Fact Sheet
Hypoxic-Anoxic Brain Injury

The brain requires a constant flow of oxygen to function normally. A hypoxic-anoxic injury, also known as HAI, occurs when that flow is disrupted, essentially starving the brain and preventing it from performing vital biochemical processes. *Hypoxic* refers to a partial lack of oxygen; *anoxic* means a total lack. In general, the more complete the deprivation, the more severe the harm to the brain and the greater the consequences.

The diminished oxygen supply can cause serious impairments in cognitive skills, as well as in physical, psychological and other functions. Recovery *can* occur in many cases, but it depends largely on the parts of the brain affected, and its pace and extent are unpredictable.

As a result, HAI can have a catastrophic impact on the lives not only of those injured but their families, friends and caregivers as well. Treatment can be costly and complicated, especially because HAI patients frequently need substantial medical and rehabilitative help and may suffer from significant long-term disabilities. A shortage of easy-to-understand, accessible information about HAI can make the situation even more stressful for affected individuals and their families. This Fact Sheet will help answer your questions about this condition.

Causes of Hypoxic-Anoxic Injury

Why is oxygen important to us? Our bodies require oxygen in order to metabolize glucose. This process provides energy for the cells. The brain consumes about a fifth of the body's total oxygen supply, and needs energy to transmit *electrochemical impulses* between cells and to maintain the ability of neurons to receive and respond to these signals.

Cells of the brain will start to die within a few minutes if they are deprived of oxygen. The result is a cascade of problems. In particular, the disruption of the transmission of electrochemical impulses impacts the production and activity of important substances called *neurotransmitters*, which regulate many cognitive, physiological and emotional processes.

There are many neurotransmitters, and they perform a wide variety of important functions, although the specific ways neurotransmitters work is not fully understood. Some, such as *serotonin*, *dopamine* and *norepinephrine*, play an important role in regulating moods. *Endorphins* are critical for controlling pain and enhancing pleasure, while *acetylcholine* is important for memory functions.

A variety of disease processes and injuries can cause HAI. The most common is called *hypoxicischemic injury*, also known as HII or stagnant anoxia. This occurs when some internal event prevents enough oxygen-rich blood from reaching the brain. While strokes and cardiac arrhythmia can both result in HII, the most frequent cause is cardiac arrest.

Anesthesia accidents and cardiovascular disease each account for just under a third of cardiac arrests, according to a 1989 study. Other possible causes are asphyxia, generally caused by suicide attempts or near-drownings (16 percent), chest trauma (10 percent), electrocution (6.5 percent), severe bronchial asthma (3 percent) and barbiturate poisoning (3 percent).

Occasionally, HAI is caused by *anoxic anoxia*, which is when the air itself does not contain enough oxygen to be absorbed and used by the body. This can occur at high altitudes, where the air is thinner than at sea level, but is extremely unusual otherwise. Another syndrome, *toxic anoxia*, involves the presence in the body of toxins or other substances that may interfere with the way an individual processes oxygen.

Another occasional cause of HAI is *anemic anoxia*, which can occur when someone does not have enough blood or hemoglobin, a chemical in the red blood cells, which carry oxygen throughout the body. Acute hemorrhage, chronic anemia, and carbon monoxide poisoning are conditions that can result in anemic anoxia.

Acute hemorrhage is essentially massive bleeding, caused, for example, by a gunshot or other wound. Chronic anemia is an ailment in which a person suffers from persistently low levels of red blood cells or hemoglobin. *Carbon monoxide poisoning*, which appears to damage parts of the brain controlling movement, occurs in suicide attempts using automobile exhaust, but can also happen due to malfunctioning furnaces and other accidents involving machinery and industrial equipment.

Symptoms

HAI is generally marked by an initial loss of consciousness or coma, a condition which looks like sleep but from which a person cannot be awakened. The period of unconsciousness, whether short or long, might be followed by a *persistent vegetative state*, in which a person is neither comatose nor responsive to external stimuli. This state is frequently referred to as "wakeful unresponsiveness."

Even when a person has fully recovered consciousness, he or she might suffer from a long list of symptoms. In many ways, these symptoms are similar to those commonly seen after a blow to the head. The effects can vary widely depending upon the part of the brain that has been injured and the extent of the damage. Some of the major cognitive (thought) problems are:

- *Short-term memory loss*. This is the most common cognitive symptom, especially among those who have HII. The reason is that the part of the brain that is believed to be responsible for learning new information, called the hippocampus, has neurons that are highly sensitive to oxygen deprivation.
- *Decline in executive functions*. Disruption of such critical tasks as reasoning, making judgments, and synthesizing information. This can lead to impulsive behavior, poor decision-making, inability to direct, divide, or switch attention.
- *Difficulty with words*, also known as *anomia*. These linguistic problems include not being able to remember the right word, selecting the wrong word, confusing similar words, not understanding commonly used words, and so on.
- *Visual disturbances*. Difficulty processing visual information can occur in some cases. One rare disorder is called cortical blindness, in which the area of the brain responsible for vision becomes disconnected from the rest of the brain. Because the brain cannot tell that this part is damaged, people may appear to act as though they can see even though they display no ability to identify or recognize objects, shapes or colors.

Some common physical deficits are:

- *Ataxia*, or a lack of coordination. This often expresses itself as a sort of bobbing or weaving, similar to what is seen in people who are drunk.
- *Apraxia*, or an inability to execute a familiar sequence of physical movements such as brushing teeth, combing hair, using eating utensils, etc.
- *Spasticity*, *rigidity* and *myoclonus*, disorders which can include a tendency toward jerky motions, trembling of the extremities, or other abnormal movements.
- *Quadriparesis*, a weakness of the arms and legs.

Other symptoms can include: hallucinations and delusions; increased agitation and confusion; depression and other mood disorders; personality changes, such as irritability and a reduced threshold for frustration; and an inability to focus or concentrate.

Predicting the Outcome

Because people with HAI have often suffered extensive damage, complete recovery is not assured. In fact, predicting the outcome of HAI is a bit like estimating how high a rocket will go. There are some general factors that are helpful in making initial forecasts, but the actual course of the rocket is also dependent upon real-world conditions and many unforeseeable variables.

Studies that have been done suggest that recovery may be more limited than in cases where a person has suffered a traumatic brain injury of comparable severity.

Nonetheless, there are some clues that can clearly offer a bit of guidance in judging the likelihood of at least a partial recovery. These include:

- *Length of coma*. As you might expect, the longer a person is in a coma, the less promising the outcome, although individual cases can vary dramatically from the norm. One study suggested that if a coma lasts less than 12 hours, there is likely to be little long-term damage. Another study indicated that 21 percent of HIA patients who remained in a coma for four weeks or less experienced a good recovery, while the recovery for others was poor.

Many patients come out of a *coma* but remain in what is called a *persistent vegetative state*, a sort of wakeful unresponsiveness in which some brain functions continue to operate but with no apparent consciousness. Some doctors believe that if the persistent vegetative state in a patient with HAI continues for more than three months, there is virtually no chance of further recovery.

- *Visual cues*. If both eyes have fixed or dilated pupils, the prognosis is generally poor. Since this can indicate significant damage to the brain-stem, the area of the brain responsible for regulating such basic functions as breathing, the outcome is not promising. Neurologists can also conduct tests to measure some standard eye-movement responses to determine what kind of damage has been suffered.
- *Age*. Some studies suggest that patients younger than 25 have a better rate of recovery than those who are older.
- *Brain imaging tests*, such as MRI or CT scans. Acute brain damage that has occurred in the immediate past does not typically show up on this type of scan. However, imaging tests conducted several months down the line may indicate the atrophy or loss of some brain matter.
- *Electroencephalography (EEG) and evoked potentials (EPs).* An EEG that reveals continued cortical activity is a positive sign. An EP, which charts electrical activity arising in response to outside stimuli, can also give some indication of the state of the brain after HAI.

Treatment

Unfortunately, direct treatment of anoxia is limited. Some studies have suggested that the use of barbiturates, which slow down the brain's activity, may be helpful in the first two or three days after the onset of the injury. Otherwise, the general medical approach is to maintain the body's status.

Once a person's condition has been stabilized, the next question is to what extent he or she can recover. Recovery can take many months and even years, and in many cases the person never regains his or her prior level of functioning. In general, the sooner rehabilitation starts, the better.

During rehabilitation, the individual and family members may interact with a variety of professionals as the need for constant medical attention from a doctor decreases. Such professionals may include a physical therapist, who aids in improving motor skills such as walking; an occupational therapist, who assists in retraining the person to perform skills of daily living, such as dressing and going to the bathroom; a speech therapist, who may help address cognitive problems as well as language disorders; and a neuropsychologist, who may assess the level and type of cognitive impairment, collaborate on retraining and assist both the individual and family members with behavior and emotional issues.

Advice for Caregivers

As recovery may take months and even years, it is important for both the patient and family members involved in rehabilitation efforts to establish a good working relationship with the various specialists. It's important to understand that rehab often proceeds in an unpredictable way, with progress measured in small steps rather than giant leaps.

Patients and family caregivers, therefore, often experience intense bouts of frustration at what they perceive to be the slow pace of recovery. Expectations and hope may at times outstrip the person's actual level of progress, and the potential for disappointment and misunderstanding—between patient and family, or caregivers and rehabilitation professionals—can be significant.

While the process will never be easy, the following tips may help to minimize possible tension and conflict:

- *Find out as early as possible who will be part of the rehab team*. Get to know the professionals as soon as they begin working with the patient. Ask them for a realistic assessment of the situation. What can you and the patient expect? What is the bare minimum they hope to achieve? What is the likely outcome? What is the

most optimistic forecast? This way, you will understand the range of possibilities and can gauge your expectations accordingly.

- *Learn as much as possible about the role of each of the rehabilitation specialists*. Ask them how you can make their jobs easier. Are there steps you need to take to prepare the patient for them each day? Are there exercises you can help with? Are there times you would be better off staying out of the way?
- *Stay informed and involved*. Family members and friends can play a critical role in monitoring care, charting progress, providing support to both the patient and the professionals, and answering any questions that may arise. Working as a team is one way to help maximize the recovery potential.
- *Plan regular meetings for family members and friends involved in the caregiving process*. This will give everyone a chance to exchange information, voice concerns and stay on top of the changing situation. If possible, invite one or more of the rehabilitation professionals so they can fill in the group as a whole rather than having to repeat information to every individual.
- *Recovery can be completely unpredictable, and the love of those around a patient can play a key role in stimulating progress*. Motivation is an important factor, and someone who feels supported in his or her efforts may well find greater reserves of internal strength to press forward with the rehabilitation process.
- *Celebrate every success, not just the big ones*. The first time the patient takes a step unaided, handles a fork properly or remembers someone's name should be considered a major victory. Hopefully, more will follow, but it is important to take joy in every advance, small or large.

Credits

National Institute of Neurological Disorders and Stroke Cerebral Hypoxia Information Page
www.ninds.nih.gov/health_and_medical/disorders/anoxia_doc.htm

Zasler, Nathan. Ask the Doctor. Brain Injury Source (magazine of the Brain Injury Association of America), Vol. 3, Issue 3. Summer 1999.
www.biausa.org/Pages/askthedoctor.html

Groswasser, Ze'ev, Cohen, M., & Costeff, H.: Rehabilitation outcome after anoxic brain damage. Archives of Physical Medicine & Rehabilitation, 70, 186-188, 1989.

Resources

Los Angeles Caregiver Resource Center
3715 McClintock Avenue
Los Angeles, CA 90089-0191
(800) 540-4442 (in CA) or (213) 821-7777
Web Site: www.losangelescrc.org
E-mail: lacrc@usc.edu

The Los Angeles Caregiver Resource Center serves family caregivers of a brain impaired or frail, older adult through education, research, services and advocacy.

For residents of the Los Angeles County Area, LACRC provides direct family support services for caregivers of those with Alzheimer's disease, stroke, traumatic brain injury, Parkinson's, ALS, Multiple Sclerosis, Huntington's disease and other debilitating brain disorders that strike adults.

Brain Injury Association of America
8201 Greensboro Drive/Suite 611
McLean, VA 22102
www.biausa.org
(800) 444-6443

Brain Trauma Foundation
523 East 72nd Street
New York, NY 10021
www.braintrauma.org
(212) 772-0608

Head Injury Hotline
212 Pioneer Bldg
Seattle, WA 98104
www.headinjury.com
(206) 621-8558

National Institute of Neurological Disorders and Stroke
P.O. Box 5801
Bethesda, MD 20824
www.ninds.nih.gov
(800) 352-9424

National Rehabilitation Information Center
4200 Forbes Boulevard/Suite 202
Lanham, MD 20706
www.naric.com
(301) 459-5900/5984 (TTY) or (800) 346-2742

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