Inquiro, the UAB undergraduate science research journal

Volume 2014 | Number 8 Article 10

2014

A "Cooler" Approach to Long-Term Organ Preservation

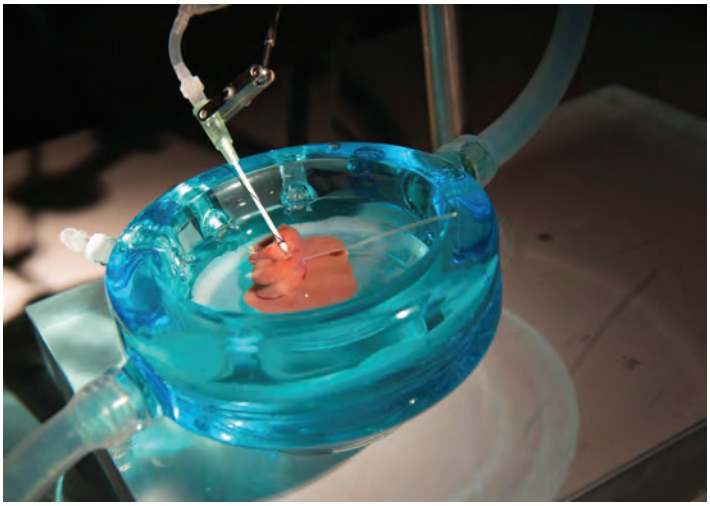
Susmita Murthy

science news

A "Cooler" Approach to Long-Term Organ Preservation

Susmita Murthy

From the first procedure in 1954, the almost miraculous procedure of organ transplantation has been critical to the development of modern medicine and surgery, and it is in wide use today to give individuals a new lease on life. However, clinicians and researchers have encountered several persistent problems with organ transplantation through the last 60 years that have prevented some patients from getting the happy ending they were promised. In addition to donor organ rejection and the perpetual shortage of organs available for transplant, a major issue is the brief lifetime of organs once removed from the donor's body—typically only 24 hours. Because of this short window for usage, thousands of organs go to waste every year. The United Network for Organ Sharing estimates that, on average, 3,881 organs



A rat liver being "supercooled" using the machine perfusion system developed at Harvard University.

are discarded every calendar year (Sack, K. 2012). Imagine a world in which such donor organs would never go to waste: one in which organs could be preserved indefinitely before being transplanted into dying patients. This lofty goal is the focus of much of the recent research in the field of organ transplantation.

In 1988, Folkert O. Belzer and James H. Southard from the University of Wisconsin-Madison developed the current, accepted method of organ preservation: a cold storage liquid known as the "UW solution" (Belzer, F.O., & Southard, J.H. 1988). Designed first for pancreas preservation, the solution is often hailed as the best method of organ preservation to date (Guibert, E.E. 2011). The UW solution mimics the body's internal conditions, and the solutes contained in the cold water prevent the organ from undergoing swelling or crenation (a type of undesirable shape change due to osmotic water loss) (Belzer, F.O., & Southard, J.H. 1988). Though the UW solution was a leap forward in organ preservation techniques, it is only able to keep organs viable for up to 24 hours outside of the body (National Institutes of Health 2014). Belzer and Southard also attempted to cool the temperature of their water solution in order to keep the organs viable for longer, but below certain temperatures the solution began to form ice crystals that created holes in the organs (Belzer, F.O., & Southard, J.H. 1988).

To combat this weakness of the UW solution, a team of researchers and doctors at the Massachusetts General Hospital in Boston developed a preservation technique dubbed "supercooling." In this experiment, a rat liver was cooled to about 21 degrees Fahrenheit and, utilizing machine perfusion, a solution was pumped through the organ. This solution consisted of water and a modified glucose compound which lowers the freezing point of the liquid water around the organ and prevents the cell membranes from lysing (Berendsen, T.A., et al. 2014). After this solution was delivered to the liver cells, the organ slowly cooled without freezing. The livers were then stored for a variable number of days, rewarmed, and transplanted into rat subjects. The supercooling technique allowed the researchers to extend the 24-hour organ viability window substantially: in 32 rats transplanted with supercooled livers that were stored for four days, the survival rate was 58 % (Berendsen, T.A., et al. 2014). Even more remarkably, rats that received livers that had been supercooled for three days had a 100 % survival rate (Berendsen, T.A., et al. 2014).

Expanding upon the existing methods of organ preservation, the researchers in Boston have developed a technique that keeps organs viable for up to two days longer than traditional methods. The next step for these researchers will be to test the supercooling technique in larger organisms and various other organs. The longer donor organs can be stored, the better chance there will be to find the best possible match for a patient. Thus, advances in organ preservation will not only reduce waste, but may also help to ameliorate problems with rejection. While the new technique is only the next step towards an approach that might someday allow the preservation of organs for indefinite periods of time, two days, for now, will be more than enough to make the difference between life and death for many patients awaiting transplants.

References

1. Belzer, F.O., & Southard, J.H. (1988). Principles of Solid-Organ Preservation by Cold Storage. Transplantation, (45)4, 673-676.

2. Berendsen, T.A., et al. (2014). Supercooling enables long-term transplantation survival following 4 days of liver preservation. Nature Medicine, (20), 790-793.

3. Guibert, E.E., et.al. (2011). Organ Preservation: Current Concepts and New Strategies for the Next Decade. Transfusion Medicine and Hemotherapy, (38)2, 125-142.

4. Reeves, W., Uygun, K., & Yarmush, M. Harvard University. [Web Photo]. Retrieved December 12, 2014 from http://www.livescience.com/46596-supercooling-technique-liver-preservation.html

5. National Institutes of Health. (2014). NIH-funded researchers extend liver preservation for transplantation. Retrieved October 28, 2014 from http://www.eurekalert.org/pub_releases/2014-06/niob-nre062614.php

6. Sack, Kevin. (2012). In discarding of kidneys, system reveals its flaws. The New York Times. Retrieved October 28, 2014 from http://www.nytimes.com/2012/09/20/health/transplant-experts-blame-allocation-system-for-discarding-kidneys.html?pagewanted=all&_r=0.