من حياته وفى ما يتعلق بتنامى الحواس المختلفه والتطورات الحركيه والعصبيه والاجتماعيه عند هؤلاء الاطفال.

التعامل مع اصابات المخ : انه لمن المهم جدا التصرف فى الساعات القليله التى تلى اصابات المخ عند الاطفال حيث يطلق عليها الساعات الذهبيه لما تمثله من اهميه فى الناتج النهائى من الشفاء حيث يتم السؤال عن طريقه اصابه المريض واخذ تاريخ كامل بالاصابه ويتم تقييم حاله المريض عن طريق مقياس جلاسكو للغيبوبه ويتم عمل الاشعات اللازمه من اشعه مقطعيه على المخ واخرى متعلقه بالاصابات الاخرى فى الجسم وبالنسبه للاصابات الشديده للمخ يتم التعامل معها وفقا لخطوط (BTF) حيث يتم التعامل مع مجرى الهواء والتاكد من سلامته والتزود بالاكسجين ويتم اللجوء الى عمليات الانعاش للقلب والصدر عند اللزوم. يتم استخدام الادويه المهدئه عند الحاجه اليها ومتابعه ضغط الدم وتزويد المريض بالمحاليل اللازمه ويتم مراقبه ضغط السائل النخاعى بالمخ حسب الحاجه ويمكن التخلص من بعض هذا السائل عند ارتفاع الضغط عن المطلوب كما يمكن استخدام مجففات السائل حول المخ مثل المانيتول فى بعض الاحيان يتم استخدام رفع سرعه التنفس عن طريق التنفس الصناعى ويتم المحافظه على درجه حراره المريض ووقايته من جلطات الاورده العميقه والتشنجات المحتمله ويتم امداد المريض بتغذيه وريديه كامله وفى بعض الاحيان يحتاج الى عمليه جراحيه لازاله ضغط النزيف عن المخ.

اعاده تاهيل المريض: ان الابحاث المتعلقه بما بعد الاصابات العصبيه للمرضى الاطفال وجدت الكثير من الاندفاعيه والعدوانيه والتوتر وعدم القدره على السيطره على الغضب وعدم الاندماج بالمجتمع ولا شك ان هذه الصعوبات تسبب خللا كبيرا فى حياه المريض وحتى مرحله النضوج اكثر من الصعوبات التى تسببها الاعاقات الفيزيائيه والحركيه الناتجه عن اصابات المخ. وبالنسبه للتدخلات العلاجيه لعلاج اثار ما بعد الاصابه العصبيه بالمخ فمعظم الدراسات المتعلقه بها تخص البالغين والقليل منها فقط عن الاطفال وتنقسم تلك التدخلات الى خطين الاول مباشر وهو محاوله استعاده القدرات الحركيه والعصبيه للجزء المصاب والثانى غير مباشر وهو محاوله خلق مهارات جديده للاعضاء التى لم تطالها الاصابه. الكثر من الدراسات التى اجريت اثبتت فاعليه نظام التحليل التقليدى للسلوك والتصرفات (ABA) استنادا الى نتائج علميه مثبته وموثوق منها ويعتمد هذا التحليل على تنميه التصرفات الايجابيه والعمل على انحسار التصرفات السلبيه وايضا العمل على توفير الظروف البيئيه المناسبه حول المريض ويتم كل ذلك بواسطه اجتماعيين متخصصين. ومما لاشك فيه ان نقل المريض الى اسرته هو احد اهم الصعوبات التى يجب تخطيها وخاصه اذا علمنا ان محيط اسره المريض من اهم عوامل وبالنسبه لمرحله النقل الى المدرسه لهؤلاء الاطفال فهو يحتاج تضافر جهود الاسره والمدرسه والفريق المعالج وخاصه ان نسبه كبيره من هؤلاء الاطفال يحتاجون نوعا خاصا من المدارس.

الاستنتاج :البحث فى اصابات المخ عند الاطفال والتاهيل اللذى يليها ما زال يحتاج الكثير من البحث وخاصه فيما يتعلق بالجوانب النفسيه والغير ماديه بينما البحث الاكلينيكى والعلاجى فقد توصل الى نتائج مفيده نوعا ما وبصفه عامه فان الابحاث المجراه اثبتت ان الاطفال المصابين باصابات المخ يواجهون الكثير من الصعوبات الماديه والنفسيه عليهم وعلى اسرهم ومجتمعهم وهناك الكثير من الوسائل لمساعدتهم ولكنها تحتاج الى التنظيم والتعميم لتحديد التدخلات المطلوبه بدقه بالنسبه لكل حاله ويجب التوسع فى انشاء المدارس الخاصه بهؤلاء الاطفال وكذلك الاهتمام بتدريب متخصصين فى هذا المجال لتحقيق اكبر فائده ممكنه.