TRAUMATIC BRAIN INJURY

by Respiratory Care Student Jerolyn Patterson

Traumatic brain injuries (TBI) are the leading cause of disability in the United States and are one the most common reasons for neurological illness. TBI is "an injury to the head that temporarily or permanently disrupts the normal function of the brain" (Merck, p.1427). Included in this category are cerebral vascular accidents, contusions, skull fractures, introduction of foreign bodies into the cranial cavity and many other neurological injuries. Special considerations for the cerebral composition is the main focus for initial intervention and subsequent management.

In order to understand the dynamics of the damage caused by brain injury, it is first important to know that the brain is an enclosed organ whose blood supply is separate from all other body systems. Indeed, the blood brain barrier is selective in what body chemicals it allows to enter the brain. Gases such as oxygen and carbon dioxide can readily cross this barrier; however, many other substances cannot (e.g. antibodies hormones). Unfortunately, when the protective mechanisms are breached by injury an inflammatory response occurs. The inflammatory response is a compensatory reaction to aid healing; however, in the brain this can be catastrophic. Vasodilatation of blood vessels makes the influx of cells needed to repair the injured area(s) possible, but it can cause increased intracranial pressure (ICP), decreased brain oxygenation (PbrO2), cerebral blood flow (CBF) and cerebral perfusion pressure(CPP).

The management of brain injuries acutely focuses on stabilization. Ensuring adequate oxygenation decreases the risk of further damage. It is extremely important to sustain appropriate ICP, PbrO2, CPP and CBF . The balance that is required to sustain these indices must be addressed promptly to arrest further brain damage. Providing and/or maintaining a patent airway is the first intervention in acute critical care. By doing so, adequate ventilation and oxygenation can be maintained. Consideration for all other injuries especially those that could potentially affect respiration, must be addressed immediately. Intubation with mechanical ventilation may be utilized, as well as infusions to increase blood volume. These interventions should be carefully inducted in an effort to minimize increases in ICP.

In the past, emphasis was placed on lowering PaCO2 levels by hyperventilation. This modality of treatment works by increasing the CPP and decreasing the ICP. Normal ICP ranges from 1-15 mm Hg under normal circumstances; however, a person who has sustained brain injury can greatly exceed this range. ICPs ranging from 20-40 mm Hg are a good indicator of diminished neurological function; pressures exceeding 60 mm Hg are lethal. It has been found that brain tissue oxygenation (PbtO2) decreases can promote additional brain injury. Decreasing ICP and increasing CPP are still the goals of early intervention but the new emphasis is on increasing or maintaining adequate PbrO2.

Continuous or episodic periods of cerebral anoxia can create an environment conducive to death of brain cells. Normally the brain uses 20-25% of the oxygen in the body, and to ensure normal performance this supply must be continuous. When injured the need for oxygen is not diminished. Anoxic episodes result in utilization of the small oxygen stores to metabolize glucose. The by-products of anaerobic metabolism in the brain are toxic to the delicate biochemistry needed for neural cell survival. Studies have revealed a link between adequate PbrO2 levels and favorable outcomes. Hyperventilation has been shown to increase the risk of hypoxia by decreasing the flow of blood to the brain tissue thus increasing the risk of subsequent injury such as ischemia. In the critical phase of brain injury a normal PaCO2 of 35-45 mm Hg should be maintained as deviations from the norm have been shown to adversely affect PbtO2.

There are many other considerations in the initial phase of TBIs. Blood pressure should be monitored and maintained at levels that will not decrease CPP. Unfavorable outcomes follow patients who experience periods of low blood pressure. It is important to perform procedures in a timely manner to minimize extreme changes in blood pressure.

Ensuring adequate body temperature and electrolytes is essential to guarantee proper cell and body function. According to the nature of the injury, there is the possibility of leakage of cerebral spinal fluid (CSF) and compression of the brain itself. Brain compression, midline shift and CSF leakage are easily diagnosable by CT scan or x-ray and should be addressed as soon as possible to help prevent any adverse sequelae (e.g. ischemia, etc.).

Jerolyn Patterson is a RC Student at Midlands Technical College, Columbia, SC . Her paper on Traumatic Brain Injury was chosen from 9 papers submitted to Focus for this issue. Ms. Patterson will receive a $100 gift certificate and a gratis registration to the 2008 Focus Conference. Her school's RC Program will also receive a $100 donation. Students are encouraged to submit their papers for the Jan/Feb issue by Jan 5th. Papers should be 1300 - 1400 words and should be submitted as MS Word files to Craig Baker at BakerCT78@yahoo.com.

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Drug therapy for brain injury is used to manage or prevent neurological events. Resuscitative drugs given for the purpose of addressing an arrest, either cardiac or respiratory, are commonly given. Other medications given for these types of injuries help by decreasing ICP, preventing seizures, decreasing brain metabolism and inflammation. Notable drugs that are commonly utilized for treatment of TBIs are Mannitol, Nembutal, Lasix and Dilantin. Mannitol is the drug of choice to decrease ICP; however; Nembutal is primarily reserved for increased ICP that is unresponsive to traditional treatment modalities. Lasix, a diuretic, is commonly used to counter hypervolemia induced by long term use of Mannitol. Anticonvulsive therapy includes but is not limited to Dilantin. Medications are also given to induce sedation, relieve anxiety and prevent delirium. Diprovan is commonly used for long term sedation and is considered a drug of choice because it is metabolized quickly. Ativan, an anxiolytic, is used to decrease anxiety and induce sedation. Antipsychotics (e.g. Haldol, Neurontin are used to offset delirium. All drugs, regardless of the issues they address, should be used judiciously and properly monitored in order to not exacerbate existing problems.

Brain injuries have become of interest to the Center for Disease Control (CDC). The CDC now maintains a TBI registry that keeps updated information on the morbidity and mortality associated with these illnesses. Statistics have shown that there are many situations in which head injuries can occur: motor vehicle accidents, falls, assaults and other situations. In the United States "approximately 1.1 million people are treated for head injuries, 235,000 are hospitalized, 50,000 die…5.3 million persons need help performing activities of daily living as a result of a TBI" (NCICP). Statistics show that men are more affected than women and children more than adults, with the exception of those older than 70 years of age.

Neurological problems that can result after brain injury are many. Problems that can persist are, but are not limited to, epilepsy, disorders in vision, speech, cognition, memory, and persistent vegetative states. Although outcomes are somewhat improved for those persons who received prompt treatment, the nature of these injuries dictate some loss of previous function. Chronic conditions in previously healthy people can be a strain on families, communities, and the healthcare system in general.

There are some preventative measures that can be taken to prevent TBIs. Since motorcycle riders and children on bicycles, represent a large population of TBI patients, prevention can be focused on wearing helmets when riding. This simple precautionary measure can prevent severe trauma to the head; although sustaining some injury may be unavoidable, reducing the chance for serious injury decreases morbidity and mortality. Older people who live alone may need to have handle bars placed in convenient places or non-slip mats within their home to minimize the risk of falling. The simple act of putting on a seatbelt can prevent injuries incurred from hitting a windshield or being ejected from a car. Accidents will still happen across the board in all segments of the population; however, there are some preventative measures that can decrease the risk of some types of head injuries.

Traumatic Brain injuries still represent a challenge to healthcare. The delicate cerebral balance can be altered greatly by injury, and prompt interventions are vital for improving outcomes. Despite great strides within the medical profession, these injuries are a noteworthy cause of death and disability in the United States. Striving to educate the general public of the precautions that can be taken in everyday life is important to minimize the growing number of people represented within this population.