TBI Inform - Hypoxic/Anoxic Brain Injury

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Hypoxia refers to a reduction of oxygen supply to the body tissues, which includes the brain. Anoxia is a more extreme condition in which there is no oxygen in the bloodstream. Oxygen is a colorless, odorless gas that comprises about 20% of the air around us. When we breathe, oxygen is absorbed into the bloodstream through the lungs. Oxygen is essential to the normal functioning and survival of the cells that compose our bodies. Oxygen is used to generate the energy our cells need to perform all functions. A drop in oxygen availability can cause cell death leading to tissue damage, particularly in organs that require a great deal of oxygen, such as the brain.

Causes of Hypoxia/Anoxia

Any event that interrupts breathing or circulation of blood can cause hypoxia/anoxia. The best known example is cardiac arrest, when the heart stops pumping blood. It takes just a few minutes of cardiac arrest to cause brain injury, and in some cases even less time depending on the circumstances. Another cause is respiratory arrest, when a person stops breathing, such as might occur with drowning or choking. Significant blood loss might also cause hypoxia/anoxia since there is not sufficient blood to carry oxygen to the tissues. These events can have a direct impact on the brain. In addition, increased intracranial pressure (ICP) can affect the brain. When brain tissue swells, which often occurs following injury, the compression caused by the swelling may affect the blood vessels in the brain leading to a drop in the supply of oxygen. There is evidence that brain tissue directly underneath a large blood clot, such as a subdural hematoma, may experience hypoxia/anoxia due to the pressure on the brain.

Even people who are in good health can feel the consequences of lowered oxygen levels. Oxygen in the air diminishes with altitude so there is less oxygen to breathe at high altitudes. Our bodies naturally compensate by breathing more often, but it takes time to adjust to high altitudes. Some people experience neurological problems such as dizziness, headache, or difficulty concentrating when they first encounter high altitude.

What Happens to the Brain?

A lack of oxygen in the brain tissue sets off a series of events that significantly disrupt the functioning of cells. The brain operates on the basis of a very delicate chemistry that is changed by hypoxia/anoxia. The cells cannot create energy efficiently, resulting in an
imbalance of ions (electrically charged molecules) and neurotransmitters inside the cell. The cell no longer has the energy to control these substances. Ions and neurotransmitters are normal components of the brain chemistry, but at much higher concentration when hypoxia/anoxia occurs. When the balance of these substances is disrupted, injury to the cell can occur, even to the point that the cell dies.

In the presence of hypoxia/anoxia, cell death occurs throughout the brain. However, some areas of the brain are more sensitive to hypoxia/anoxia because of higher metabolism (greater use of oxygen) or the presence of certain neurotransmitters. Areas in which there is often more extensive injury include the cortex (the outer surface of the brain), the hippocampus, the basal ganglia, and the cerebellum. Injury to these areas can have specific affects on behavior and thinking.

Problems with Hypoxia/Anoxia

If hypoxia/anoxia is extended, the person may die or not regain consciousness due to the extent of the brain disorder. For those who do recover, there are often problems related to the brain injury, particularly in those areas most sensitive to lack of oxygen. For instance, the basal ganglia and cerebellum together help us to move in a smooth and coordinated fashion. Injury to these areas may cause a person to move in an uncoordinated fashion such that it might be difficult for them to walk or use their hands. Their movements appear jerky and there may be a tremor. Balance can also be affected.

Injury to the hippocampus is also common in hypoxia/anoxia and results in memory difficulties. The type of memory disturbance that most commonly occurs is known as anterograde amnesia. This means that the person cannot record new information into memory so there is limited or no recall of events that have happened since the hypoxic/anoxic event. Over half of people experiencing hypoxia/anoxia exhibit memory problems.

Injury to the cortex can affect sensory abilities, such as vision, as well as higher-level thinking skills, such as reasoning and problem solving.

Long-Term Outcome

There are no studies of long-term outcome following hypoxic/anoxic episodes involving large numbers of people. Case studies indicate that progress occurs, but in many cases significant problems persist that impact the ability to return to independent living, school, or work. Much of this depends on the extent of the brain disorder.

Can the Brain Recover?

In general, there are no cells in the brain to replace the cells lost due to hypoxia/anoxia. The brain tries to recover by generating new connections between the surviving cells, but this is unlikely to be substantial in cases of extended hypoxia/anoxia. In some areas, including the basal ganglia and hippocampus, it is difficult for the brain to create new connections. As a
result the difficulties a person exhibits at 3-6 months after an episode of hypoxia/anoxia often persist. It is possible that medications may lessen the problems with movement and even memory in some cases, but this does not change the underlying brain disorder. Rapid recovery of physical and cognitive abilities within the first month after a hypoxic/anoxic episode is usually a predictor of a good outcome.


This paper is published by the UAB Traumatic Brain Injury Model System, supported by grant #H133A020509 from the National Institute of Disability and Rehabilitation Research, Office of Special Education and Rehabilitative Services, Dept of Education, Washington, DC. Opinions expressed are not necessarily those of the granting agency. Permission to reprint this newsletter, in part or completely, is granted for educational purposes. Published by the UAB-TBIMS, Birmingham, AL © 2006 Board of Trustees, University of Alabama.
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