

# Medical Ice Slurry Protective Cooling Technology

Kenneth E. Kasza (PhD), Yue Wu (PhD)

Argonne National Laboratory



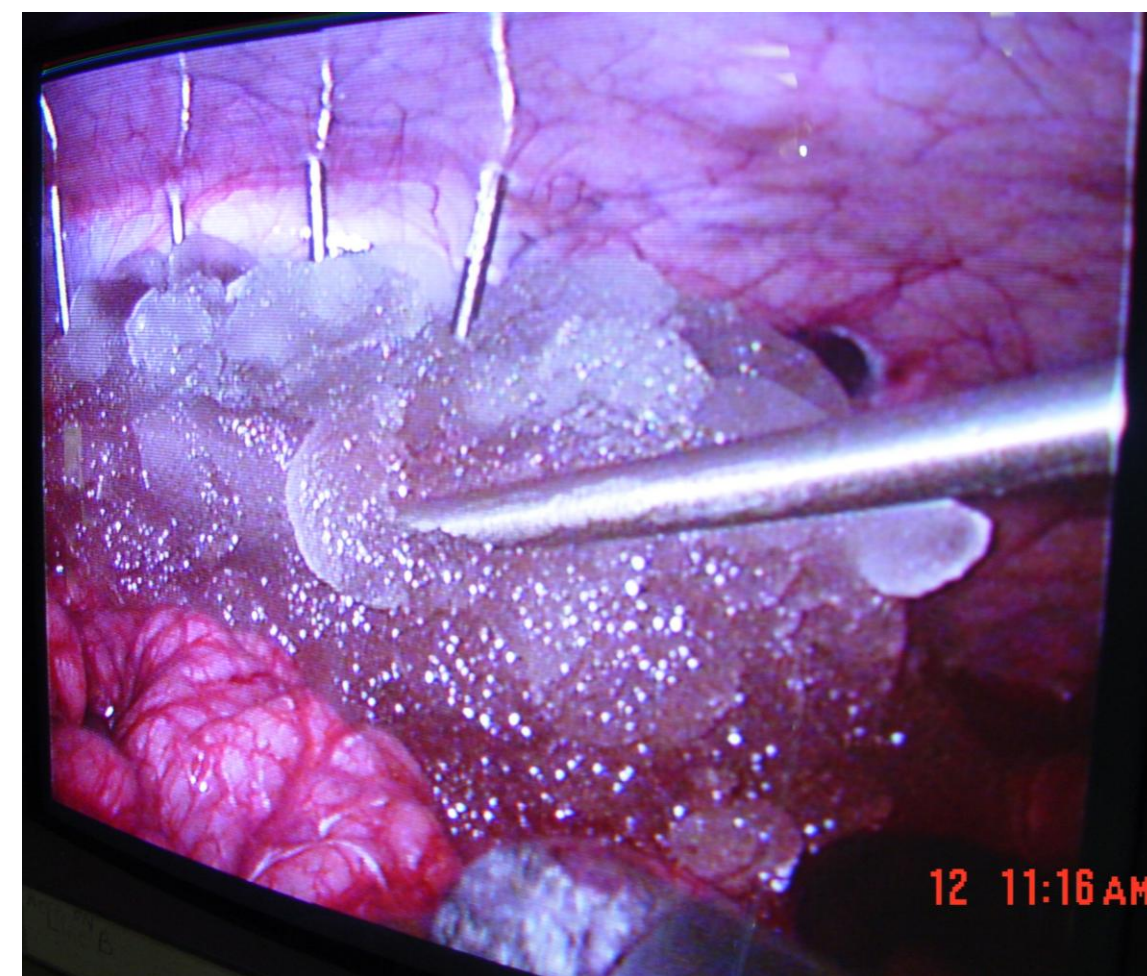
## Technology

The ability of organs and tissue to survive ischemia, reperfusion damage, and surgical insults is improved by cooling rapidly in 5-15 minutes 4-15 ° C (depending on the organ) below the normal temperature of 37° C. Cooling slows metabolism and reduces the need for oxygen which slows cell death--providing more time for medical treatment. However, current methods of cooling using external means (ice packs, blankets, caps and jackets ) or heat exchangers are very slow (< 0.03 ° C/min) and cool the entire body often causing adverse secondary effects such as uncontrolled shivering or arrhythmias. Thus, there is an unmet need to protect critical organs during medical emergencies such as cardiac arrest, stroke, and spinal or head trauma and through the course of surgical manipulations.

Argonne inventors have developed a proprietary method and equipment for making an ice slurry coolant which is used to induce therapeutic hypothermia. Argonne's proprietary ice slurry has the following useful characteristics: (1) small ice particle (less than 100 micron), (2) excellent fluidity and storability obtained by altering ice particle size, shape, and surface roughness, (3) high ice concentration (>50%) and, as a consequence, 4-7 times the cooling capacity of chilled water, (4) can be pumped easily through laparoscopic ports for coating the outside of organs [Figure 1] or narrow catheters, and (5) can be made using any biologically compatible carrier liquid, such as saline solution or a blood substitute.

Argonne has also developed a prototype portable, fully automated medical slurry production and delivery device [Figures 2]. The equipment makes slurry in less than 2 minutes, is easy to use, and delivers it selectively to a specific organ. This fully integrated and computer controlled device delivers slurry as needed and tracks the amounts of slurry used and remaining, while reporting the target organ temperature.

Figure 1



Kidney being protectively coated with slurry prior to performing a partial nephrectomy using a laparoscopic procedure.

## Markets

### APPLICATIONS

- Protective cooling for emergencies such as cardiac arrest, stroke, heart attack, brain injury, heat stroke, fever, and severe trauma
- Protective targeted cooling of organs whose blood supply is cut off or diminished during surgery
- Targeted cooling to increase viability of organs harvested for transplantation

### BENEFITS

- Ability to moderately lower patient's entire body temperature or target specific organs for protective cooling
- Cooling only a specific target minimizes secondary complications like shivering or arrhythmias
- Increases survival rate of cardiac arrest patients as a result of easily being administered by first responders out-of-hospital
- Reduction of brain damage due to lack of blood supply
- Cools more quickly than other methods available

Figure 2



Argonne's prototype portable automated medical ice slurry production/delivery system produces three liters of slurry in less than two minutes and delivers slurry continuously or intermittently, as required.

## Commercial Readiness

- Proof-of-concept studies completed in animals for laparoscopic kidney surgery and cardiac arrest; similar studies planned for heart protection during surgery
- Constructed a portable prototype device for automated medical ice slurry production and delivery
- Small scale human clinical trials need to be conducted for certain applications that require U.S. Food and Drug Administration (FDA) approval
- Technology is ready for transfer to industry for commercial development
- It may take from one to two years of time and a capital investment of a few million dollars for commercialization

## Intellectual Property

### Patents and Published Patent Applications

- US 6,244,052
- US 6,413,444
- (US 6,547,811
- US 7,389,653
- US 7,422,601
- US 2006/0036302
- US 2009/0125087
- US 2009/0255276

### Slurry Production/Delivery System Features:

- Computer-automation greatly reduces operator manual interventions, making system easy to use and very reliable
- Produces 3 liters of sterile ice slurry in 2 minutes
- Slurry can be made using any biologically compatible carrier liquid (e.g., saline, perfluorocarbon, blood substitute)
- Slurry has 3-5 times the cooling capacity of single phase coolants (e.g., cold saline)
- Computer tracks/records: slurry delivered, ice loading, patient temperature, and Operation Room surgical notes (verbal and text)

## Contact

Yash Vaishnav, PhD, MBA  
Senior Manager  
Technology Development and  
Commercialization Division  
Argonne National Laboratory  
9700 S. Cass Avenue, Bldg. 201  
Argonne, IL 60439-4832

Phone: 630-252-1346  
E-mail: yvaishnav@anl.gov