CRYONICS

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Near the Glass Transition Point

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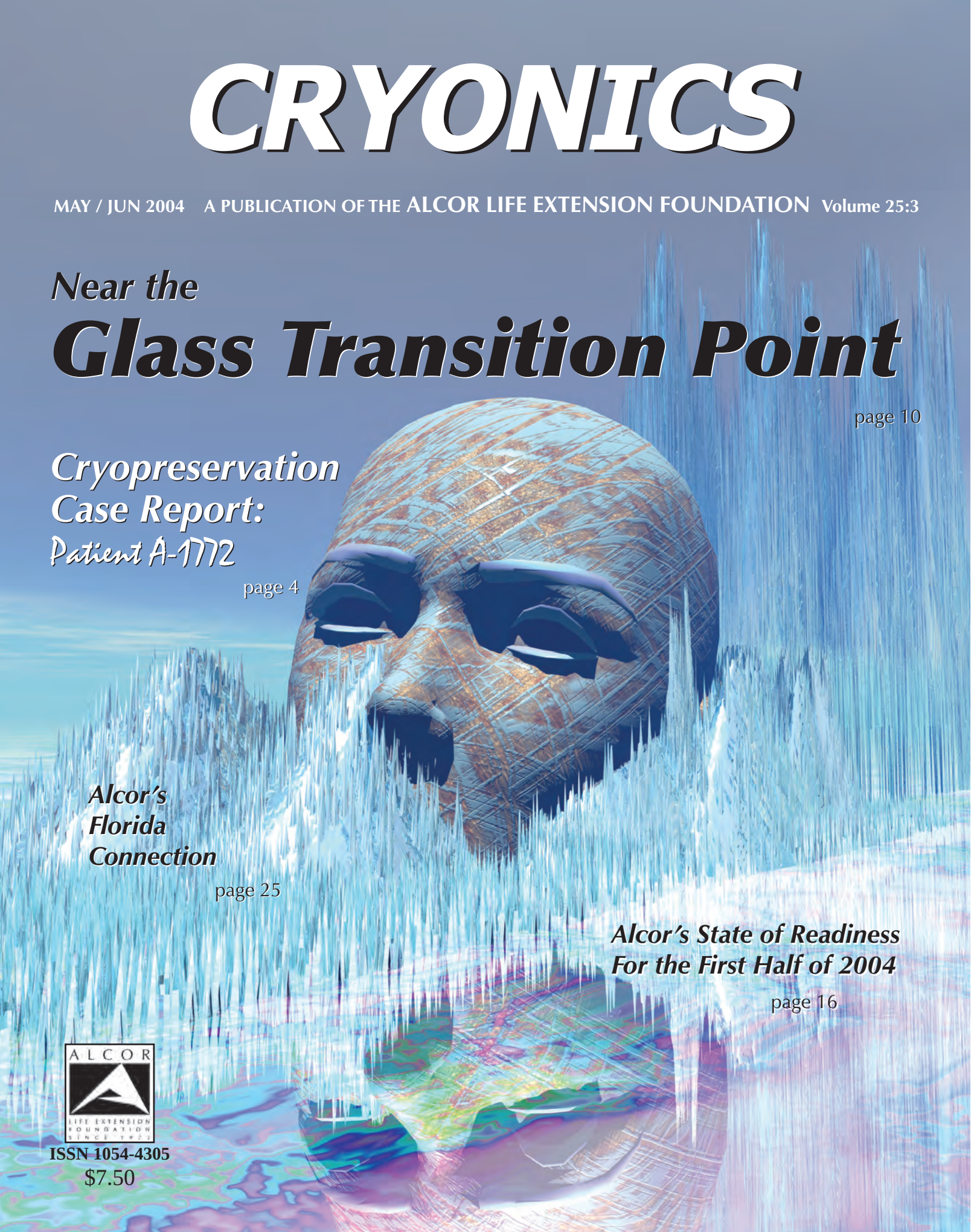

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"What *is* cryopreservation?"

Cryopreservation (cryonics) is the ultra-low-temperature preservation (biostasis or cryostasis) of patients who cannot be maintained in a normal, living state by present-day medical practice. The goal is to move these patients into the future (with as little further damage as possible), to a time when cell and tissue repair technology far beyond today's capabilities are readily available, and where a more comprehensive evaluation of these patients' chances can be made, where restoration to full function and health may be a realistic possibility. In principle, this is no different from bringing a seriously ill person out of the jungle and to a modern hospital. Applied to cryotransport, the concept is that the only way "out of the jungle" is to travel forward in time. The "modern hospitals" *we* need can be reached only by traveling decades into the future.

As human knowledge and medical technology continue to expand, people who today are considered hopeless will be easily restored to health. Throughout history, this has been the hallmark of medical progress. Rapidly evolving control of biological and molecular structures promises to soon permit the synthesis of medical devices far smaller than living cells. Through molecular repair, these devices should be able to eliminate virtually all of today's diseases and allow us to intervene in the aging process, ultimately "curing" and eliminating it. These technologies will also allow us to attempt the repair and recovery of patients waiting in cryostasis. The challenge for us today is to devise techniques that will give these patients the best chances for survival.

"How do I find out more?"

The best source of detailed introductory information about cryotransport is *Alcor Life Extension Foundation: An Introduction* (published December 2001). At 100 pages long, *ALEFI* presents an engaging examination of the social, practical, and scientific arguments that support the continuing refinement of today's cryotransport techniques in pursuit of a perfected "suspended animation" technology.

ALEFI features chapters on the possibilities in nanomedicine; society's views of dying throughout the ages; the history of cryonics; the mutability of death; the mechanics of rescue operations, cryonic suspension, and vitrification; the science of molecular engineering; religious and ethical issues surrounding cryonic suspension; key psychological issues faced in the decisionmaking process regarding cryosuspension and advice on how to resolve them; frequently asked questions and answers; and how to join Alcor. Price: $10.00. Visit our web site at www.alcor.org or contact our front office at 480-905-1906, ext. 113, to order.

For those considering Alcor Membership. . .

Cryonics is published four times a year by Alcor Life Extension Foundation. The magazine is an important benefit of membership and is mailed to all members. Read about the latest findings from cryonics experts, keep up with happenings at Alcor Central, and learn about special events and conferences in cryonics and related fields.

Alcor's toll-free number for membership inquiries or donations is: 1-877-GO-ALCOR. For other services, call 1-480-905-1906. For inquiries and member services, contact Membership Administrator Jennifer Chapman at jennifer@alcor.org.

Don't miss a single issue of *Cryonics*—BECOME A MEMBER TODAY!

Artist Tim Hubley's depiction of the glass transition point

Cryonics

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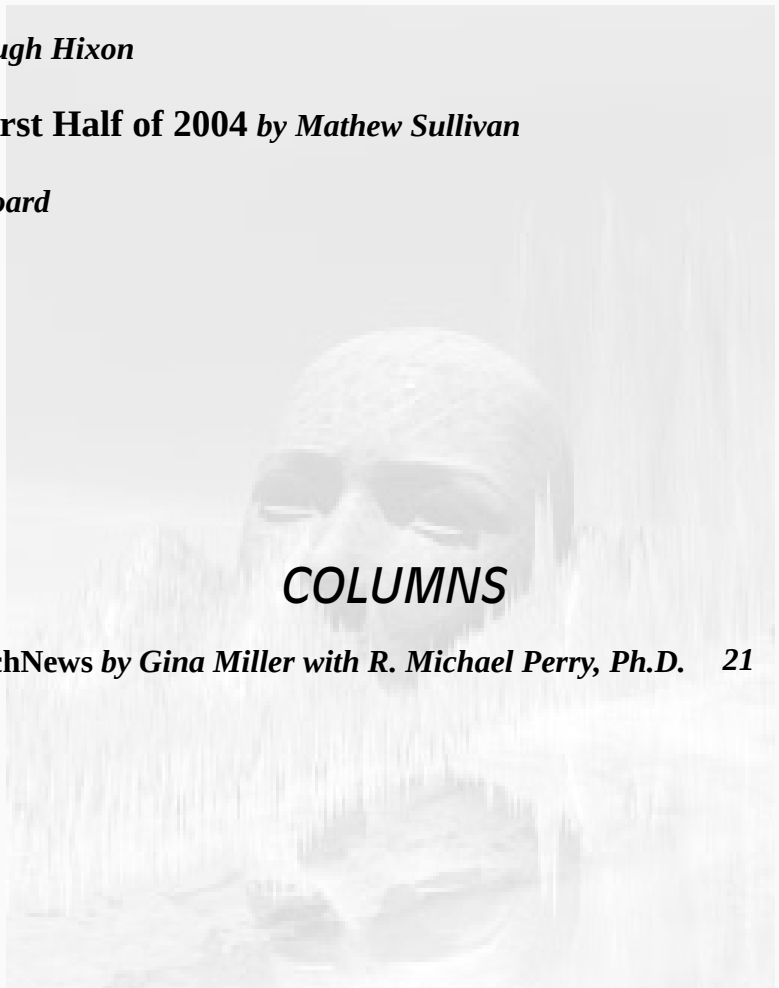

COLUMNS

ALCOR UPDATES

Alcor: The Origin of Our Name

In September of 1970 Fred and Linda Chamberlain (the founders of Alcor) were asked to come up with a name for a rescue team for the now-defunct Cryonics Society of California (CSC). In view of our logical destiny (the stars), they searched through star catalogs and books on astronomy, hoping to find a star that could serve as a cryonics acronym. *Alcor,* 80 Ursae Majoris, was just what they had been looking for. It not only had some acronymic "fit" for cryonics but was also symbolic for its historical use as a test for eyesight and was located in a very well known constellation.

Alcor, a companion star of Mizar in the Big Dipper's handle, is approximately 5th magnitude, barely within the threshold of human vision. Additionally, it is quite close to Mizar from an angular standpoint, and dimmer. Only with excellent vision can one tell there are two stars rather than just one. For thousands of years, people in the Middle East have used Alcor as a critical test of visual sensitivity and focus. If you could see Alcor, you had excellent vision indeed. In the early days of cryonics, few people could see the need for a rescue team or even for cryonics itself. Symbolically then, Alcor would be a "test" of vision as regards life extension.

As an acronym, Alcor is a close if not perfect fit with *Allopathic Cryogenic Rescue.* The Chamberlains could have forced a five-word string, but these three seemed sufficient. *Allopathy* (as opposed to *Homeopathy)* is a medical perspective wherein *any treatment that improves the prognosis is valid. Cryogenic* preservation is the most powerful method known to halt the rapid, entropic disorganization of people following clinical death. *Rescue* differentiates a cryonics approach from (yet to be developed) proven suspended animation. The acronymic interpretation of Alcor is therefore *use of a cryogenic procedure, though unproven, to preserve structure and potential viability, since failing to do so allows further disorganization to occur and reduces the probability (prognosis) of reversal and reanimation at any future time.*

Some of these thoughts were presented at a CSC dinner meeting in the autumn of 1970. A number of people who have subsequently become members of the Alcor Life Extension Foundation were present at that gathering. Over the months that followed, it became increasingly evident that the leadership of CSC would not support or even tolerate a rescue team concept. Less than one year after the 1970 dinner meeting, the Chamberlains severed all ties with CSC and incorporated the "Rocky Mountain Cryonics Society" in the State of Washington. The articles and bylaws of this organization specifically provided for "Alcor Members," who were to be the core of rescue team activity. Difficulties in securing nonprofit status in Washington then led to reincorporation in California, this time under the name "Alcor Society for Solid State Hypothermia." In the late 1970s, to further broaden the organization's objectives, the present name (Alcor Life Extension Foundation) was adopted.

Despite many transitions, the symbolism of the name remains. How long will it take for more people to see that "Ashes to ashes and dust to dust" is a meaningless destiny... to see that it is possible to reach for a distant tomorrow and perhaps to attain it... to *see* Alcor for what it really is: a vehicle with which to attempt that fantastic voyage!

—Reprinted from *Cryonics,* August 1984.

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Editor
The Alcor Staff

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Cryonics
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Scottsdale, AZ 85260

Visit us on the Web at www.alcor.org

How to Join Alcor

Your research is finally complete. You browsed our web site (www.alcor.org), presented your questions to our Membership Administrator (jennifer@alcor.org), and toured our facility. Now you are ready to establish your membership with Alcor Foundation. Congratulations and welcome!

Upon receipt of your completed application for membership and application fee, Alcor will send you various membership documents (samples available upon request). After reviewing these documents, you will need to execute them in the presence of two signing witnesses. Perhaps a representative of your local bank can notarize the single document that also requires this official witness. After returning all of your documents to Alcor for approval, you can expect to receive one original copy of each for your personal records.

Most people use life insurance to fund their suspension, although cash prepayment is also acceptable. If you do not already have an insurance policy, Alcor recommends that you apply for one at your earliest convenience, as the underwriting process can last several weeks. Jennifer Chapman, Alcor Membership Administrator, can provide you with a list of insurance agents who have previously written policies for this purpose. These agents can assist you with satisfying Alcor's various funding requirements, such as naming Alcor as the owner and irrevocable beneficiary of your policy and ensuring that your benefit amount is sufficient.

With your membership documents completed and your funding approved by Alcor, you will be issued emergency identification tags engraved with your personal Suspension Number. This is your confirmation that Alcor will provide you with suspension services, should our emergency technicians ever receive a call on your behalf. Certainly, Alcor hopes that you will not need our services anytime soon, but as a member of Alcor you can feel confident that our organization will care for you and your future. Please call 480-905-1906 ext. 113 today to request your application.

TO ALL ALCOR MEMBERS AND THOSE IN THE SIGN-UP PROCESS

Please! Please! Please!

When you move, or change phone numbers (work number as well), change e-mail addresses, or undergo any medical procedure where general anesthesia is used, please inform us as far ahead of time as you can.

Too many times we have tried to contact our members and found out the contact information we have is no longer valid.

Other times we find out well after the fact that a member has undergone a medical procedure with life threatening potential.

Help us to serve you better!
Keep in touch!

CryoPreservation Case Report:
The Cryopreservation of Patient A-1772

by Todd Huffman and Tanya Jones

Alcor patient A-1772 had been a member for approximately five years, before developing pancreatic cancer late last year. Conventional cancer treatments had been tried with poor results, and experimental cancer treatments were attempted. Though the experimental treatments intially showed promising results, his cancer ultimately progressed to a terminal state.

Approximately two weeks before the patient's arrest, his wife called us to discuss the possibility of moving to Scottsdale. The patient's physician determined that with emboli in his lungs, air transportation would represent a significant risk. Driving would have been problematic, since the patient's condition was declining rapidly. He and his wife made the decision to remain in Florida. Alcor kept in regular touch with the physician, and as the patient's condition worsened, sent a representative to Florida to assemble a field team for standby.

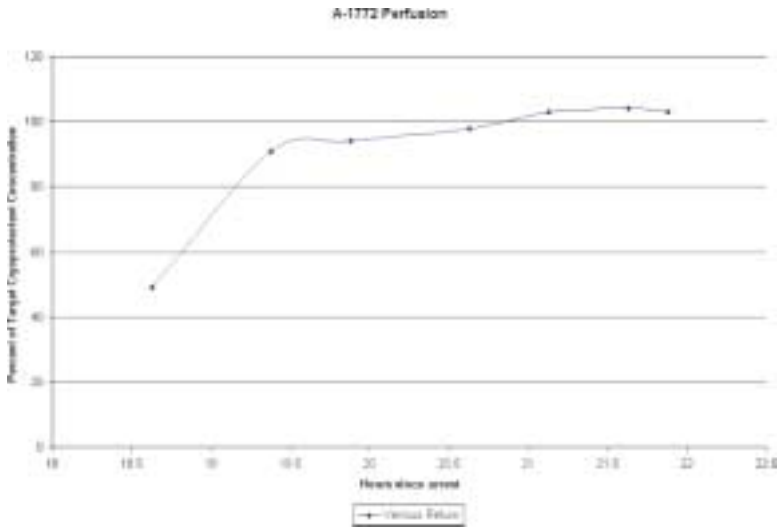
When the physician felt the patient's health was declining significantly, Tanya Jones flew out to meet with the patient and his family. In an early morning meeting, she met with the patient, his wife, and friends. While the patient slept in the other room, Tanya discussed Alcor's arrangements and procedures, the importance of a rapid transport, standby funding preparations, and other aspects of Alcor's procedures with his wife. On the whole, this was a critical meeting, as the patient had never discussed specifics with his wife once his arrangements were in place, since she had not chosen cryonics for herself. Once they understood what was desired, the family was cooperative and supportive on all issues.

Later that afternoon, Tanya encouraged admitting the patient to a nearby hospice for 24-hour care, and drove with the family to see the patient settled into the facility. At this point, the patient's doctor estimated a terminal event within no more than a week. A standby was lauched, and the Florida team members assembled their equipment, rented a van, and departed for the hospice. Over the next couple days, the patient appeared to improve, but his doctor was now estimating a terminal event with 2-5 days. A decision to remain on standby was made, and arrangements with a local mortuary were made.

Because some investigation had already been done into nearby funeral homes, the team had a contact in the area. When they arrived at the funeral home to discuss specifics of the preparation and documentation requirements, the general manager was uncomfortable and tried to back out of the verbal agreement. Being prepared however, team members were able to produce copies of emails exchanged that clarified the level of cooperation that had previously been discussed. With written confirmation in hand, the manager changed his mind and became supportive.

During this time, the funeral home had to confer with their corporate headquarters, because they'd never worked with on a cryonics case. The corporate headquarters gave the necessary approvals, and authorized the funeral director to assist Alcor personnel with the cutdown and washout. Alcor's remote team was treated and billed as an out-of-state funeral home. The funeral home allowed the remote team to store equipment on the premesis and made a funeral director available 24-hours a day to assist in cannulating the femorals. The remote team was given priority access to the preparation room when needed. Portions of the equipment used in the washout were stored at the local funeral home, and transport equipment was stored at the hospice.

In the week before his legal death, our patient had been losing significant amounts of blood in his urine and exhibited extensive bruising. Evidence of jaundice was seen on his limbs, and his stomach was distended. Emboli were present in the lungs. The patient came in and out of consciousness, and on occasion, was able to smile and recognize one of the standby members who knew him prior to his cancer. Though most of his conversation was inappropriate at this point, he did have occasional moments of lucidity.



By this time, chemotherapy and other treatments had been

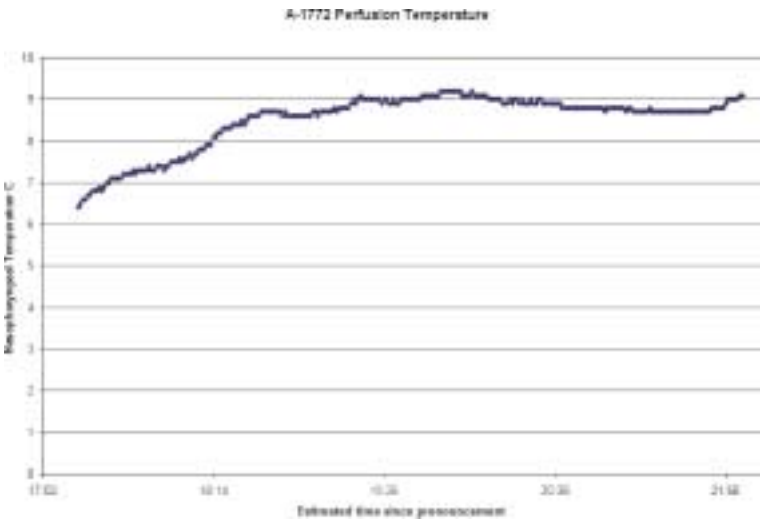
discontinued, and the bulk of the medications being administered were for comfort. The patient had been receiving coumadin, but this was discontinued due to the internal bleeding and bruising. Because simply stopping the coumadin would not have acted quickly enough to slow the bleeding, a dose of vitamin K was administered while he was in the hospice. Unfortunately, vitamin K takes some time to begin counteracting the effects, and was not administered in time to actually show signs of helping prior to the patient's pronouncement. As a cryonics patient, this was not a significant development in the transport, as the coumadin was acting in very similar fashion to the heparin we administer during a stabilization. All medications were being administered by hospice personnel through a stent line, which was subsequently left in place after pronouncement for use by the transport team.

As needed medications included: Ambien for sleep, Marinol for appetite, Tagamet for upset stomach, Adavan (lorzapan) for nausea, and Effexor for depression. He was receiving Oxycontin for pain, twice a day; Digoxin for irregular heat beat, 125 mg once per day; and Cartia (a low dose aspirin), 180 mg per day. On his second day in the hospice, a foley catheter was introduced to monitor both urine output and to allow for on-going observation of the internal bleeding indicated by blood in his urine. The patient was confused by the foley and tried to get out of bed a few times to use the restroom, despite being told he had a catheter in place for that purpose.. Examination of the urine output revealed continued levels of blood.

Final preparations for the transport were made, including calculating medication doses, bagging ice, and assembling the portable ice bath. Early in the morning a couple days into the standby, the hospice staff felt the patient's status was declining and called Tanya Jones at 0637. Tanya, who had been getting some rest in a nearby motel, arrived several minutes later and joined the night-shift team members. The timing was quite good, as at 0645, the patient arrested. The nurses and doctor were present, and the patient was pronounced immediately. The transport team placed ice around the patient, focusing on the head, axilla and groin. Concurrently, the first round of emergency medications were administered. Once the medications were completely administered, the patient was transported by the funeral directors to the mortuary.

Tanya and one of the Florida team members went ahead to the funeral home, while two others remained with the patient to continue administration of the large-volume medications and to await the funeral director and his vehicle for transport. By the time the patient arrived at the funeral home, the ATP and surgical equipment were set up, and perfusion circuit was primed and de-bubbled. As an aside, setting up the perfusion circuit has been much-simplified over the years and the making the actual connections took less than ten minutes for a person who'd not seen the system in years. This represents a significant improvement to emergency transport capability, as the preparing for perfusion used to take more than a hour to string, prime and de-bubble the field pump.

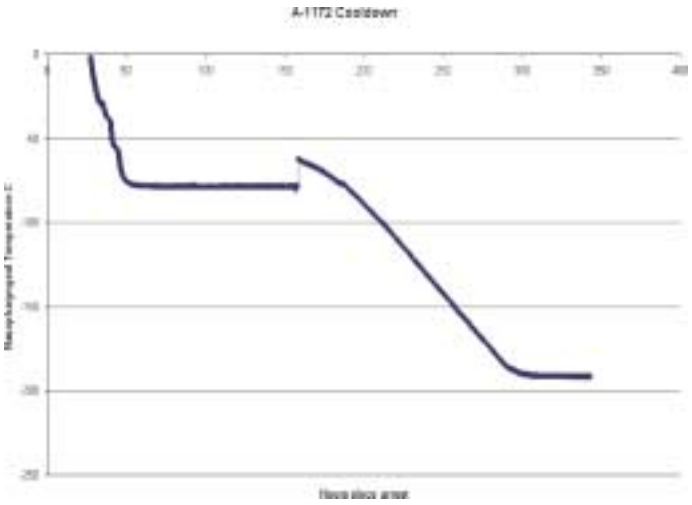
At 0913, the first surgical incisions were made. Femoral veins and an artery were cannulated without incident by 0929. Connecting the circuit and starting the bypass proceeded without difficulty. The blood washout began immediately, and good return volume was obtained from the venous lines. Unfortunately, the transport team members were unable to locate the manometer in the field kit, so no pressure information was available. As a result, the washout proceeded at a lower, more conservative pressure in order to avoid damaging the vascular system. When the circuit was closed at 0945, we observed a consistent reduction in circulating volume, further indication that internal bleeding continued. The patient's temperature was 30.1 degrees C at the beginning of the washout and was reduced to 12.9 by the time perfusion was stopped due to the significant loss of circulating volume at 1030. Perfusate circulation was continued until the last possible moment.



The target temperature during glycerol perfusion is 9 degrees C, because at lower temperatures, glycerol becomes too viscous to perfuse. The patient arrived several degrees colder, was warmed by the perfusion to 9 degrees.

While the washout was being done, the local funeral director started preparing the paperwork and flight arrangements for shipment. The nearest airport was two hours away, and we would have to drive fast to make certain we reached the cargo terminal in time for the pre-flight screening deadlines required since September 2002. The patient was promptly packed in ice and insulated for the trip; and by 1120, was secured for shipment via commercial airline. The prep room was cleaned and the equipment repacked in time for the departure. Tanya followed the funeral director to the airport and accompanied the patient on the flight to Phoenix. The patient's flight took a little longer than we like, because departing from a smaller airport meant a transfer and subsequent time delay at an intermediate airport.

The patient's flight arrived in Phoenix at 2034, and the patient was secured by our local funeral director. By 2138, the patient arrived at Alcor and was transferred from the Ziegler case to the operating room table at 2141. One area that has been improved in recent cases is in reducing the time between patient arrival and start of surgical procedures.



The patient's cooldown followed the prescribed curves. At around 150 hours, there is a temperature jump because of the temperature differential between the Silicool system and the cooldown dewar.

This has been achieved by improving the personnel and equipment organization and preparation before the patient arrives. The patient arrived at the facility with a nasopharyngeal temperature of 5.1 degrees C, and there were still substantial amounts of ice in the Ziegler case. The amount of ice that could be placed in the Ziegler case was a concern in this case, because of the airplane transfer and time delay, and the size of the patient being larger than we usually see.

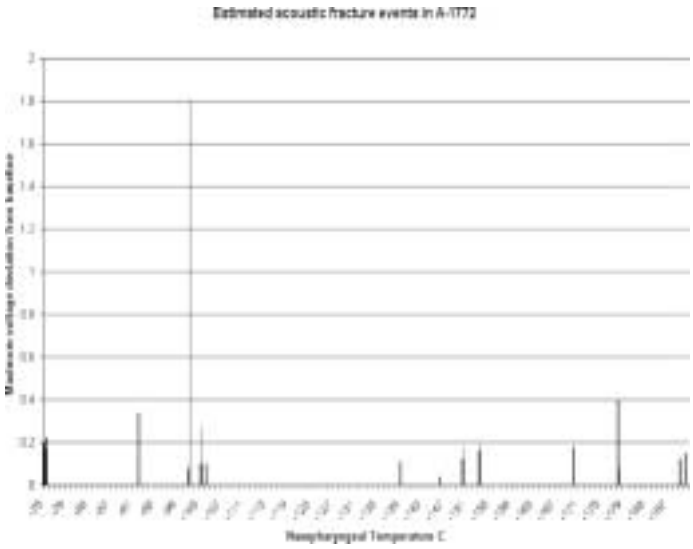
The patient's arrangements were for a whole body glycerol perfusion, and access to the vascular system was obtained through a median sternotomy and cannulation of the aorta. The venous return was obtained via the right atrium. Surgical preparations were complete, and the first incisions were made at 2206, with the only delay being a short in the electrocautery knife, which was immediately replaced. Once the perfusion circuit was connected to the cannula and flow initiated at 2250, perfusion solution began accumulating in the chest cavity. Our surgeons paused the perfusion as they clamped off a compromised vein. Some difficulty was experienced keeping the cannnula in place, and lines were stitched into place to avoid unwanted extubation. After 30 minutes on bypass, the concentration ramp was initiated, increasing the concentration of cryoprotectants. The first signs of glycerolization were seen on the chest, as the skin took on the characteristic bronze color.

Burr holes were drilled to observe the surface of the brain, and temperature and thermoacoustic probes installed. Fluid was obtained from the burr holes, and there has considerable discussion about the composition of the fluid. The fluid may be coming from the vasculature disrupted in making the burr holes, or the fluid may be a product of the cerebrospinal fluid system. Determining the origin of the burr hole fluid is important, and analysis of the fluid is expected to provide further information as to how well the brain is perfusing. On future cases, more effort will be expended in trying to accurately monitor the activity of the burr holes.

During the case, significant perfusion solutions built up in the abdominal cavity. This phenomenon is not unknown, and was not surprising in this case, because of the extensive cancer in the abdominal area. A sample of the fluid was removed at the end of the case and analysis indicates it most likely occurred during the remote washout portion of the procedure, where no direct measures could be taken to stop the internal leakage that ultimately caused the field washout to be stopped.

The whole-body cooldown proceeded according to protocol and without incident. A total of 20 acoustic fracturing events were recorded, beginning at about -75 degrees C and with the last occuring at near-liquid nitrogen temperature. There were three distinct events recorded at -75 that may have been artifacts of physical or other disturbance of the monitoring system, as those events occurred at temperatures about 20 degrees above the glass transition point. The next acoustic event was recorded at about -93 degrees C and is believed to be the first actual fracture event for this case.

This patient was transferred to long-term storage a few days later. His family drove out for a visit a couple weeks later, bringing some personal items for Alcor to store in its underground vaults, to hold in trust for the patient when he's awakened. This is a practice we encourage for all our patients and their families, and we really appreciate when one takes the time to prepare these items for archival storage. A-1772 was Alcor's 62nd patient.



A total of 20 acoustic fracturing events were recorded. The first event occurred at -75 degrees, and the final event at -190 degrees C. Determining what constitutes an acoustic fracturing event is difficult, and there is some controversy on the three events at -75. Those events did not exhibit the same behavior of most known events, and occurred approximately 20 degrees higher than the glass transition temperature of glycerol.

SEEKING HIGHER TEMPERATURE STORAGE

by Tanya Jones

As the years pass, the nature of Alcor's cryopreservation options is becoming increasingly complex. More options have become available since Alcor was founded; and as research improves the quality of each cryopreservation in general, more options will be added to the mix. In this article, I discuss the changes to patient storage systems that are being investigated.

Today, storage is the same for all patients: controlled cooling and immersion in liquid nitrogen. As a long-term storage medium, liquid nitrogen offered several advantages, including the ease of storage using simple dewar technology; the availability and relative low cost of liquid nitrogen in metropolitan areas; and the reliability of a low-tech, power-free solution.

With all its advantages, there is one serious disadvantage to our current storage system: pathogen cross-contamination. Patients sharing a single dewar are being exposed to the pathogens carried by the other patients in the space. Though this is unlikely to impact the ultimate prognosis given anticipated medical nanotechnology, it does represent a risk to the staff that cares for these patients. The consequence of this is that all liquid nitrogen in every dewar must be treated as contaminated fluid, and appropriate precautions taken during handling.

Advances in patient care alternatives are leading us to a point where co-mingled storage in liquid nitrogen may no longer be the only option. Gaseous nitrogen could be used to store patients at higher temperatures, above the glass transition points for the various cryoprotectants. For glycerol, our data indicates that cracking occurs below -85°C (patient range: -87°C to -113°C); and for B2C, cracking temperature lies below -115°C (range: -117°C to -134°C).[1] Unfortunately, neither of these temperatures is sufficiently low to provide for protracted storage (current goal: -134°C), so we must continue to investigate methods for further lowering storage temperatures.

"Temperatures of -130°C or -196°C… should therefore be similarly effective for stopping biological time because they are both significantly below the temperature at which molecules can no longer freely interact."

Investigating higher temperature methods for storage is an on-going process. Prior to the prototype storage pod being built, preliminary examination indicated several problems that would need solving for any deployable design. Several of these are detailed on our website, and include gas stratification, active control with minimal power, having gas and liquid mixtures on fill, and reliability.[2]

- ***Gas stratification.*** *Between the cold liquid in the bottom of a dewar and the outside temperature at the top, there is a natural convective stagnation of the cold gas in a temperature/density gradient. In order to obtain a uniform temperature in the storage volume it is necessary to vertically circulate the gas by stirring, with fans or other means. Conventional fans are not normally expected to operate at cryogenic temperatures, primarily because the lubricant in the bearings freezes.*

As we looked at this problem in greater depth, we discovered there were distinct areas of stratification. First, there is stratification for the patient and within the individual pod itself. Stratification issues also exist where multiple patients are stacked vertically in the same dewar. During the testing of a prototype individual pod placed in an LR-40 dewar with a 1" pool of liquid nitrogen at the bottom, we discovered there was an 80 degree (Celsius) difference between the top and the bottom of the pod's external environment and a three degree difference internally. This served to indicate the serious nature of this issue, since temperature differentials of less than a degree are desired internally; and the external temperatures, though not directly impacting the patient's temperature, will dictate the workload of the heating elements.

We use specialized aluminum containers for our patients, where aluminum's excellent conduction properties are an advantage. New vapor storage pods will have insulation, sensors and micro heaters to control the temperatures. Pods will be in an environment that is colder than the patient's target temperature, and heaters will adjust the temperature upward. For patients stored together in a single dewar, the ones at the top will potentially be at warmer external temperatures, which in turn could cause the bottom pods to require excessive heating power. To address this, we'll be examining copper and aluminum framework designs to allow for the passive temperature control mechanisms that are preferred in patient care.

- ***Difficulty of achieving active control with minimum power.*** *Active systems can require a significant amount of power. Since the proposed high temperature storage systems are expected to operate through periods of*

commercial power failure, power requirements must be minimized. To achieve close temperature regulation and minimal power requirements, a combination of active and passive regulation is required, with fine active control being superimposed on passive regulation.

A combination of active and passive systems is unavoidable for vapor storage. The use of exclusively passive systems to achieve our goals is not possible, since there is no storage medium with a boiling point that is in the right range, readily available, inexpensive, and non-toxic. We still intend to use passive systems as often as possible, since more intervention requires more power, and more power means more potential failure points. Compromises will be required in the degree of control and the accuracy available.

To illustrate, the framework mentioned above should reduce the stratification problems significantly, but an active system will be required to obtain the necessary precision in achieving target temperatures. If the active systems (in this case, the heaters) fail, the lower the differential between the ambient and the internal temperatures, the less risk there is for the patient.

Assume for the moment that the internal pod temperature is maintained by redundant active systems and the ambient temperature is maintained exclusively by passive systems, there are several ways we can adjust the efficiency of the passive systems. Methods to affect the ambient temperature include: the metal framework thickness, shape and composition; the size of the liquid nitrogen pool at the bottom of the dewar; and the amount and type of insulation used.

- ***Gas-liquid mixture on fill.*** *In filling, large quantities of cold gas can be introduced along with the liquid nitrogen, interfering with control system regulation. Since the system is being designed for minimum power requirements, however, separating the cold gas from the liquid prior to its entering the dewar reservoir is necessary.*

We accept regular deliveries of liquid nitrogen. Cylinders and the requisite plumbing are used to pump nitrogen into the dewars; and the nitrogen has to be delivered through the top, because anything else would compromise the shell vacuum. A gaseous nitrogen storage system would require a small pool of liquid nitrogen at the bottom of the dewar, with nitrogen gas surrounding the patients. Pumping liquid nitrogen into the dewar and moving it past the patients on the way to the bottom, would cause turbulence and change the delicate temperature balance a great deal.

Still, the pods are designed to tolerate wide external temperature swings, and this is not a significant problem in the long run. It would however be nice to resolve from the beginning since hostile external gradients and temperature swings could, over time, degrade pod insulation, thereby reducing long-term durability.

One proposed design would deal with this problem through the application of a commercially-available device to separate the liquid from the gas prior to entering the dewar. There would also need to be a waste line, one providing a path of least resistance for gas exit, and that in combination, should reduce the impact of nitrogen fills on the controlled dewar environment. This has not been tested and must still be developed more thoroughly.

- ***Lack of reliability.*** *Backup systems and alarms are required for redundancy, thus it is expected that the final product will have no less than two nearly separate systems, each independently able to carry regulation on its own, plus appropriate alarms to notify operators of component failure.*

As far as impediments go, the lack of reliability is one of our highest concerns. This has become more of an issue since we started developing vapor storage systems for our patients, and will continue to be a problem until we have sufficient safeguards in place. Safeguards will include (at a minimum) typical level and temperature alarms, and must be expanded to include alarms for the new controllers and heaters and other moving parts in this storage design. One additional safeguard is that most of the failure modes would involve the patient's temperature becoming colder, rather than warmer as would be the case with conventional refrigeration systems.

For the first time, the use of computers to control the finer points of temperature stabilization will be possible. The amount of networking required is still being examined, and we're fully aware that more complexity increases the chances of failure. We're anticipating the use of two independent controllers, each monitoring a slightly different range of temperatures (though possessing the same target temp) and being on independent circuits. If deviation occurs, the devices will collaborate to set off alarms. Without going into too much detail, because much of this aspect has yet to be built, the expectation is that we'll be able to have a complete failure in any single component, and the system will still remain online.

Power redundancies are a separate issue and will be addressed. We already have back-up generators in the facility to allow for things like use of the operating room equipment in case of power failure. We fully expect to have independent universal power supplies for the new storage system with connections to a larger generator, in case it's needed. That said, the power requirements for this system are extremely modest, on the order of 15 watts per patient — it would take nearly ten patients to equal one bright light bulb.

Currently our plan is for each pod to have the capability for providing a single, idealized storage temperature for an individual patient. Preliminary calculations indicate that storage costs for patients who chose vapor storage will at least double, but more likely triple, due to the greater demand for liquid nitrogen. (Storage costs only would be higher, not the full cost of cryopreservation.) This might put individualized vapor storage out of reach for some of our members. As a result, we're looking into the potential of storing multiple patients at a common storage temperature.

There are problems associated with this approach, which may or may not be show-stoppers in the long run.

An important concern surrounding storage at temperatures warmer than liquid nitrogen is whether chemical deterioration will be more rapid. For a reference table, see our website for Hugh Hixon's article *How Cold is Cold Enough?*[3] Though Hugh's calculations were conservative and somewhat incomplete, they do give a rough indication as to how long patients may be stored at various temperatures. The most important point of the article is that below the glass transition temperature (approximately -120°C for patients vitrified today), molecules can no longer move freely; and therefore, chemical reactions cannot occur. Temperatures of -130°C or -196°C (liquid nitrogen temperature) should therefore be similarly effective for stopping biological time because they are both significantly below the temperature at which molecules can no longer freely interact.

Keeping in mind that -85°C would be the storage temperature chosen today for patients perfused with glycerol and -115°C for B2C cases, you can see there is a good chance that the cumulative damage may not give us enough time to effect revival. Unfortunately, the only way to firmly establish the cracking point in a patient is to actually pass through the glass transition point and observe cracking events as they happen.

We intend to carry out more testing on annealing methods. Annealing involves approaching the target temperature slowly — over the course of weeks or months — to relieve the thermal stresses that cause fracturing. Work in this area could lead to fracture-free storage at lower temperatures than we contemplate today, and lower is better in the long run.

Development of the intermediate temperature storage will continue, as it would represent a major advance in patient care. We encourage you to stay tuned for more information as this project continues.

1. Unpublished patient cooling data from 24 patients.
2. http://alcor.org/Library/html/CryopreservationAndFracturing.html
3. http://alcor.org/Library/html/HowColdIsColdEnough.html

Near The GLASS TRANSITION *Point*

By Hugh Hixon

The preferred method of cryopreservation for human patients is vitrification, and the reason for this is simple: freezing is extremely damaging. (Vitrification is a process whereby water in the cells does not crystallize, but instead enters a solid state resembling a liquid.) The idea that sharp ice crystals damage cells by puncturing them does not hold up well to the microscopic thought experiment of the process, however. Ice crystals advance their growth at the tip, and in contact with a cell membrane, water molecules cannot get into that interface to continue the advance of the crystal.

> *"Things would be much clearer if it were not necessary to make everything perfectly clear."* —Kant

Ice crystals form first in the spaces between the cells. Since they are crystals, and thereby pure water, the solutes in the interstitial fluid are excluded from the forming crystals and become concentrated in the remaining fluid. The solutes outside the cells are now more concentrated, and osmotic forces drive the transport of water out of the cells in an effort to dilute the interstitial fluid whose solutes have been concentrated by the ice formation. As heat is removed from the system, the ice crystals continue to grow, and the cells continue to become dehydrated. Concurrently, the freezing point of the remaining fluid outside and inside the cells drops. If there are no surfaces to start ice crystal growth inside the cell, the fluid becomes supercooled, an unstable state where ice *can* form, but is prevented from doing so by the lack of a starting point.

At the same time, the increasing solute concentration (particularly the salts) binds more water, stealing it from the proteins and other cell structures that depend on an exact concentration of water to hold their conformation. Proteins lose their working (native) conformation and can no longer perform their function; particularly at risk are the many enzymes that direct the biochemistry of the cell. Crushed between growing walls of ice, poisoned by the concentrated salts, the final act comes when the supercooled contents have the energy difference from the falling temperature necessary to form a stable ice nucleus; and the fluids in the cell flash over to dirty ice.

This is not good for the cell, and furthermore, is generally not a reversible process. Dehydated proteins and other large molecules are either permanently deformed or cannot search through all the possible shapes in configuration space find their native configuration in reasonable time. Critical biochemical paths are blocked, and the cell can't find its way back to the dynamic stability of life. It dies. The remarkable thing is that in any single freeze-thaw cycle, a few cells *do* survive, unfortunately, not enough to ensure survival of the organism. As an example of this ability to survive a freeze/thaw cycle, consider the common wart. If you've ever had a wart burned off with liquid nitrogen, you probably remember the spot being frozen several times. Each freeze-thaw cycle kills more of the surviving cells, until there are none left to regenerate the growth.

A lot of organisms, mostly single-celled, can survive this process. They do so because somewhere in their billions of years and quadrillions of generations, a few of their ancestors were caught in the ice and had mutations to the structure of their macromolecules that *did* allow them to withstand and reverse the processes attendent on freezing. The multicelled critters that can survive often also have evolved to produce their own cryoprotectants. Also note that for single-celled organisms, this resistance to freezing does not have to be particularly efficient; all that is necessary is that a single cell of an entire line survive.

The intent of cryoprotection is to avoid as much of the above process as possible. The first point of attack is to prevent the formation of ices from liquids. This done, as the temperature drops, the energy available for molecular motion decreases. The liquid becomes thicker and thicker until it is immobile. This is vitrification, the point at which a liquid becomes a glass. When this occurs, the temperature is variously and somewhat inexactly defined as the glass transition temperature (T_g) of the particular liquid being cooled.

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"The problem with chemistry is that it's much too difficult for chemists."
— Einstein

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In common usage, "freezing" simply means cooling something until it gets hard. The scientific definition is more exact: the production of crystals of a substance from the chaos of liquid or gas. As in a lot of other cases, a lot of argument and confusion can be avoided by agreeing on definitions first.

There are two attractive forces between atoms; ionic (electrical charge related), and electron spin pairing in molecular orbitals (covalent bonding). Electron pairing accounts for most chemical properties, and ionic forces for most physical properties. Within molecules, charge is rarely of uniform distribution, and polar attractions occur. These forces are tangled together so that, for example, quartz forms a random web of covalent bonds; and its physical properties are largely derived from the covalent force. The highly polar water molecule forms bonds that are around 10% covalent.

Where charge is (on average) uniformly distributed, random fluctuations in the electron distribution result in corresponding fluctuations in adjacent molecules and a net attractive "mirror force" (van der Waals force). The physical properties resulting from these interactions are temperature-dependent. Adding energy (usually by heating) overwhelms these attractive forces, resulting in melting, and then boiling of the compound. If the solvent is water, then the water is ordered around the other molecules dissolved in it.

These transitory reactions continue to be the subject of intense study; the 21 May, 2004 issue of *Science* has two articles with the following titles: "Infrared Spectroscopic Evidence for Protonated Water Clusters Forming Nanoscale Cages"; and "Infrared Signature of Structures Associated with the $H+(H_2O)n$ (n = 6 to 27) Clusters." In short, H^+ -- the simplest possible ion -- forms a cage of water molecules around itself, with a typical lifetime in the microsecond range. A reviewer noted, however, "In fact, these first spectral data on large protonated water clusters raise nearly as many questions as they answer."

So far, I have just described pure compounds. Start mixing in ions, polar compounds, non-polar compounds, and compounds with one thing on one end and another on the other, and things begin to get complicated.

For example, non-polar compounds have very little interaction with polar compounds. But non-polar compounds also have an effect on the structure of water, forcing the water molecules to interact more with each other and form a shell around the non-polar compound. As an example, methane clathrates, which are found by the megaton on the sea floor, have geological lifetimes. To further complicate matters, some non-polar compounds are *polarizable*, resulting in still more interactions.

These associations occur when they are energetically favored. Change the temperature, and this may not be the case any more. The most dramatic example is the melting of pure crystals in an almost infinitesimal temperature range, which brings us back to cryoprotectants. Cryoprotectants are compounds whose molecules, ions, or whatever, water molecules will bind more strongly to than they will to ice crystals, over the temperature range of interest. (The same criteria also apply to the cryoprotectants and to any combinations of them and water.)

Though detailed discussion is beyond the scope of this article, it also helps if the cryoprotectants are not particularly toxic. I once sat down and came up with ten toxic mechanisms, which means there are still more. Only a few mechanisms are probably applicable here. We do know that the toxicity of some known cryoprotectants depends on time and temperature, which narrows the field a bit, but beyond that, toxicity studies are currently limited to a dead/not dead observation. This lack of knowledge is unfortunate, since practical cryoprotection involves some choices; and it would be useful to know what other choices we are making at the same time, with respect to toxicity.

All the above processes are accompanied by changes in the energy of the system. If the reaction results in a release of energy, it is favored. If it absorbs energy, then that energy has to be supplied from somewhere, or the reaction doesn't happen. Energy in this context usually takes the form of heat, but may appear in other forms, such as bonds or entropy.

The other criterion for a reaction to proceed is its energy of activation, the kick needed to get it started. A dramatic

Compound	Melting Point	Bonding Type
methane (CH_4)	**91 °K**	**mirror (Van der Waals) force**
water (H_2O)	**273 °K**	**polar**
salt (NaCl)	**1686 °K**	**ionic**
quartz (SiO_2)	**1883 °K**	**covalent**

Relative strengths of different attractive forces can be had by looking at some absolute temperature melting points.

example of this kinetic stability is explosives. A more valuable one is oxygen, which will react energetically with a lot of things, but (usually) only when heated to a fairly high temperature. Free oxygen's combination of thermodynamic instability and kinetic stability is responsible for life as we know it.

Finally, a definition: *a minimum of internal energy of a solid occurs when it is in the form of a perfect crystal*. This is a statement of the 3rd law of thermodynamics, and defines the minimum of entropy at any temperature.

Let's cool something simple for an example. An ideal case would be argon, nice round uniform spheres. (Not water; water is *very* strange.) In its crystalline form, each atom will find its lowest energy when it is surrounded by the maximum number of other argon atoms possible and unable to move. That number will be 12, in the array known as *hexagonal close-packed*. In the liquid state, the atoms are attracted to each other, but because the amount of energy they have is greater than the energy that can be released by being in contact, they just bounce away again. Looking at the curve of volume versus temperature (Figure 1), the effect of raising the temperature is to increase the rate of movement; and each move creates a void. The net effect of this void is an increase in the volume of liquid. As the liquid is cooled, the reverse happens. The number of voids is reduced, and the liquid contracts.

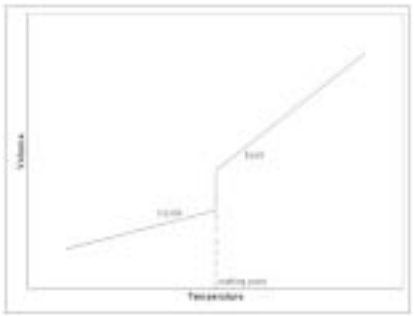

Figure 1

At the freezing point, atoms still are mobile, and voids exist; but if any more energy is removed, an atom will associate with the growing crystal, thereby giving up its kinetic energy to maintain the temperature. This isothermal process will continue until all the kinetic energy is removed and only the crystal remains, with its energy confined to vibrational and rotational states. Below the freezing point, the slope of volume contraction is shallower because, only vibrational and rotational states are left to give up energy.

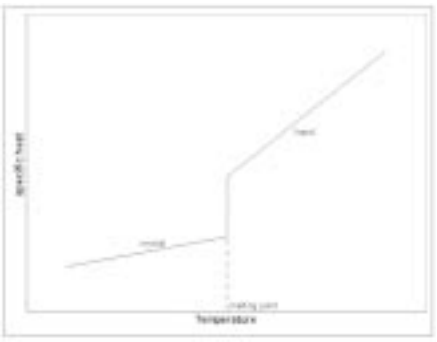

Figure 2

We can also look at the process of cooling by plotting the specific heat (the amount of heat it takes to effect a given temperature change) against the temperature. This plot takes the same general shape, because the same process is taking place -- the partition of energy between kinetic, vibrational, and rotational degrees of freedom. This, by the way, is the Kinetic Theory of Thermodynamics: that motion (kinetic energy) and temperature are the same thing.

Figure 3

Here is another way to look at things. Figure 3 plots an "energy landscape", where the horizontal axis is a grossly oversimplified representation of the possible states that a substance can assume, and the vertical axis is the energy. Again, this is for argon. Note that above a certain energy (the melting/freezing temperature), everything is liquid. There are tiny fluctuations at the melting/freezing point as the liquid finds crystal-like states, and in this otherwise almost featureless landscape, the single, infinitesimally narrow well of the perfect crystal exists.

Molecular motion occurs in the picosecond range (10-12 sec). Electronic motion occurs in the attosecond range (10-18 sec).

Ideally, the freezing and melting temperatures are the same. In practice, only the melting point is the real thing, because due to the kinetics of freezing, liquids can be supercooled (remain liquid below the melting temperature) fairly easily. (It's possible to *superheat* a solid above its melting point, but only for a time of a few atomic vibrations. You use a pulsed laser to deliver the energy.)

Supercooling occurs when there is an energy barrier to crystal nuclei forming spontaneously from solution. While molecular aggregates are continually appearing and disappearing, the arrangements of molecules at the interface between the spherical aggregate and the liquid do not resemble those of crystal planes. As the temperature decreases, the probability of an aggregate large enough to have some part of its surface flat enough to resemble a crystal increases, until finally a crystal can start to form. Since the

How many states are there in an energy landscape?

How about roughly e^N, where N is the number of particles involved! And that assumes featureless spheres, which molecules are not.

liquid is already below the freezing point, crystallization goes runaway until the released heat of crystallization warms the liquid back to the freezing temperature. As the liquid cools, its viscosity increases, which reduces the probability of an ice nucleus forming, so there's a maximum rate of crystal nucleus formation with temperature. In systems that are ordered enough to allow a crystal nucleus to form, vitrification can be forced by rapid cooling (quenching). For simple systems like a collection of featureless spheres, argon atoms for example, the formation of a crystal nucleus is quite easy. For something like water, with its directed bonds, supercooling can go as low as -40°C. For glass-forming mixtures, crystal nuclei may never form at all.

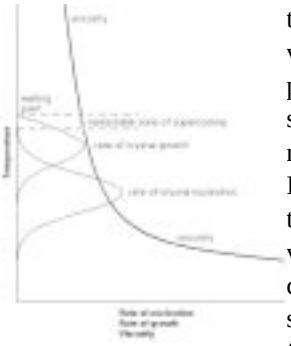

Figure 4

Now let's look at the energy landscape for something vitrifiable. (Figure 2) As the temperature is very slowly lowered, the system has to explore each configuration, or potential well, in a random-walk fashion. A short calculation demonstrates that even a small system is not going to find the configuration of lowest energy in the life of the universe. A plot of specific heat (C_p) can be seen in (Figure 5). (C_p of a crystal included for comparison). As heat is removed from the system by lowering the temperature, less energy is available for molecular motion, and the viscosity begins to rise rapidly. As freedom of motion declines, the specific heat decreases, until finally there is no energy available for motion, and the system is solid.

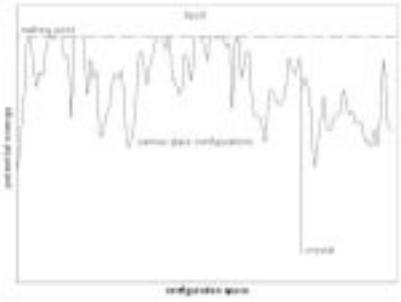

Figure 5

Somewhere in this process, we pass through T_g. The practical import of this is that we are now in a region where flow still is possible, but slow. Think of something like, say, a bar of chocolate. You can break it into pieces, but if you support it at both ends and come back in a day or so, it has sagged into the gap. Of course, the speed at which it sags will depend on the temperature. In a freezer, it could take a long time. This slow flow to relieve strain is called annealing. It assumes considerable importance in cryonics, because for a number of reasons, below T_g-strains begin to build up in the tissues. When the strain exceeds the mechanical strength of the cryoprotected tissues, cracking occurs. For a while, slowing the temperature descent will allow the annealing mechanism to catch up, but eventually it falls behind. Since chemical reactions depend both on the temperature and the ability of molecules to move around, chemistry also ceases.

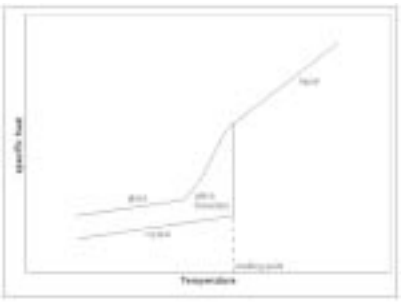

Figure 6

This is the simple version; the newer cryoprotectants are more complex. There is a carrier solution, mostly water, for initial washout and perfusion. Water is slowly replaced (over the course of hours, to minimize osmotic stress) with a mixture of polar organic compounds (the basic cryoprotectants) to bind the remaining water; long-chain macromolecules that are added to increase the viscosity; and ice blockers that coat, forming ice crystals with a growth-blocking layer of molecules. The proportions of these components are balanced to obtain the best survival rate for tissue samples in a complete cryoprotection / cooling / warming / decryoprotection cycle.

In practical situations like cryonics, things get even more complicated:

- If portions of tissue are poorly perfused for some reason, there may not be enough cryoprotectant to bind all the water, and ice crystals form. How much of this can be tolerated before tissue damage becomes a problem?
- If vascular barriers are intact, particularly the blood-brain barrier, are the macromolecules of the viscosity increasing agents and the ice blockers getting into the tissues?
- The cryoprotectant components may diffuse into the tissues and cells at different rates; is the ratio of cryoprotectants the same in tissues as it was in test tubes, and if not, does that make any difference?
- Are the tissues perfusing to the final equilibrium concentration fast enough that cryoprotectant toxicity is not a problem?
- What is the mechanism of cryoptotectant toxicity? Is it some form of permanent damage, or is it ultimately reversible?

These and other questions remain to be explored, and hopefully, dealt with. The design of cryoprotectants is complicated even with scientific insight, and like the energy landscape, contains enormous numbers of possibilities. Only a few though, will be good enough.

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Author's note: I have attempted here a description of vitrification at the molecular level, based in large part on an overview class I took at Arizona State University almost two years ago (Chem 598, Glassy Materials: Formation, Properties, and Applications). This is not how the class was taught, and all errors are mine. I don't think I could pass the final any more.

A L C O R

Update

CEO Report

by Joseph A. Waynick

My first six months at Alcor have been nothing less than a blur. There are always time-sensitive issues to solve and fires to put out. And there is never a dull moment. I suspect that the second half of 2004 will be just as challenging as the first. This report will give the membership an overview of some of the accomplishments from the first half of the year.

Despite a slight detour during the first quarter, we have managed to put quite a few oars in the water. We believe the membership will be pleased with the pace and amount of progress made to improve the quality of service and patient care we are providing.

Alcor has entered into a new three-year agreement with Emergency Educational Institute, Inc (EEI). They will provide standby and transport response teams for the east coast. With the renewal of this agreement, we have increased the qualifications needed to participate on transport response teams for Alcor members. Each team member must be a state certified or state licensed Emergency Medical Service (EMS) professional. EEI is based in Fort Lauderdale, Florida and is fully equipped with Alcor ATP kits. Additionally, EEI will be providing monthly EMS training to Alcor transport team members while simultaneously receiving cryonics refresher training from Alcor. Tanya Jones and I recently visited EEI to tour their facility, meet their staff and assess their state of readiness. You can get a full report on EEI later in this issue from Todd Soard, the President of EEI.

This level of professionalism is a first for the industry. We are raising the bar for cryonics organizations worldwide. Our membership can take comfort in the fact that when needed, the largest and most technologically advanced cryonics facility in the world will be there for them with a trained team of medical professionals. No other facility comes close to the level of service provided by Alcor.

Our field readiness is stronger than ever. Over the past couple of months Mathew Sullivan put together a crash effort to recover from six consecutive suspensions. Mathew organized a production system that enabled us to replace a full year of medications, consumable supplies, and instruments in short order (based on our historical average of six cases per year). He tapped resources from every department in the organization to marshal the skills and labor needed to accomplish the task. Our preparedness to accept multiple back-to-back cases is better than ever because our capability is now equally balanced between the field and operating room. Our inventory includes enough med kits, tubing packs, and cryoprotectant for an average year of suspensions.

In addition, Mathew has finalized the field kit cost analysis project. This will enable the accounting department to more accurately bill the actual cost of standby and transport services. Mathew's newest project is to complete an operating room cost analysis. This will involve performing an accurate inventory count of all instrumentation, equipment, and supplies in the operating room for appropriate chargeback by accounting.

Moving on, we are very excited to announce that our attempts to establish a new relationship with Arizona State University (ASU) is making progress. Alcor is applying to participate in the ASU "Distinguished Professorship" program. Through the university Alcor will sponsor research into the bioethics of cryopreservation. Our desire is to help educate academicians and the public about the potential benefits of cryonics to society. In addition, we want to spark serious intellectual discussion on the ethical and moral attitudes of those who seek to restrict research and development into the areas of science we view as crucial to future reanimation of our patients, such as stem cell research and nanotechnology.

Furthermore, we have established an internship program with graduate level science students

to assist us with analyzing and writing up our backlog of case reports. This is an excellent opportunity for us to involve the next generation of scientists with cryonics in a highly positive way. We are doing this because we need as many credible voices as possible external to our community to participate in cryonics research and speak about its staggering potential. We may also learn a few things ourselves by getting outside input to our operation, methods, and protocols. Gaining the assistance of a major state university will enhance our credibility with academic, scientific, and political constituencies.

Our financial picture continues to brighten. The Board of Directors has approved the establishment of a true Endowment Fund with the purpose of generating income for the organization. The assets will be invested in a professionally managed mutual fund; and the income will be used for research and development, facility upgrades, and general operating expenses. Our intention is to create a trust designed to disburse 7.5% of the fund assets annually. Each disbursement will be allocated across the organization and used as appropriate.

We anticipate the fund to outpace the level of disbursements and grow larger each year. This in turn will generate even larger disbursements since the income stream will be based on total fund assets. Alcor will have a solid financial base on which predicable financial forecasts can be made.

In keeping with our ongoing efforts to manage our revenue and expenses, we have finally instituted a computerized budgeting system. Now we are able to create budget forecasts years in advance and generate running variance reports on a monthly basis. This gives us greater flexibility in managing our cash flow needs while focusing attention on budget variances for planning purposes. This is just one more step forward in a more professionally managed organization.

On the legislative front, we have not taken a break. Meetings have already begun with relevant stakeholders in preparation for the next legislative session. Our objective is to obtain a consensus on the need or lack of need for regulation and establish support among the stakeholders for the consensus position. We believe that entering the next legislative session with support in place and reasonable solutions to the issues expressed in the previous session will strengthen our ability to ensure harmful legislation is not passed by the Arizona legislature.

Meanwhile, the membership continues to show their individual financial support of forward thinking legislators in their generous contributions to their reelection campaigns. Due to campaign finance laws, Alcor cannot be directly involved in political fundraising; however, any member who desires to exercise their constitutional right to participate in the political process by donating to the reelection campaigns of Representative Linda Lopez and others who stood by our right to self-determination, may do so by contacting the office of Barry Aarons at (602) 253-1821.

Two major project initiatives that have now gained traction are the Facility Expansion Project and Transport Vehicle Upgrade. Tanya Jones, Hugh Hixon, Cindy Felix and I have spent many hours reviewing the project plan for the final stages of the facility expansion. Detailed construction specifications have been developed, professional architectural drawings have been completed, and formalized project task lists have been created to move the project forward. We are very excited to get this effort concluded since it is so important to the long-term capability of the organization.

Furthermore, I have engaged Charles Platt to complete the Project Plan to upgrade our new Transport Vehicle. Charles has visited the facility, recorded detailed specifications about the vehicle for use in generating 3-D images of possible interior configurations and equipment recommendations. With the help of Tanya and Hugh, Charles will identify and articulate the intended uses of the vehicle, establish an operating range, and work with the technical team to ensure that the equipment recommendations support the mission of the vehicle while staying within budgetary constraints.

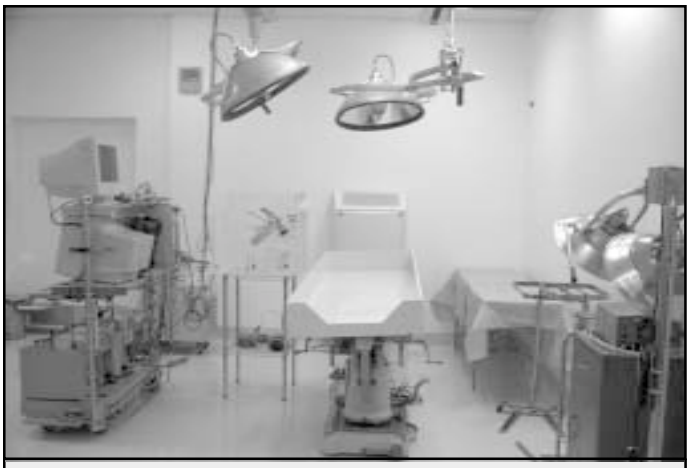
A final major event that occurred in the first half of the year was the announcement that the public relations firm of WalshCOMM was selected to represent Alcor for a six month engagement, and then on a month-to-month basis thereafter. The owner of the company is Cheryl Wash. Barry, Michael Riskin, Tanya, and I interviewed Cheryl and her team extensively prior to making the selection. WalshCOMM won out over three other strong competitors.

Over the next six months, Cheryl and her team will perform the following tasks for us:

- Identifying company marketing priorities;
- Telephone research with Board members, Advisors, staff and members;
- Lobbying support;
- Community positioning, awards, recognition;
- Development and placement of PR articles;
- Ghostwriting and placement of relevant articles;
- Assistance in retaining ASU for an economic impact study;
- Development of strategic partnerships with Valley non-profits and associations; and
- Introduction to and development of alliances with complementary businesses, associations, etc.

These are all important activities that will aid us in our pending efforts in the legislative session. In addition, these activities lay the groundwork for a more targeted marketing effort to increase membership growth, fundraising, and general revenues.

Our work to advance the science of cryonics, provide unparalleled rescue, transport, and cryopreservation service to our members, as well as ensure unending long-term patient care continues to move forward. Alcor is the world leader in the field of cryonics. It is my intention, as well as the intention of the entire Alcor central staff, Board of Directors, and all of our advisors to keep it that way. We are all grateful to the continued support of our volunteers, political supporters, and financial donors, as we meet the challenges ahead.



Alcor's State of Readiness

For the First Half of 2004

by Mathew Sullivan

Alcor has experienced a notable shift in focus on its commitment to readiness. I was tasked with improving our ability to recover from a cryosuspension in 10 days or less. With the possibility of another last-minute case looming, we renewed our commitment to recover quickly, not only from previous cases, but from future cases as well.

Part of the challenge of ramping up our readiness capability was that in December of last year my father deanimated just after a cryosuspension. Consequently, I had to leave town for a period of time to attend personal family matters. (A case report is planned for a future edition of *Cryonics* magazine.) The downside to my being out of town during or just after a cryosuspension is that our rate of recovery slows down. Once I returned to Scottsdale, I was able to devote the necessary time to the recovery process during the month of January.

In addition to the early January recovery process, there was a need to perform a number of transfers from our smaller dewars into the Bigfoot dewars. If patients remain in our short and mid-term dewars too long, it ties up valuable resources and hampers our ability to do future cool downs.

Not everyone sees the amount of work required to ensure a healthy state of readiness. When specific issues are recognized that need to be addressed, other matters may be put on hold. Over the years, I have seen this phenomenon occur numerous times with the regular rotation of staff. Most people, including those who are activists, do not fully understand what it takes to remain operational. Therefore, we as an organization must remain vigilant to stay on course in critical areas of readiness while addressing secondary priorities.

In support of my new mandate to elevate and maintain a higher readiness level for our kits, I was able to replenish eight of those kits and complete the following tasks:

Transport Kits:	Qty
Training ATP tubing pack:	1
Updated and repacked ATP:	3
Updated and repacked ATP Support:	1
Repacked PIB/SCD:	1
Pack training washout case:	1
Built new PIB/SCD:	1

One issue I resolved was repacking the Air Transportable Perfusion Case (ATP) kit, which most people rightfully complained about as being too heavy at 85 lbs. I transferred a number of items to the ATP support kit, reducing the ATP kit to less than 73 lbs.

Our field team has a tendency to ship back equipment that is still wet from being used. Despite their efforts to wipe it down, it can be difficult to dry it out completely without taking it apart. As a consequence, our sterilized supplies often get wet or are exposed to enough moisture that mold grows inside the case. This slows our recovery because it takes extra time to strip out all the cannulae, wash, dry, and re-sterilize it. Each ATP holds 35 sterile cannulae, so they were transferred to the ATP Support kit to reduce the possibility of contaminating them. (We still have not been able to groom our field teams into sending the supplies back in other kits such as the ATP support kit, and our sterile supplies are still being returned as before.)

Our kits that were destined for shipment to Canada were complete, and were being stored in my office to help ensure that they were not used elsewhere. After the kits sat in my office for several months, they were reintegrated into the Alcor central supply system to strengthen our stock of kits ready for deployment on short notice. This turned out to be an advantage because of the new expectations that would come from management on what should be kept in stock and ready to go.

Additional progress was made in determining the weight of our kits and the cost to produce them. The results of that work can be seen below:

Transport Kits:	Lbs.
ATP	72.55
ATP Support	75.75
MDS	44.80
MDS Support	37.95
PIB/SCD	47.20
Refrigerated and frozen meds	05.00 Plus gel packs and shipping material
Washout case	58.50
Training Kits:	
ATP training tubing pack	10.45 Plus shipping material
Washout training case	15.55

In my reports to management, my preference is to report projects that have been completed, but here I wish to make an exception. Over the years there have been multiple attempts on my part and the part of others to break down the cost of producing our transport kits. With the most recent attempt, I came reasonably close to making a determination as can be seen below. These figures also include an estimate for labor, overhead and shipping, but do not cover the cost to deliver the kits into the field. For example, a next day a.m. delivery of our kits to Florida via FedEx costs about $1,300.

Transport Kits:	Cost
ATP	$5,340.56
ATP Plate – Training	$1,742.44
ATP Support	$6,544.91
Meds	$2,976.86
Meds Support	$1,264.04
Perfusate Case	$1,589.83
Perfusate Case – Training	$383.93
PIB/SCD	$759.08
Total	**$20,601.65**

Also in support of the readiness drive, Hugh Hixon repacked our surgical trays and perforator and had them sterilized. On this note, I reminded everyone that we no longer had the capability to have our large mixing reservoirs EtO sterilized, and that our remaining stock was limited. This issue does not apply to neuro cryosuspensions.

By February I was able to report that the bulk of my effort since January had been devoted to giving the operating room an overhaul in support of cryosuspension readiness. For example, our equipment was cleaned in detail. Anything from old tape and paint being removed from equipment, to the removal of suture from casters, to oiling the casters and other equipment as needed.

With the expectation of a near-term neuro case, the operating room was put into a high state of readiness, including laying out supplies and stringing the heart/lung machine. Furthermore, I worked with the American Red Cross for AED and CPR certification and the following staff members were certified: Hugh Hixon, Todd Huffman, and me.

During March, we performed another suspension. Fortunately, I had already finished prepping the OR for a neuro suspension. In addition, our digital camera issue had been also been resolved. Initially, the camera lacked enough function that it appeared to have been damaged, but it only turned out to be a matter of adjusting the settings.

By April, we had performed two more cryosuspensions. Our inventory of dry components necessary to make MHP-2 dropped to 30 liters. Consequently, Judy Muhlestein and I pre-weighed and packed enough chemicals to make seven batches of 40 liters and six batches of 20 liters, for a total of 400 liters. That brought our total stock of dry components to 430 liters, plus we had two 20-liter batches in liquid form stored in the refrigerator. This did not include the pre-deployment of 20 liters in California, Florida, and the UK.

In support of cryosuspension readiness, I reported the lab had been cleaned up and organized to make room for chemical and transport kit production. Considering the number of times I emptied out the trashcan, my estimate was that roughly 500 gallons of unnecessary and/or obsolete supplies were discarded. With assistance from Cindy Felix, a fair amount of equipment and supplies were transferred from the lab into suite 108 for storage. Enough space has been freed up in the lab to allow me to function on single projects such as chemical production, provided there were no other interested parties wanting to use much in the way of space.

In the midst of all of the readiness preparation and suspensions, I also assisted management with formulating and estimating this year's budget expenses for the clinical aspects of performing suspensions.

By May, we had performed yet another pair of suspensions. Both were from the state of Florida and we redeployed a second set of kits to that location. At the time of my board report, none of the used kits had been returned.

Judy Muhlestein and I refurbished five med kits and built one new one, minus the med packs. Med packs are stored separately in a refrigerator from the main Thomas pack (medical/paramedic backpack). Even though we only had two med packs in storage we restocked our supplies enough to build six more, minus Promit. There have been some problems with the manufacturer of that medication, and Promit has been on backorder with the distributor since June 2003. I placed a standing order to purchase more Promit once it became available. Promit is administered prior to Dextran-40 to prevent the rare instances of anaphylactic shock for those who are allergic to Dextran-40. I also repacked three med support kits and three ATP support kits. Hugh Hixon made two 20-liter batches of MHP-2, bringing our refrigerated stock up to 60 litters.

Due to OSHA regulations restricting the use of Freon, we are unable to recharge the Blanketrol unit used for cooling our patients during cryoprotection. The Blanketrol's cooling capacity failed during our first case since April, but we were able to compensate by manually feeding the bath with ice for whole body cryosuspensions, and LN_2 into an isopropyl alcohol bath for our neuro cryosuspensions.

Also during the first cryosuspension case since April, one of our 4351 PCI boards from National Instruments (used to monitor temperatures) was found to be inoperative. The failure appeared to be a result of an unknown power surge causing one of the chips (L7) on the circuit board to burn out. We were able to compensate during the cryosuspension by using numerous handheld DuaLogr Thermometers. With assistance from LabView technical support, our monitoring system was restored for the second cryosuspension after cannibalizing our new cooldown computer that was under development. During this process, the old Pentium P133 MHz was replaced with a P4 1.8 GHz, and newer LabView software.

At about this time, our supplier of Hydroxyethyl Starch (HES) planned to suspend production for several years and indicated that they may never resume production again. HES is a crucial component in the production of our organ washout solution and also for our whole body cryoprotectant. Our current stock of HES would most likely not last more than two years, and the manufacturer asked us to place our final order before May 15th. I reported to the board that I was looking into several leads for an alternate supplier, but had no other information at that time. Therefore, we purchased 120 kilograms of HES at a cost of $400 per kilogram for a total of $48,000, giving us an estimated three years to solve this problem.

In addition, we were again faced with the issue of no longer being able to have our large concentrate and mixing reservoirs EtO sterilized. At the conclusion of our most recent whole-body cryosuspension, I attempted to have the reservoirs steam sterilized, but that effort was rejected by our new provider. The timing of the rejection turned out to be less than ideal because our provider had a new interim Clinical Supervisor who was unfamiliar with our arrangements. As a consequence, all our arrangements were held in question, but I was able to negotiate a continuation for the sterilization of our smaller items. If the Clinical Supervisor's position became permanent, I believed we might be able to work something out to have the reservoirs steam sterilized, but that effort would later fail.

We have worried that the reservoirs might not hold up to steam sterilization, but I was told by an employee from our previous provider that that is how they handled our reservoirs because they would not fit into their EtO sterilizers. Hugh Hixon believed this assessment was incorrect and cites our use of gas tape versus steam tape. During this process I learned that EtO sterilization with a cycle time of 24 hours is on the way out as a result of a newer process called Sterad, which can be done in 45 minutes at room temperature. The downside to Sterad is that it does not penetrate as deeply into small areas, and therefore, does not completely eliminate all demand for EtO sterilization.

Our overall current state of readiness was adequate (within in the context of performing back to back cryosuspensions), but we only had two neuro tubing packs and two 40-liter sterilizing tubing packs. We could have compensated for the lack of the 40-liter sterilizing packs with 20-liter packs. Traditionally, we only used the smaller sterilizing packs, but the frequency of cryosuspensions over the last few years has pushed us into making up more than one batch at a time and then refrigerating it. We were also out of refrigerated stock of B1, our neuro washout solution. We had approximately 18 liters of our neuro cryoprotectant, B2C. Normally we use no more than 7.5 liters of B2C for a neuro cryosuspension, but we did have an exception where we used 13 liters in one case. In addition, we had sufficient pre-bagged components to make B1 and B2C, which could easily be mixed on short notice.

By June, all kits held up in Florida had been returned to Alcor and a set of refurbished kits had been sent to the Florida team. Even though the order had been given to ship another set of kits next day air to Florida, they did not arrive in time for a sudden cryosuspension. Therefore, Alcor enlisted the services of Suspended Animation to assist with the case. Having three cryosuspensions come from the same area within a ten week period pushed us to our limits.

With the help of Cindy Felix, Hugh Hixon, Todd Huffman, and Jerry Searcy, the following tasks were completed:

Transport Kits:	Qty
ATP kit:	1
ATP Support kit:	2
B1 washout solution, wet:	4 – 10L
B2C cryoprotectant, wet:	2 – 20L
Field cut down tray:	1
Med pack:	6
Med Support kit:	2
Neuro surgicaltray:	1
PIB/SCD kit:	2
Washout kit:	2
Whole body surgical tray:	1

The extra help I received was the result of the new recovery policy in support of cryosuspension readiness that required we be recovered from a cryosuspension in 10 days or less with assigned tasks to a list of staff members. This is not the first time staffers from other departments have been enlisted to help recover from a backlog. However, the difference was that staff members assigned to the recovery team were give specific responsibilities for all future recoveries to prevent future backlogs.

Alcor is not well-positioned to handle simultaneous cryosuspensions due to limited space in the facility and a lack of redundant equipment. We have compensated for this over the years by having extra supplies ready to go such as pre-weighed chemicals, and extra tubing packs. This was done to help simplify our recovery process, so that we could focus on the key issues such as cleaning up and repacking our instruments. However, the current Facility Expansion Project is expected to help address some of these critical issues and give us the added capability we need within the next six to eight months.

Our Blanketrol unit used for cooling the patients during cryoprotection was recharged with Freon by a local company. Although the unit does not have the cooling capacity it once did, it is sufficient for our needs. As a result, we now have a stronger need for LN_2 to assist cooling during the cryoprotective pause at the midpoint of the procedure when the patient is aggressively cooled.

After the last cryosuspension, all the pumps from the heart/lung machine were removed for cleaning. Consequently, the stand became top-heavy and toppled. Our computerized LabView system with the thermocouple and refractometer equipment fell on the floor. Both monitors were damaged and had to be discarded. The remaining equipment was tested to verify its functionality. Until the LabView system is brought back online, we will have a greater need for helpers in the operating room for sample taking. Prior to the use of LabView, we had 5 team members (including

sample takers for lab testing) who were dedicated to taking samples and charting the refractive index on the wall.

Our current state of readiness had improved over and above what was reported in May despite our adding another patient. I noted we were beginning to feel the impact of having to wait up to a week or more to get our equipment sterilized. This is in contrast to our previous supplier where we were able to get our instruments sterilized in 1-2 days.

Over the course of a 10-week period this year Alcor performed five cryosuspensions, breaking all previous caseload records. Since the last cryosuspension, we were also on alert for a local member while we had both our whole-body and neuro instrument trays in for sterilization. Without additional surgical instruments and/or our own ability to sterilize our equipment, there will be complications in the future with our current caseload.

To address the challenges facing Alcor's increased caseload, management asked me to prepare a proposal that could further reduce our recovery time from ten days to five days. Here is a summary of that proposal:

Trained helpers

With more experienced help, we will be less dependent on one or two specific individuals for the various tasks, and more tasks could be accomplished simultaneously.

Dedicated lab/work space

Adding more helpers that are experienced will require additional space for production. The current dry lab space is limited to performing one or two tasks at a time. However, once we are fully functional in the new operating room, we can enlist the old operating room as auxiliary space for recovery production tasks.

Enclosed cabinets

We need more cabinets and bins to better organize our supplies. Replacing our rack shelves with cabinets will help save the time needed for periodically wiping everything down.

Mobile cart

We need a mobile cart with many bins for the supplies used in transport kits and tubing packs. This will dramatically reduce retrieval time for supplies by eliminating the need for going room to room hunting down little odds and ends.

Instrument storage

We need a better system for organizing and storing our spare (non-sterile) surgical instruments. Currently, our instruments are piled on top of each other in a tool box or cabinet. This makes it difficult to find what we need in a timely fashion. It also risks contamination because of additional handling. The problem can be reduced by purchasing a larger tool cabinet or by developing a different methodology for storing and handling instruments.

Steam sterilizer

We need a larger steam sterilizer to ensure we can (1) sterilize our instruments at the last minute and still have a complete tray that is properly organized, and (2) reduce our dependence on EtO sterilization. We can use our current steam sterilizer, but that would mean not having anything stocked on our shelves and ready to go. The reason is that our instrument trays are large and organized enough that proper packaging cannot be done with the current sterilizer.

EtO sterilizer

Having our own EtO sterilizer would eliminate or at least reduce our dependence on outside sources of sterilization where the stability of our arrangements are always in question. I must admit that we have not been terribly aggressive in finding alternative sources for our sterilization needs. However, we realize that finding other outsourcers will reduce the likelihood of burning out any one provider.

We can also reduce our need for EtO sterilization by replacing our Concentrate Reservoir and Perfusate Withdrawal Buffer reservoirs with disposable bladders. One large downside to this plan is that we are not well positioned to measure liquid levels in bladders. We can compensate by placing each bladder on a weight scale, but we will need to do a few calculations to the Perfusate Withdrawal Buffer bladder to compensate for density variations.

Instrument trays

Having extra instrument trays on the shelves will reduce the likelihood of running out of usable instruments because of sterilization wait times or because more than one cryosuspension is in progress. (To date the latter has not happened, but we've had cases close enough that cooldown times have overlapped.)

Feed rack for tubing and tubing cutter

A rack-mounted cabinet can improve our efficiency with tubing pack production. The tubing can be pulled from a dispenser out on the cutting table and a tubing cutter will simplify and accelerate the process by avoiding the use of scissors. Using scissors to cut the tubing is inefficient.

Ensure all diagrams are current

New computer generated tubing pack and instrument diagrams will be easier to read and follow than hand written notes. This will allow more people to readily participate on the recovery team as well as help reduce the likelihood of errors during construction. Digitizing our diagrams will improve our overall efficiency because it will take less time to update them.

Auto label system

Our current system is to print out labels on paper and then use packing tape to secure them on our transport kits and bags of chemicals. This is somewhat labor-intensive because the tape has to be cut multiple times and folded on one side for the chemical bags, so they can be easily removed. Having an appropriate label maker and pre-cut labels will reduce the amount of time for each of the projects.

Larger stock on shelves

We can notably reduce our recovery time by including more products on the shelves and skipping non-critical tasks after each case. This does not have to dramatically tie up Alcor's cash flow, because we don't necessarily have to have extra product in all categories. The way we can to do this is to set a minimum and maximum threshold for each line item and only produce when necessary. Having a staggered production cycle will balance out our overall expenses over time.

Scaling up

As Alcor's growth rate increases we will need to examine the possibility of outsourcing the production of tubing packs, chemicals, and custom meds.

By July, there were no new cryosuspensions to report. We are fully recovered from our previous cryosuspensions. However, we must still resolve the problems of getting our large reservoirs sterilized, repairing our LabView computer system, and our inability to obtain Promit.

I spoke with the hospital Clinical Supervisor about making arrangements to get our reservoirs steam sterilized and he said it would be too inconvenient for them because shelves would have to be removed from their racking system. He also expressed concern about the volume of material we had been sending him. He went on to say that he would continue taking our equipment "for now," giving the impression that our arrangement would not be permanent. I told him we had a string of cryosuspensions from which we were trying recover. I further informed him that with the load I was currently dropping off we were caught up and that things should settle down until the next case.

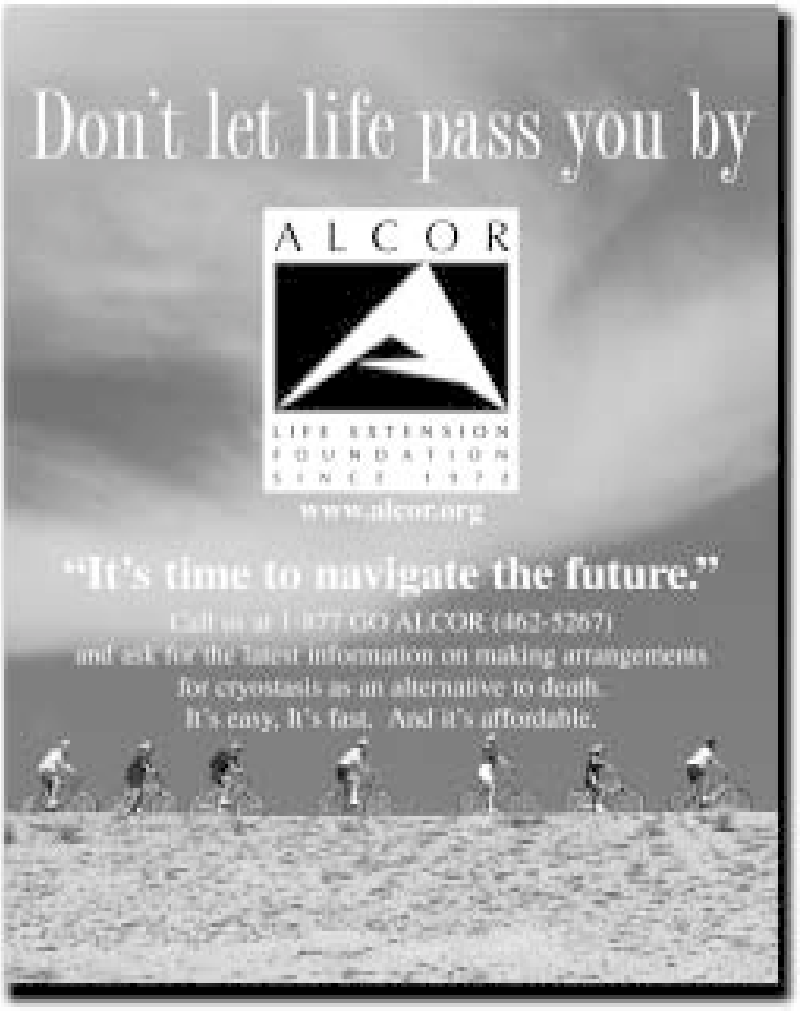
I called the manufacturer and distributor of Promit and the medication continues to be on backorder since June 2003. Promit is manufactured by Taylor Pharmaceuticals, who was recently purchased by Akorn, the distributor of Promit. Despite calling multiple numbers to try and get an idea of when the product will be back on the market, no one was able to provide any additional information.

We only have three vials of Promit left at Alcor central. Each of our med kits requires two vials of the medicine. The medication must be administered no more than 15 minutes prior to administering Dextran-40 to avoid the unlikely event of anaphylactic shock. If 15 minutes has elapsed before administering Dextran-40 then another vial of Promit must be administered due to the short half-life of Promit. To stretch our supplies I reduced the number vials in the med kits from two to one. At that point, I recommend that we consider finding an alternative to Dextran-40.

By July, we had also found a new supplier of HES willing to ship us product. We ordered a sample to have its chemical composition independently tested for equivalence to the HES from our previous supplier. In addition, the following tasks were completed with help from Cindy Felix, Hugh Hixon, Nakia Hughes, Judy Muhlestein, and Tim Reeves:

Transport Kits:	Qty
2-20 liter sterilizing tubing pack:	12
ATP Support kit:	1
Med kits:	2
Neuro tubing pack:	7
Pre-weighed 40 liter MHP-2 dry components:	2

Completing the above tasks have enabled us to declare that we are fully recovered from all previous cases performed this year. Thus, we have managed to carry a record caseload while implementing a new policy that improves the recovery process. This paves the way for Alcor to address other pressing issues and further improve the quality of care and cryosuspension service it provides.



TechNews

by Gina Miller with R. Michael Perry, Ph.D.

Making Nanodots Useful for Chemistry. Nanosized clusters of germanium that can be reacted chemically to make useful materials, such as plastics, have been made by chemists at the University of Wisconsin-Stevens Point and UC Davis. Robin Tanke, an assistant professor of chemistry at UWSP, worked with UC Davis chemistry professors Susan Kauzlarich and Tim Patten to put useful coatings on germanium nanoclusters. Kauzlarich's laboratory has developed methods for making germanium and silicon nanoclusters, while Patten's research focuses on attaching polymer coatings to different kinds of nanoparticles. (EurekAlert 6/18/03) http://www.eurekalert.org/pub_releases/2003-06/uoc—mnu061803.php [NGN 6/20/03]

Machines That Reproduce May be Reality. Can machines reproduce? More importantly, perhaps—should they be allowed to? In a recent issue of the journal *Artificial Life*, a group of Canadian researchers says yes despite warnings to the contrary—most notably from author Michael Crichton in his new book "*Prey*," about self-replicating nanobots run amok. To prove their point, the researchers have created a primordial soup that works like a digital DNA factory, where T-shaped "codons" swim in a computer-generated virtual liquid forming single, double, and even triple strands. Like DNA, these digital particles "can be assembled into patterns that encode" information, claims robotics scientist Peter Turney in a new paper. For the first time ever, "we demonstrate that, if an arbitrary seed pattern is put in a soup of separate individual particles, the pattern will replicate by assembling the individual particles into copies of itself." (NewsFactor *SciTech* 7/10/03) http://sci.newsfactor.com/perl/story/21893.html [NGN 7/12/03]

Nanotech Advances toward Artificial Organs. Scientists have built a minute, functioning vascular system—the branching network of blood vessels which supply nutrients and oxygen to tissues—in a significant step towards building whole organs. Conventional tissue engineering methods have successfully grown structural tissues such as skin and cartilage in the lab. But not being able to create the supporting vascular system has proved a major stumbling block preventing scientists from creating large functioning organs such as liver or kidneys. Now, researchers from Massachusetts Institute of Technology and Harvard Medical School have used computers to design branching networks of venous and arterial capillaries, which start at three millimetres wide and reach a fineness of just 10 microns. (*New Scientist* 7/8/03) http://www.newscientist.com/news/news.jsp?id=ns99993916 [NGN 7/12/03]

New Way to Control Tiny Particles' Motion. Nanotechnology researchers may soon be able to design new types of tiny shuttles or conveyor belts which could be used to deliver medications to specific cells or to replace wires in molecular-sized electronic devices. An international team of investigators, including a physicist from the University of Michigan, has devised a method that could help researchers with one of the most challenging problems in nanotechnology: controlling the motion of tiny particles, both in artificial nanodevices and biological systems such as ion channels in cell membranes. (*Newswise* 6/19/03) http://www.newswise.com/articles/view/?id=36282 [NGN 7/12/03]

Bone Healing through Nano in China. For the past six years, Cui Fuzhai had been developing a new method of healing broken bones using nanotechnology. But with the threat of SARS lurking, he had to stop his experiments in late April. Hospitals where clinical trials on the new technology were being held were sealed off, making it impossible for Fuzhai's doctors to see patients. One clinical patient even came down with SARS and couldn't undergo surgery to have the "nano bone" implanted. Fortunately for Fuzhai, the threat of SARS has waned in China. After being halted for a month, experiments are once again being conducted and clinical trials are proceeding. Fuzhai and his team of researchers have successfully implanted nano bones in dozens of patients and he hopes that the technology will be commercialized soon. (*Small Times* 7/1/03) http://www.smalltimes.com/document_display.cfm?document_id=6300 [NGN 7/12/03]

Movement for Posthuman Rights. Cyborg Liberation Front. By Erik Baard. This article examines the challenges and opportunities facing the transhumanist movement with respect to communicating with other groups, potential friends and potential foes. (*The Village Voice* 7/30/03) http://www.villagevoice.com/issues/0331/baard.php [NGN 7/31/03]

Nanoparticles Keep Brain Cells Alive. Nanoparticles

originally developed for industry have an unexpected effect: They triple or even quadruple the life of rat brain cells, suggesting that they could help extend human lifespan and decrease age-related health problems. (*Betterhumans* 8/15/03) http://www.betterhumans.com/News/news.aspx?articleID=2003-08-15-5 [NGN 8/21/03]

Researcher Attempts to Become a Cyborg. Imagine a world where people make lunch plans via telepathy, acquire genius-level mathematical skills in an instant, and learn to golf by downloading the neural impulses of Tiger Woods. According to Kevin Warwick, professor of cybernetics and researcher at England's University of Reading, all of these things might be possible. And that's why the 47-year-old researcher has chosen to become a cyborg: part human, part machine. (*The News Sentinel/Fortwayne* 8/15/03) http://www.fortwayne.com/mld/newssentinel/6541921.htm [NGN 8/21/03]

3-D Printing's Great Leap Forward. Rapid prototyping is a concept straight out of Star Trek. Feed an RP machine a 3-D blueprint of an object and it will carve a model of that object out of metal, paper, plastic or starch, just like the replicator aboard the USS Enterprise. Now, these RP devices, also known as 3-D printers, are about to get even better. Engineers are giving the machines the ability to build moving parts, not just block models. (*Wired* 8/11/03) http://www.wired.com/news/technology/0,1282,59648,00.html [NGN 8/21/03]

Biomolecular Motors at DARPA. Biomolecular motors are nature's nanomachines that convert chemical energy into mechanical work with performance and scale unparalleled by any manmade motors or machines. The principal goal of this program is to develop an understanding of the fundamental operating principles of biomolecular motors and exploit this knowledge to harvest, modify, and integrate these macromolecular assemblies into useful devices from the nano to macro scale. (DARPA) http://www.darpa.mil/dso/thrust/biosci/biomomo.htm [NGN 9/7/03]

Patent Awarded for Method of Making Nanobatteries. A University of Tulsa chemistry professor and two former students have been awarded a patent for a method of making nanobatteries for use in tiny machines similar to the microbe-size craft that traveled through a human's blood vessels in the 1966 science-fiction movie, "Fantastic Voyage." U.S. Patent 6,586,133 was awarded July 1, 2003, to chemistry professor Dale Teeters and to Nina Korzhova and Lane Fisher, who were both chemical engineering students at TU when they worked on the process to manufacture nanoscale microscopic batteries. One nanometer is one-billionth of a meter. The diameter of an average hair is 50,000 nanometers. (*Newswise* 8/20/03) http://www.newswise.com/articles/view/500572/ [NGN 9/7/03]

Nano, Inc. vs. Nano Think. Nanotechnology, long a favorite of science fiction writers, is now real enough for government money. So let the squabbling begin! On April 20, K. Eric Drexler, the futurist who coined the term "nanotechnology," published an open letter to Richard E. Smalley, a Nobel laureate working to translate nanoscience into a sustainable business. In the letter, Drexler accused Smalley of attempting to "dismiss my work in this field by misrepresenting it" and charged that "your misdirected arguments have needlessly confused public discussion of genuine long-term security concerns." In a followup published two months later, in the absence of any direct response from Smalley, Drexler continued to express his concerns: "I would not ordinarily raise an issue so persistently. But the question of what nanotechnology can ultimately achieve is perhaps the most fundamental issue in the field today. And your words have been remarkably effective in changing how this issue is perceived." There's more to this article, if you either register or sign up for a free day pass. (*Salon* 9/2/03) http://www.salon.com/tech/feature/2003/09/02/nanotechnology/index_np.html [NGN 9/20/03]

Japanese Scientists Advance Quantum Computing. A Japanese research team has for the first time successfully demonstrated one of the fundamental building blocks needed to construct a viable quantum computer. The team from NEC and the RIKEN Institute of Physical and Chemical Research were able to establish a quantum logic gate (controlled NOT or CNOT) operation in a solid-state device consisting of two coupled quantum bit (qubits). A CNOT gate is a basic building block to a quantum computer in much the same way that that AND / OR gates are building blocks in traditional semiconductor devices. However, this is just one step in a highly complex development process. For one thing, researchers need to establish how to extend the quantum entanglement of the bits necessary for the operation of the gate beyond fractions of a second. (*The Register* 10/31/03) http://www.theregister.com/content/61/33711.html [MP]

Nanomotors Realize Visionary's Dream. One of the ambitions of nanotechnology, building motors on a molecular scale, has been realized. Researchers at Berkeley at the University of California created the world's smallest electrical device earlier this year—one hundred million of which could fit on the end of a pin. The motors—the work of Berkeley researchers Alex Zettl and Adam Fennimore—were built using an atom-fine point of a nano-probe, inserting the circuits into place on a silicon chip. The motor sits in the middle of a silicon chip four millimetres square. The motor itself is much, much smaller—the shaft is 50 nanometers thick. The motors finally realized one of the visions of the 'prophet' of nanotechnology, Richard Feynman. (BBCNews 10/30/03) http://news.bbc.co.uk/2/hi/technology/3224329.stm [NGN 11/2/03]

Efficient, Accessible Nanoscale Machining. Think of a microscopic milling machine, capable of cutting just about any material with better-than-laser precision, in 3-D—and at the

nanometer scale. In a paper published this week in the Proceedings of the National Academy of Sciences, University of Michigan researchers explain how and why using a femtosecond pulsed laser enables extraordinarily precise nanomachining. The capabilities of the ultra-fast or ultrashort pulsed laser have significant implications for basic scientific research, and for practical applications in the nanotechnology industry. (*Eurekalert* 4/20/04) http://www.eurekalert.org/pub_releases/2004-04/uom-ula042004.php [NGN 4/23/04]

Getting Molecules to Do the Work. The era of nano-manufacturing is being born in hundreds of labs that are racing to perfect a technique called self-assembly. If you just listen casually to a description of what Sandia National Laboratories has been working on, you would think it had wasted its time reinventing the wheel: It has developed a robot that can walk and pick up and deliver loads of cargo. In an age of advanced assembly and landings on Mars, that hardly sounds impressive—except that Sandia's robot is a molecule. Called a motor protein, it has two little feet on one end and a tail that can grab things on the other. Once a special chemical is added to the solution in which it resides, the protein begins moving along strands of fiber that are one-fifth the width of a human hair, says Bruce Bunker, a Sandia researcher who's in charge of the project. (*Business Week Online* special report 4/22/04) http://www.businessweek.com/magazine/content/04_18/b3881609.htm [NGN 4/23/04]

Nanotech's Chemotherapy Cure. In the world of modern medicine there are few more imprecise and drastic measures than chemotherapy as a treatment for cancer. In most cases, the process involves poisoning a patient's system with toxic chemicals in an effort to kill malignant cancer cells. Anyone who has personally suffered through chemo or seen a loved one suffer can attest to its destructive and debilitating side effects. Unfortunately, one of the causes of these severe side effects comes not from the anti-cancer drugs themselves, but from the solutions used to dissolve them. When a drug won't dissolve in water, another solvent is often used in its place; occasionally the side effects of the solvent cause more discomfort than the cancer-killing agent. Scientific researchers working with nanoparticles, 1/100th the size of a red blood cell, may have discovered a solution to chemo's "solution" problem using? (*Forbes* 4/15/04) http://www.forbes.com/investmentnewsletters/2004/04/15/cz_jw_0415soapbox.html [NGN 4/23/04].

Military Uses of Nano. The U.S. military expects advances in nanotechnology to impact every major weapons system and is spending hundreds of millions of dollars annually on various research programs, a senior military science adviser said April 15 at a meeting of nanotechnology specialists. "Nanotechnology is one of the highest priority science and technology programs in the Defense Department," said Clifford Lau, the senior science adviser in the Pentagon's office of basic research. Lau, who also serves as president of the nanotechnology council at the engineering group IEEE, said research is being coordinated across the military branches, and plans are in place to transition the technology from basic research to deployment. (*GovExec* 4/19/04) http://www.govexec.com/dailyfed/0404/041904td1.htm [NGN 4/23/04].

Nanomedicine Vol. 2. The second volume in the *Nanomedicine* book series by Robert A. Freitas Jr., *Nanomedicine, Vol. IIA*: Biocompatibility, is now freely available online in its entirety at http://www.nanomedicine.com/NMIIA.htm. First published in hardcover by Landes Bioscience in 2003, this comprehensive technical book describes the many possible mechanical, physiological, immunological, cytological, and biochemical responses of the human body to the in vivo introduction of medical nanodevices, especially medical nanorobots [NGN 5/29/04].

Nanoparticles Illuminate Brain Tumors for Days under MRI. A research team from Oregon Health & Science University and the Portland Veterans Affairs Medical Center is demonstrating some of the world's first clinical applications for nanometer-size particles in the brain. The OHSU scientists have shown that an iron oxide nanoparticle as small as a virus can outline not only brain tumors under magnetic resonance imaging, but also other lesions in the brain that may otherwise have gone unnoticed, according to a study published in the journal *Neuropathology and Applied Neurobiology*. (Oregon Health & Science University 5/26/04) http://www.ohsu.edu/news/2004/052504nano.html [NGN 5/29/04].

DNA Robot Takes Its First Steps. A microscopic biped with legs just 10 nanometres long and fashioned from fragments of DNA has taken its first steps. The nanowalker is being hailed as a major breakthrough by nanotechnologists. The biped's inventors, chemists Nadrian Seeman and William Sherman of New York University, say that while many scientists have been trying to build nanoscale devices capable of bipedal motion, theirs is the first to succeed. "It's an advance on everything that has gone before," says Bernard Yurke of Bell Labs in New Jersey, part of the team that made one of the best-known molecular machines to date: a pair of "tweezers" also constructed from DNA strands (*New Scientist*, 12 August 2000, p 23). (bio.com 5/6/04) http://www.bio.com/realm/research.jhtml?realmId=5&cid=700001 [NGN 5/29/04].

Twisty Tweezers. Using only a laser beam, researchers can spin a microscopic bead, but they can't measure or control

the twisting force. Now reports in the September 2003 Physical Review A and the 14 May PRL demonstrate that the twisting force, or torque, can be measured by analyzing the light passing through the object. The PRL paper also shows how to control the torque by creating what the authors call an "optical torque wrench." The technique could be useful for exploring cellular machinery such as molecular motors or the proteins that replicate DNA. (*Phys. Rev.* 5/18/04) http://focus.aps.org/story/v13/st22 [NGN 5/29/04].

Nano Conveyor Moves Molten Metal. When an electrical current is applied to a multiwalled carbon nanotube (MWNT), the structure is transformed into a tiny conveyer belt that shuttles molten metal along the length of the tube, according to researchers at the University of California, Berkeley, and Lawrence Berkeley National Laboratory [*Nature*, 428, 924 (2004)]. Physics professor Alex Zettl, postdoc Chris Regan, and their coworkers liken the electrified tube to a nanosoldering iron that might someday be used to fabricate nanoscale devices. (*Chemical & Engineering News* 5/3/04) http://pubs.acs.org/cen/news/8218/8218notw7.html [NGN 5/29/04].

First Nanochips. As scientists and engineers continue to push back the limits of chip making technology, they have quietly entered into the nanometer realm. For most people, the notion of harnessing nanotechnology for electronic circuitry suggests something wildly futuristic. In fact, if you have used a personal computer made in the past few years, your work was most likely processed by semiconductors built with nanometer-scale features. These immensely sophisticated microchips—or rather, nanochips—are now manufactured by the millions, yet the scientists and engineers responsible for their development receive little recognition. (*Scientific American* 4/04) http://www.sciam.com/article.cfm?articleID=000CE8C4-DC31-1055-973683414B7F0000&chanID=sa008 [NGN 5/29/04].

Quantum Computing Gets Funding Boost. Waterloo, Ontario, Canada—May 12, 2004—A $33.3-million gift from Ophelia and Mike Lazaridis will help create a world-class centre for quantum-related research and teaching at the University of Waterloo. The gift from the Lazaridis family will be matched two-to-one by funds from the university and the public sector, for a total of $100 million (about $75 million in U.S. funds). The funds will be used for the creation of the new center and its programs. A new quantum science research building (est. 120,000 sq ft) with state-of-the-art equipment will be constructed on the east side of the campus and is expected to attract talented researchers from all over the world. http://www.labcanada.com/article.asp?catID=882&id=30484&story_id=&issue [MP 6/6/04].

Editor's Notes

We continue to forge ahead in getting our publishing schedule on track. We are almost there with this issue. Besides publishing on time, we are also upgrading the look and feel with more interesting graphics and more in-depth content.

Once established, the magazine will be an excellent ambassador for Alcor to the general public and to the many members of the state legislature who have requested subscriptions. With a bi-monthly schedule, it is frequent enough to hold the interest of busy legislators, yet infrequent enough to not become burdensome.

With our new emphasis on professionally designed cover art by Tim Hubley, it has great display appeal for newsstands, public and university libraries, and waiting room lounges. We have pushed the circulation up to 1,300 bi-monthly issues. It is shaping up to be an excellent mass appeal vehicle. Now if we can only get it out on time!

Editorial Content

Are you aware of any newsworthy events you would like to see covered by *Cryonics* magazine? If so, drop us a line and we will try to do a story. Is there someone in the cryonics industry you would like to see write an article for the magazine. Send us their name, and we will try to contact him or her and do our very best to persuade them to write for us. Better still, is there a particular person you would like to see us do a story about? If you think about it, there are endless possibilities for making this a more interesting publication. Send all of your ideas and suggestions to articles@alcor.org and make your contribution today.

Can You Write?

Members who would like to volunteer their time and write articles of interest for *Cryonics* magazine are encouraged to do so. We are particularly interested in articles relating to the cultural adoption of cryonics, supporting articles for the technical basis of cryonics, or even speculative fiction addressing things like potential revival scenarios. For information on deadlines and submission requirements please contact the editorial staff at articles@alcor.org.

Employment Opportunities

Have you ever thought about joining the team here at Alcor central? We have immediate needs for licensed paramedics and emergency medical technicians to join our nationwide Transport Teams. Your participation would be on a contract basis. You will be given cryonics training that will enable you to participate in our rescue and patient transport cases. Licensed professionals do not have to be members to work with us. We welcome your expertise and interest.

Alcor's Florida Connection

by Todd Soard, IEMSR-P, NREMT-P, PhD

Hello to all from the sunny State of Florida. It seems these days everyone has a Florida connection. Alcor is not immune. Joe Waynick and I are pleased to announce that Alcor has now entered into another multi-year contract agreement with Emergency Educational Institute, Inc (EEI), in South Florida to provide a professional response team for standby and transport services for Alcor members.

How is this team professional you may ask? Well, let me explain and provide you with some background on your East Coast Response Facility and Team. EEI is based out of Coral Springs, FL, just outside Fort Lauderdale. EEI has been training medical professionals for 12 years with a dominant interest in Emergency Medical Services (EMS). Our clients are primarily EMS but many do come from all areas of the medical field.

Our newest facility has two classrooms and two areas for breakout stations. EEI will be providing continuous education in medical emergency techniques to our team and to students seeking certification as an Emergency Medical Technician (EMT) and/or Paramedic. In addition, we will be providing ongoing training in emergency medical techniques to Alcor members and Regional Coordinators as requested. Alcor has signed a three-year agreement for these services, and we look forward to a long and lasting relationship.

The equipment needed for a standby and transport will be kept at EEI so that our team will have easy and rapid access to it. This provides 24/7 rapid response to Alcor members residing on the east coast, 365 days per year. We have implemented a "chain of command" in the event any team member is absent and a standby is necessary. In doing this, an emergency response will run rapidly and smoothly.

EEI maintains working relationships with many ambulance services as well as funeral homes, so transport and operating room facilities are readily available to ensure cryopatient care protocols can be followed with the utmost care. Standby time can be long for the team so we have set in place a rotation schedule so that each team member has time to rest.

Just who are the people who make up this new response team? They are a group of dedicated individuals, professionally trained in emergency response services, and certified in the state of Florida. Here is a quick summary of the team members and their qualifications:

Todd Soard – I have been with Alcor since 1998 and have participated in several standbys, transports, as well as assisted in the operating room. I have been in EMS since 1982 and hold a PhD in Public Health and Emergency Management. I worked in the field as a Paramedic for 16 years and was a Supervisor. I founded EEI in 1992 based on the need of providing education at a fair price. This has been accomplished and EEI has advanced to opening schools throughout the Caribbean. I am also the Trauma Education Coordinator here in Florida. With my practical experience and teaching in all areas of EMS I know that all of our clients will benefit from this background.

Sindiana Echeverri – Sindiana has been an EMS technician since 1994. I actually had the privilege of training Sindiana in the mid 1990s. She is a well-accomplished EMS Instructor with experience working in hospital settings as well. Sindiana is also currently taking classes at Broward Community College and has one year left before graduating as a licensed Registered Nurse. Sindiana has already participated in at least two standby and transport operations.

Dave Weiss – Dave is an EMT with field and

supervisory experience in EMS since 1995. He is also an EMS Instructor. He recently completed Paramedic school and will be taking his State exam soon, so we wish him all the best. Dave has worked as a 911 response operator in the Palm Beach County area most of his career and has gained much experience. Dave has also been on three standbys and has been part of the preparation team on these three cases.

Ernest Morera - Ernest has been a Paramedic since 1989 and lives in Northern Florida. This provides our team with a head start person from the North. Ernest has field and management experience, operates an extension of EEI in Northern Florida and is an EMS Instructor. Ernest has been on one standby and has been in our training sessions for the last 2 years.

Barbara Vinci – Barbara has been a Radiology and Emergency Room Technician since 1988. Her hospital experience gives the team a well-rounded view of patient care as well as providing us with a great working relationship with hospital staff. Barbara has been on 2 standbys and assisted the team in preparation of patient transport.

Jay Soard – Jay is a certified Medical First Responder and CPR Instructor. Along with his medical knowledge, Jay is an Information Technology (IT) Manager. This provides EEI with needed backup in case our computers or devices decide to take a break. Jay has been on two standbys and has assisted the team in cryopatient preparation for transport to Alcor.

As you can see we have put together a well-rounded group of professionals and will be adding more in the months to come. The team will be conducting monthly training sessions, as mentioned before, and quarterly equipment checks so that team member skills are kept sharp and the equipment ready for use on a moments notice.

Alcor has entered into a new three year agreement with Emergency Educational Institute, Inc (EEI) to provide standby and transport response teams for the east coast. Each standby and transport operation will be staffed with at least any two of the following: a licensed EMT, licensed Paramedic, or a licensed nurse. Furthermore, two additional team members will be certified medical professionals, for a minimum of four participants. One member of each team will be formally appointed the Team Leader. The Team Leader will be in charge of the case and will report directly to Alcor. Lastly, Alcor will dispatch one or more individuals from Alcor Central or from one of the Regional field teams to observe and if necessary, assist in the transport. Therefore, a five to six person team will staff each case.

Formal procedures will be in place to insure that detailed procedural data is recorded and transmitted to the laboratory to aid in providing optimum care upon arrival of the cryopatient. A specific individual will be charged with the responsibility of recording procedural data as well as the responsibility of maintaining regular and consistent communication with Alcor central. This person will also be trained and responsible for recording all physical procedures performed on the cryopatient and ensuring that all protocols are properly followed.

Despite all of these improvements, members can do a lot to enhance the quality of their own cryopreservation. I encourage all members to keep Alcor informed of any changes to your address, contact phone numbers, and places where you may be staying for a long period of time. Any changes in your health condition needs to be communicated as well. Please make sure that you have relayed your cryopreservation wishes to your family and physician. All of this will assist the team in a seamless and successful procedure.

I hope this has given you a better and more informed view of your East Coast team and what our partnership with Alcor means to you, the membership.

| | |

Alcor Membership Status

Alcor has 667 Suspension Members (including 106 Life Members) and 64 patients in suspension. These numbers are broken down by country below.

Country	Members	Applicants	Subscribers
Argentina	0	0	1
Australia	8	1	3
Austria	0	0	0
Canada	19	6	12
China	0	0	0
France	0	0	1
Germany	4	2	2
Ireland	1	0	0
Italy	0	2	3
Japan	1	1	2
Lebanon	0	0	1
Mexico	0	1	1
Monaco	2	0	0

Country	Members	Applicants	Subscribers
Netherlands	1	0	1
Russia	0	0	3
South Africa	0	0	1
South Korea	0	0	0
Spain	0	5	0
Sri Lanka	0	0	1
Sweden	0	0	1
Switzerland	0	0	2
Taiwan	0	0	1
U.K.	13	9	8
U.S.A.	618	97	246
TOTALS	**667**	**124**	**290**

Letters to the Editor

Letters to the editors are most welcome on all topics, including counterpoint on previously published materials and suggestions as to future content. We especially invite questions about cryopreservation (cryonics) that are original and far-reaching. If you are seeking information about Alcor, please consult our web site, at www.alcor.org. If you have questions about developmental programs within Alcor, you may stir us into talking about them even sooner than we might have otherwise. If your letter is lengthy and involved, we may use it as a separate article and may ask you to expand it. We need your ideas, your personal visions. This is the place to start.

Please send letters and/or articles to: articles@alcor.org.

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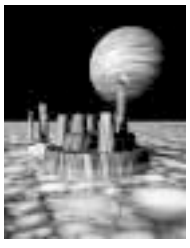
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Over the last several years, Tim Hubley has provided this magazine with some of the most beautiful and creative CGI art we've ever seen. Now Tim is selling a *limited run (only 20 copies each!)* of matted 8.5" x 11" color ink-jet prints of these images (without all the messy text added in layout) for only $15.00, plus shipping and handling.

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About the Alcor Foundation

The Alcor Life Extension Foundation is a nonprofit tax-exempt scientific and educational organization dedicated to advancing the science of cryotransport and promoting it as a rational option. Alcor currently cares for 58 patients in cryostasis, and has more than 600 signed-up Members. Being an Alcor Member means knowing that—should the worst happen—Alcor's Emergency Response Team is ready to respond for you, 24 hours a day, 365 days a year.

Alcor's Emergency Response capability includes equipment and trained technicians in Arizona, northern California, southern California, and south Florida, as well as many additional cryotransport technicians on-call around the United States. Alcor's Arizona facility includes a full-time staff with employees present 24 hours a day.

MEETINGS

ARIZONA

Scottsdale:
Alcor Board of Directors Meetings

Alcor business meetings are generally held on the first Saturday of every month starting at 11:00 am. Guests are welcome. For more information, contact Alcor at (480) 905-1906.

Scottsdale/Phoenix:
Alcor Social Meetings

Frequent meetings are held in members' homes and at Alcor Central. Call Alcor (480) 905-1906 for up-to-date details about Arizona events, or e-mail paula@alcor.org.

Las Vegas:

To all Las Vegas members: Are you feeling alone and isolated from other cryonics members? There are many Alcor members in the Las Vegas area. If you wish to form a loose group to meet and socialize, contact Katie Kars at (702) 251-1975. Katie has given several interviews on the subject of cryonics to the Las Vegas media. She is a wonderful person and wishes to get to know as many local Alcor members as possible. Let's get together!

CALIFORNIA

Los Angeles Area:
Alcor Southern California Meetings

For information on *Southern California* meetings, call Russ Cheney at (310) 316-5761 or e-mail him at rbcheney@msn.com.

Although monthly meetings are not regularly held, there are no shortages of Los Angeles Alcor Members you can contact via Russ.

San Francisco Bay Area:
Alcor Northern California Meetings

The remaining Alcor Northern California meetings in 2003 will be held on September 14 and December 14 at 4:00 pm, followed by a potluck dinner and socializing. Guests are welcome to attend. For more information, call Tim Freeman at (408) 774-1298 or e-mail to tim@fungible.com.

The September 14 meeting will be at:
381 North Fernwood Circle
Sunnyvale, CA 94085

WASHINGTON

Seattle Area:

For information on Northwest meetings, call Richard Gillman at (425) 641-5136 or join our e-mail group CryonicsNW at http://groups.yahoo.com/group/CryonicsNW

DISTRICT OF COLUMBIA

Life Extension Society, Inc. is a cryonics and life extension group with members from Washington, D.C., Virginia, and Maryland. Meetings are held monthly. Contact Secretary Keith Lynch at kfl@keithlynch.net. For information on LES, see our web site at www.keithlynch.net/les.

MASSACHUSETTS

Boston Area:

A cryonics discussion group meets the second Sunday of each month. For more information, contact Tony Reno by phone at (978)433-5574, or e-mail: tonyreno@concentric.net. Information can also be obtained from David Greenstein at (508) 879-3234, e-mail: davidsgreenstein@juno.com.

UNITED KINGDOM

There is an Alcor chapter in England. Its members are working hard to build solid emergency response, transport, and suspension capability. For information about meetings, contact Andrew Clifford at andrew@banknotes.ws or sue.hopkins1@virgin.net. See our web site at www.alcor-uk.org.

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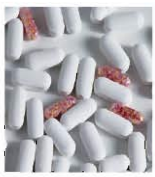

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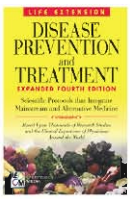

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