SCIENCE REPORT

When Freezing to Death May Save Your Life

David Gennert

Recent studies on induced hypothermia as treatment for victims of traumatic injury, including a recently approved human trial at Massachusetts General Hospital, are culminating in the development of effective methods for arresting brain damage during periods of oxygen deprivation by causing a state of suspended animation in the patient.

Lower a human's body temperature by 1°C, and pain will be felt in the extremities. Lower the temperature another ten degrees, and the person is at severe risk of death.[1] Despite this, recent research is pointing to hypothermia as a means of saving the lives of those suffering from traumatic injury to their bodies. Induced hypothermia has been known to be an effective treatment for a number of medical conditions for millennia. The ancient Greek physician Hippocrates wrote about treating wounded soldiers with snow and ice, and recent research has pointed to hypothermia as a successful treatment to prevent neurological damage in times of stress for the brain.[2]

When a person's core body temperature drops from 37°C to 33°, brain function begins to be affected, and the person often experiences amnesia. When it drops to 30°, the person will lose consciousness. At 28°, the heart stops beating. Although a human will seem to be on the brink of death at this point, the brain mysteriously retains its viability while remaining in a state of major arrest.[1] It is well known that a brain will lose significant functionality if deprived of oxygen for a few minutes. However, hypothermia reduces the brain's demand for oxygen and impedes several deleterious biomechanical pathways that lead to free-radical release in the brain, thus preventing significant cell death.[3] This protection during anoxia is the key to new treatments being developed, as well as the explanation for some puzzling and unbelievable stories of survival that fuel the curiosity that drives this field of research.

Dr. Anna Bagenholm was on a skiing trip with friends in northern Norway above the Arctic Circle eleven years ago. Her skis went through a patch of ice during a run down the mountain, plunging her into the frigid water below. It took her friends 40 minutes to pull her out of the water, and by the time the rescue helicopter transported Dr. Bagenholm to the nearest emergency room, she had been without heartbeat for over two hours, her core body temperature had dropped to 13.7°C, and no neuronal activity could be detected.

With the help of the hospital's medical staff, she seemed to achieve the impossible, though, and survived the ordeal, waking up from her coma three weeks later and making a full recovery. Earlier this year, she sat down with Dr. Kevin Fong, a consultant anesthesiologist from the University College London Hospital, for his documentary "Back From the Dead" aired in September 2010, in order to talk about her experience and the phenomenon of extreme hypothermia that actually saved her life.[1]

Dr. Bagenholm's story exemplifies the power of this phenomenon, which researchers like Professor Marianne Thoresen, of St. Michael's Hospital, Bristol, England, and Dr. John Elefteriades, at the Yale New Haven Hospital, are harnessing into powerful therapeutic tools. Professor Thoresen works in the neonatal ward, and she has been a leader in research on hypoxic brain injury in infants. One of the effective treatments she has seen develop is the use of induced hypothermia on afflicted infants to quell the threat posed to premature newborns by hypoxia.[1]

Dr. Elefteriades, a surgeon at Yale Hospital, is one of the leading figures in the advancement of hypothermic techniques during surgery, having performed numerous operations whose successes relied heavily on the new method, called Deep Hypothermic Circulatory Arrest. He has developed a system to cool a patient's body to 18°C, where the body's metabolic requirements drop to around 12.5% of normal levels. Dr. Elefteriades says this is low enough to give a surgical team a 45-60 minute window, during which blood flow can be completely shut off, while ensuring that the patient will regain full brain functionality after the procedure.[1,4]

As one example of the results seen by Dr. Elefteriades, Dr. Fong followed one of his patients during and after this procedure in order to repair a potentially deadly aneurism on his aorta. In order to access and repair this major blood vessel, the patient's body was cooled, his heartbeat stopped, and his brain was put into a state of suspension animation in order to survive the event. The patient later regained full functionality and returned home with his family with no observable complications.[1]

Such a powerful tool must certainly have applications outside the standard surgical suite, so researchers began investigating how this procedure could be used to treat those whose hearts stop before the brain is put into a state of suspended animation. They began to investigate the applications in the field of trauma medicine to see if emergency medical teams can gain the edge in very time-critical situations.

Since 2002, when the New England Journal of Medicine published several articles detailing the use of induced hypothermia in cardiac arrest cases, many new findings and innovations have been made to help put this technique into regular use.3 In January 2009, New York City began Project Hypothermia to analyze the effects induced hypothermia had on cardiac arrest victims. During Phase I of the project, patients arriving at one of the city's hospitals would receive hypothermia treatment. Since the study began, the survival rate of cardiac arrest victims in the city rose 20%, and hospital discharges increased 30%. In Phase II, underway now, paramedics administer the hypothermic treatment prior to arriving at the hospital if other resuscitation methods are not successful in restarting the heart.[2]

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Another research study currently underway is taking place at Massachusetts General Hospital in Boston, where Dr. Hasan Alam is spearheading the study of using the hypothermic treatment on victims of traumatic injury. After seeing great successes in trials using animals, Dr. Alam received permission in September 2010, to conduct human trials of the techniques, which he wishes to administer to victims of gunshots, stabbings, and automobile accidents. He plans to drop the patient's temperature to 10-15°C, giving his team a window of 60-120 minutes during which time the patient's heart can be stopped without damaging the brain. He has developed a very effective method of cooling the patient's body, which replaces warm blood with cold saline injected rapidly into the body directly, mostly at the head. This can lower the body's temperature by 2°C per minute. Dr. Alam is confident that this fast cooling will result in a 90% or greater survival rate for patients whose situations are routinely considered fatal.[1,4]

Although induced hypothermia is emerging as a very effective and versatile treatment for patients in serious condition, the reasons it works are not fully understood. Prof. Lance Becker, of the University of Pennsylvania, has been studying the effects of anoxia at the cellular level at the Center for Resuscitation Science in Philadelphia in order to try to reveal how cold temperatures put the body's cells into a state of suspended animation that can withstand a lack of oxygen. He has found that oxygen deprivation itself does not kill a human's cells; a brief lack of oxygen merely puts them in an arrested state. He then saw that it was only after oxygen was reintroduced to the cells that the cells began to undergoing apoptosis–cell suicide. Up until the reintroduction of oxygen, Prof. Becker describes the cells as "unhappy," but still alive.

He is now trying to figure out what gets altered in anoxic cells to trigger apoptosis upon the reintroduction of oxygen. He also observed that cooling the cells, just like in the induced hypothermic patients, results in a greater chance that the cell will survive, but that is not the entire answer. Prof. Becker stated that they are beginning to understand these mechanisms, and they are moving toward the solution, but the processes remain a mystery.[1]

As more research comes out regarding the use of induced hypothermia in the treatment of victims of traumatic injury, the definition of death itself may have to be reconsidered. As clearly seen in the case of Dr. Bagenholm, a lack of pulse, brain activity, and normal body temperature are no longer clear indicators of death. Dr. Fong described a "no man's land between life and death that we might be able to manipulate."1 The work currently going on to illuminate this phenomenon, and the work that has already given us a glimpse of its potential, is furthering our understanding of this middle-ground, giving the medical community tools capable of reaching out to pluck those on the brink of death and bring them back to life.

References

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RESEARCH HIGHLIGHT

Asthma Incidence Reduced after Public Ban on Smoking in Scotland

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A study funded by the NHS Health Scotland found that following legislation to ban smoking in public places and work places the number of hospital admission due to asthma decreased significantly among children. While the rate of hospitalization for both pre-school age children and school-age children had been increasing by 4.4% per year before legislation, however after legislation there was a reduction of 15.1% relative to the rate before legislation. There is a strong correlation between environmental smoke and the incidence of asthma.

Asthma has been a growing problem for many countries around the world. However health officials and politicians have been weary of implementing public and work smoking bans because many believe this will push smokers to smoke more at home where children reside. In Scotland 40% of children live with smokers in their home. The data was consistent across groups of different gender, geography and socioeconomic standing. The study in Scotland proved that legislation banning smoking would decrease the incidence of asthma in a population, and not cause an increase in home smoking. While the consortium study could find no way to directly prove the correlation, they find it hard to credit the lowered incidence to any other change.mation demonstrates that public support and donation is having a positive effect.

Reference: Grady, Denise. (2010, April 13). Maternal Deaths Decline Sharply Across the Globe. *The New York Times.*

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