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Brain Cooling Probe Offers Improved Treatment for Brain Trauma

Cooling the brain a few degrees can reduce cell death, neurological damage and tissue swelling when a traumatic event occurs, such as a stroke or head impact trauma.

Technology Description

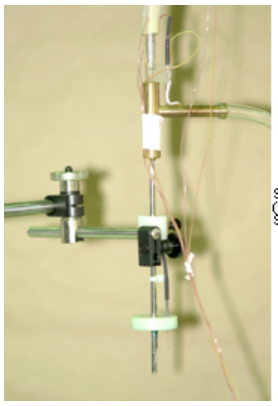
Brain injuries caused by a stroke, car accident, fall or other head trauma may cause localized brain tissue swelling and neurological damage. Initial localized swelling frequently leads to a rapidly expanding damage zone, which can cause death from large increases in cranial pressure. Lowering the temperature of the affected region of the brain early in treatment helps to both alleviate swelling and slow or arrest brain death.

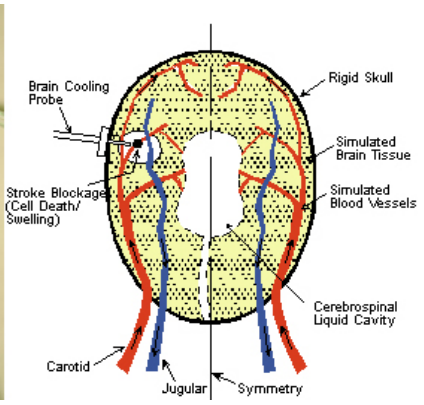
Researchers at Argonne National Laboratory, led by Ken Kasza, have developed a brain cooling probe for targeted protective cooling and an associated coolant supply system. The cooling probe is a miniature tube-in-tube heat exchanger designed to operate with an adjustable, very stable and uniform surface temperature probe when implanted in tissue that requires protective cooling. The coolant supply system consists of:

- An insulated chest, which contains a coolant reservoir with an ice bed from which only water circulates to the probe. The reservoir is fitted with a screen strainer that allows pumped recirculation of single-phase chilled water through the heat exchanger;
- A variable-speed, high-pressure coolant recirculation pump, which circulates 0°C water through the probe at a rate needed to maintain the desired protective tissue temperature; and
- Two digital recorders, which record data from thermocouples mounted on the cooling probe that monitor tissue and probe coolant and surface temperatures.

Potential Benefits

Most traditional cooling systems are designed to treat brain trauma cool globally instead of locally and are frequently applied outside of the body. Global cooling methods, such as an ice bath, cooling blankets or other apparel, can be effective to a certain degree, but they can also lead to such problems as heart arrhythmias and organ failure. Furthermore, all external methods are very slow in cooling the brain. Other localized cooling methods exist, but they do not precisely control or truly localize the cooling.





The cooling probe is a miniature tube-in-tube heat exchanger. As shown in the diagram at right, the probe can be inserted into the brain where swelling is occurring through a small skull bore hole.

A significant need exists for a technology like Argonne's brain cooling probe. It provides precisely targeted localized cooling — and does so very rapidly. This innovation will greatly benefit the treatment of patients, especially those with localized brain swelling that is difficult to control.

In addition to cooling, Argonne's probe can monitor changes in tissue health resulting from cell death or deterioration due to insufficient oxygen. Monitoring involves using the cooling probe to assess changes in tissue heat transfer characteristics as it interacts with the tissue. Tissue heat transfer characteristics are a strong function of cell health. For example, as tissue dies, its metabolic heat generation declines. This decline in heat generation reduces the heat load on the cooling probe, causing the temperature of the coolant returning from the probe to change. This information may lead to an improved understanding of traumatized brain tissue and the development of new treatment approaches for saving lives.

Technology Area: Medical device
Product: Protective cooling probe and tissue health monitoring device
Development Stage: Proof of concept
Primary Inventor: Ken Kasza, kasza@anl.gov
Scientific Publication: Chang F.C., Kasza K.E., Majumdar S., and Chien T.H., June 2005, "Computer Modeling of Tissue Cooling Using a Local Brain Cooling Probe," 2005 Summer Bioengineering Conference, Vail, CO.
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