ALCOR LIFE EXTENSION FOUNDATION
A Non-Profit Organization

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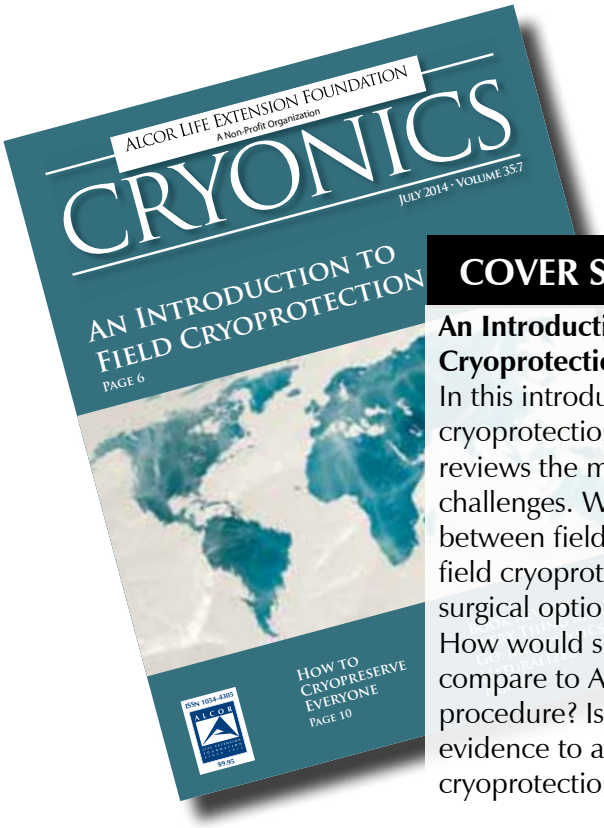

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An Introduction to Field Cryoprotection

In this introduction to field cryoprotection Aschwin de Wolf reviews the main issues and challenges. What is the difference between field vitrification and field cryoprotection? What surgical options are available? How would such a procedure compare to Alcor's standard procedure? Is there sufficient evidence to authorize field cryoprotection for remote cases?

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A Non-Profit Organization
CRYONICS

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QUOD INCEPIMUS CONFICIEMUS

Photo: Cryo-Care Equipment Corporation at 2340 E. Washington St., Phoenix, AZ. Dr. Bedford's "home" in 1970 or 1971.

I'M NOT DEAD YET! By Aschwin de Wolf

The prevailing view among cryonics advocates is that cryonics patients are not dead. This view is reflected in the cryonics custom of calling people who are cryopreserved "patients" instead of corpses. We feel quite strongly about this, but to what extent do our organization and practices actually reflect this perspective?

Let us consider an event in which a person had a traumatic accident that put him in a coma. There is no evidence of severe brain damage but it is not known if and when the patient will regain consciousness again. In a sense this patient appears better off than a cryonics patient because contemporary technologies are at least sufficient to sustain the patient in his current state. On the other hand, unlike the coma patient, the cryonics patient is not in a race against time and will be in a stable condition until advanced resuscitation technologies are made available.

We would be surprised, if not outraged, if we learned that family members and friends started calling a patient in a stable coma a corpse and started closing his bank accounts, selling his assets, and removing his internet presence. But this is what often happens to cryonics patients. While some of this behavior can be attributed to the different legal status of coma patients and cryonics patients in many cases we simply don't make the effort. Despite our objection that our patients are "not dead" we do not always act consistently with this view. Why is this important?

Acting consistently with our perspective that our patients are not dead is of crucial importance because the most formidable obstacle for people to make actual cryonics arrangements (instead of just endorsing the practice) is fear of losing their family, friends, and assets in an unknown future. Alcor's response should not be to simply assure them that everything will be fine but to offer constructive solutions to these concerns that makes potential members feel *safer*.

Making potential members feel safer, and even positively interested in surviving and reaching the future, should start by broadening our presentation of cryonics to include topics such as re-integration and asset preservation. Currently, these topics (if discussed at all) are delegated to a dark corner on the Alcor website as such concerns are just afterthoughts. We need to think of better ways to integrate these topics in our presentation of cryonics to the general public.

When someone decides to become an Alcor member (s)he should be issued an Alcor email address with the assurance that this email address will remain functional during cryopreservation and that Alcor will keep updating technologies to let communication options evolve with the times. Alcor can also offer a secure space on the main website where personal data and memories can be stored. After cryopreservation of the patient, authorized family members, relatives and/or Alcor should be able to update this space as well.

An even more ambitious realization of this idea is for Alcor to appoint a reintegration staff member whose sole responsibility is to help members maintain a presence during cryopreservation by assisting the member in preservation of assets and execution of trusts. This person could also function as a liaison between family members / friends and the patient during cryopreservation.

I think moving in this direction could go some way towards reducing the fears that people have about alienation and loss in the future. It is interesting to reflect why such efforts have not received a more important place in the history of Alcor. I think the most obvious answer is that Alcor has a hard enough time keeping the organization running and making sure members get a good cryopreservation. But I suspect there is also another reason. The people who have shaped most of Alcor's presentation and policies are invariably "hardcore" advocates of cryonics and combine a strong desire to survive with a strong confidence in the technical feasibility of the idea. It would be a mistake to base our presentation and implementation of cryonics on such an unconventional subset of the population. We need to keep calibrating our presentation and services until it all becomes hugely attractive, not a source of anxiety. ■

An Introduction to
Field Cryoprotection

By Aschwin de Wolf

Two of the most important variables in cryonics patient care are time and temperature. These two concepts are clearly related. If the time between pronouncement of legal death and the start of cryoprotection is minimized we can place the patient in long-term cryostasis without incurring unnecessary cold ischemic injury. Not surprisingly, it has occurred to a number of people in the cryonics field that the quality of care could be improved if we eliminate the prolonged cold ischemic time that is typically associated with remote cryonics cases (i.e. cases outside of the Scottsdale area). In this article I will outline potential protocols and challenges concerning field cryoprotection. Field cryoprotection is the replacement of blood and tissue water by solutions of cryoprotective agents (CPAs) near the location of legal death, followed by prompt cooling to dry ice (-79°C) or lower temperatures at the same remote location. If a temperature cold enough to achieve a solid state is attained (approximately -130°C), the procedure could be called field cryopreservation. For Alcor members, these procedures have historically been done only in Alcor's Scottsdale, Arizona, facility.

RATIONALE OF FIELD CRYOPROTECTION

To understand the rationale and challenges associated with the idea of field cryoprotection it is useful to briefly describe the current procedure for remote cases. Currently, when a member is considered terminal and close to legal death Alcor deploys a standby team to the bedside of the patient. For cases outside of Arizona in the continental United States, the team will typically be from Suspended Animation, Inc., and include a surgeon and clinical perfusionist. Upon pronouncement of legal death the team starts (mechanical) chest compressions and rapid cooling and administers a series of medications to mitigate ischemia. If qualified surgeons are part of the team, an additional procedure is to perform a field washout in which blood is replaced by a cold (but not freezing) organ preservation solution. The three most important objectives of the washout are to (a) increase the cooling rate (b) remove the blood and risk of coagulation and cold agglutination and (c) protect the patient against cold ischemia by introducing an organ preservation solution. The patient is then shipped on water ice to the cryonics facility for cryoprotective perfusion and long-term care.

As is clear from this suggestion, between the end of blood washout and the start of cryoprotective perfusion the patient is basically experiencing a prolonged period of cold ischemia (lack of oxygen), the duration of which is dependent on the airline schedule and distance to Alcor. While experimental evidence at a number of cryonics-associated research labs indicates that remote blood washout is superior to leaving the blood in the patient, it should be evident that prolonged cold ischemia is not beneficial to the patient and could be completely eliminated when there is a smooth transition from stabilization to cryoprotectant perfusion. For example, blood substitution with a static organ preservation solution can keep the brain viable (able to spontaneously resume function upon reperfusion with blood) for about 6 hours in the most optimistic projections.

Proposed benefits of field cryoprotection include:

- One single deployment required for both stabilization and cryoprotection
- Elimination (or minimization) of cold ischemia
- One surgical procedure required
- A reduction of total procedure time

TERMINOLOGY, HISTORICAL BACKGROUND, AND RESEARCH

In the context of this article field cryoprotection is defined as the procedure of conducting cryoprotective perfusion with a vitrification agent at a location remote from the cryonics facility followed by transport of the patient on dry ice for further cryogenic cooldown and long term care at the cryonics facility.

It is important to stress here that this procedure does not entail *field vitrification*. Field vitrification would not just require remote cryoprotective perfusion but also cryogenic cooling on-site and shipping at around -130 degrees Celsius (below the glass transition temperature of the vitrification agent) or -196 degrees Celsius (liquid nitrogen temperature). While it is

not impossible to ship the patient at such temperatures it would introduce a number of non-trivial technological and logistical challenges. This would also likely offset any cost reductions associated with conducting cryoprotective perfusion in the field. As will be discussed below, in field cryoprotection the patient is cooled below 0 degrees Celsius *after* cryoprotective perfusion but not to a temperature where the vitrification agent solidifies into a glass. For this reason the procedure discussed in this article should be named field cryoprotection (or field cryoprotective perfusion) and not field vitrification or field cryopreservation.

The idea of field cryoprotection is not new and various proposals to introduce the technology have been introduced in the past (including proposals for real field vitrification and shipping below the glass transition temperature). In June 1990 Alcor patient A-1239 received a field cryoprotection with glycerol in Australia prior to shipment on dry ice to Alcor in the USA. In addition, on October 23, 2004, the cryonics company Suspended Animation performed a field cryoprotection with glycerol for the American Cryonics Society prior to shipping the patient on dry ice to the Cryonics Institute for long-term care (see: http://suspendedinc.com/cases/case ACS001.doc). The Cryonics Institute also has authorized field cryoprotection for select (international) cases.

There are number of distinct protocol differences between this current implementation of field cryoprotection and cryoprotection at the Alcor main facility. These protocol differences are not intrinsic to either field cryoprotection or facility cryoprotection however. By historical standards, today's field cryoprotection protocols by Alcor are often more sophisticated than older facility cryoprotection protocols and even contemporary protocols at other cryonics organizations.

One concern that has often been expressed about field cryoprotection is that shipping the patient at dry ice temperature after introducing the vitrification agent could result in ice formation en-route to the cryonics facility. While this concern cannot be completely eliminated yet, independent results from at least three research labs indicate that this issue does not seem to be a problem for CPA solutions currently used for vitrification in cryonics. The cryobiologist Yuri Pichugin stored large volumes of VM-1 (the vitrification agent used by the Cryonics Institute) and cryoprotected cortical rat brain slices at dry ice temperature without observing ice formation after days of storage. Similar results have been observed in other animal models at 21st Century Medicine. In 2012 Advanced Neural Biosciences collaborated with Alcor to specifically validate Alcor's proposed field cryoprotection protocol in the rat model and again no ice formation was found after up to 48 hours of storing the brains at dry ice temperature prior to further cooling.

These encouraging research results and experience with this protocol in companion animal cases led Alcor to authorize field cryoprotection for overseas cases that otherwise would end up being "straight freeze" cases (i.e., cryopreservation without cryoprotection).

WHOLE BODY AND NEURO FIELD CRYOPROTECTION

In principle, field cryoprotection can be conducted in both whole body and neuro cases. Whole body field cryoprotection presents a number of distinct challenges. For starters, a lot more cryoprotectant is needed for whole body cases which for most locations would require the shipping of large volumes of perfusate to the location where the patient will be cryoprotected. Usually, though, there should be ample time for this because most cases in which field cryoprotection is feasible and productive involve patients with a prolonged agonal "dying" phase which allows the timely shipping of perfusate.

An additional complication involves shipping the patient. Because the patient needs to be shipped on dry ice it is crucial that the cryonics organization comply with airline regulations concerning dry ice and potential weight restrictions. Of course, since cold ischemia is basically eliminated during shipment it would also be possible to transport the patient by ground to the cryonics facility (in whole body cases).

While it is sometimes claimed that one major difference between whole body and neuro cryoprotection involves a difference in surgical procedures this is not necessarily the case. In case a median sternotomy is chosen to cannulate the heart or aorta both neuro and whole body cryoprotective perfusion can be conducted by just making minor adjustments. A more detailed discussion of potential surgical protocols follows.

SURGERY

There are basically three options for obtaining vascular access in field cryoprotection.

(1) Femoral cannulation

In femoral cannulation a "femoral cut down" is performed to cannulate the femoral artery and vein in a single leg to perfuse the patient. One advantage of this approach is that femoral cannulation used to be the preferred approach for remote blood washout and the cannulae can just remain in place for subsequent cryoprotectant perfusion (even in field cryoprotection, stabilization usually benefits from a washout to accelerate cooling and removing the patient's blood). This approach, however, would not constitute an attractive option for neuro cryoprotection because a lot of perfusate is wasted in perfusing the rest of the body. Another potential disadvantage is that in conditions of ischemia-induced edema perfusion of the brain could be suboptimal. In addition, not all patients have a healthy, patent, femoral artery that will ensure good flow.

(2) Heart (aorta) cannulation

In a median sternotomy the chest is opened to cannulate the heart or the ascending aorta. This procedure can be used to either perfuse the whole body or, when the descending aorta (and arms) are clamped, to limit perfusion to the upper body. A major advantage of this approach is that a large organ (the heart) or the widest vessel in the body (the aorta) is selected for perfusion which reduces challenges associated with cannulating patients with no flow (such as collapsed vessels) and ensures good flow. In a very basic version of the procedure, venous cannulation is not necessary and an opening in the right atrium will suffice for venous drainage. A concern about this approach is that too much perfusate is wasted in neuro cases. Median sternotomy used to be the standard surgical approach for both whole body *and* neuro cases at Alcor prior to going to isolated head perfusion for neuro patients, and as of this writing is the default approach for all cases at the Cryonics Institute.

(3) Carotid cannulation.

Carotid cannulation involves cannulating the carotid arteries, and sometimes the vertebral arteries, in the neck of the patient. This procedure is primarily designed to allow cryoprotective perfusion of the head. As such, this surgical approach is used primarily in neuro cases. It is the simplest cannulation to perform. It focuses on the head (brain) of the patient and minimizes required perfusate volumes. Another advantage is that if the cephalon is perfused separately the whole stump of the head can be used for venous drainage. Disadvantages include the lack of an easy "downstream" fall-back option in case errors are made or the vessels are too fragile or damaged for perfusion. There is also the issue that a determination would need to be made about whether a patient has an intact Circle of Willis. Without this, the vertebral arteries would need to be cannulated, too, for complete perfusion of the brain.

One argument against the carotid approach is that unless cephalic isolation is used as an approach for cryoprotection, washout will also need to be restricted to the head unless the team performs two separate cannulations. This may introduce temperature differences between the head and the rest of the body. There is also a risk of introducing blood to the brain during cryoprotective perfusion if there is some blood remaining after washout. In the opinion of the author, the most decisive argument against the carotid approach is that there are limited fall-back options in case of failure. If the femoral or heart/aortic approach is used, the field team could decide to terminate efforts to conduct cryoprotectant perfusion and transport the patient to Alcor where professional surgeons can attempt carotid cannulation. Field cryoprotective perfusion should allow for a back-up plan in case of failure, which the carotid approach does not permit. The heart / aortic approach also has the advantage that it permits both neuro and whole body cryoprotection.

PROTOCOL

Designing a protocol for field cryoprotection presents 4 challenges:

1. Ensuring a gradual introduction of the vitrification agent (CPA) to reduce osmotic injury to the cells. When a patient is cryoprotected at the main Alcor facility this goal is achieved by gradually mixing the "carrier solution" with the cryoprotectant in a recirculating reservoir and terminating perfusion when the desired terminal concentration of the agent has been consistently observed in venous fluid. In field cryoprotection such a recirculating setup would be complicated and current field cryoprotection protocols involve introducing a series of bags with increasing concentrations of the vitrification agent. Terminologically, the current field cryoprotection protocol is "open circuit" perfusion in which venous flow is discarded, while Alcor's facility protocol is "closed circuit" perfusion in which venous flow is recirculated. In Alcor's field cryoprotection protocol bags can be (and are) overlapped using a "teeter-totter" which blurs the jump between steps, further smoothing the introduction of different concentrations.

2. Temperature control. At the Alcor main facility cryoprotective perfusion is started at 0 degrees Celsius and lowered to about -3 degrees Celsius for the final half of the procedure to mitigate the cryoprotectant toxicity associated with higher concentrations. In field cryoprotection subzero perfusion presents a bigger challenge and would require an enclosure with circulating nitrogen gas and running the perfusate through a heat exchanger (HEX) capable of reducing the temperature below the freezing point of water. Alcor's current field cryoprotection protocol involves keeping the temperature of the patient and the perfusate as close to 0 degrees Celsius as possible.

3. Monitoring the refractive index (or Brix reading) of the vitrification agent as the concentration increases. At the Alcor main facility the concentration of the vitrification agent is continuously monitored in the perfusion lines to observe trends. Decisions as to whether to continue or stop perfusion are made using a benchtop refractometer. In field cryoprotection continuous in-line monitoring of concentration of the vitrification agent would be challenging and the current protocol requires the use of a hand-held digital refractometer to make frequent refractive index (or Brix) readings to observe trends and to decide whether to continue or end perfusion.

4. Controlling flow rate and pressure. There are two options for controlling flow of the perfusate in the patient: a pump or a hanging bag system. The major advantage of using a pump is that it provides precise control over flow rates and pressure. The advantage of a hanging bag system is that no priming of the pump and other associated challenges need to be performed. Another advantage is that pressure spikes are limited by the height of the bags. In reality, the choice of either a pump or a bag will greatly depend on the degree of expertise and experience in the field.

For example, the current Alcor protocol for field cryoprotection under discussion employs an 8-step bag system (including washout with B1 carrier solution):

SOLUTION	CONCENTRATION	BRIX
1 (B1)	0.00	8.20
2 M22	0.05	10.31
3 M22	0.08	11.72
4 M22	0.14	14.07
5 M22	0.23	17.99
6 M22	0.39	24.55
7 M22	0.65	35.48
8 M22	1.08	53.72

The percent concentration scale is not concentration of solutes, but percent final concentration of M22, which has defined solute concentrations. 100% M22 is also sometimes called 100% CNV (concentration needed to vitrify) to express the idea that tissue is ideally to reach full M22 solute concentration before stopping perfusion and attempting vitrification by cooling. The endpoint for perfusion in this protocol has been measurement of jugular

effluent of M22 over 50.35 Brix (100% CNV) for over 30 minutes. This protocol ensures a concentration necessary to vitrify (CNV) in the cells without prolonged exposure to even higher concentrations.

TWO VISIONS OF FIELD CRYOPROTECTION

While Alcor has authorized field cryoprotection for overseas cases (see the announcement in this magazine) there is still an ongoing debate about the desirability of introducing field cryoprotection for most Alcor members who are pronounced legally dead in the United States and Canada. Issues that have been discussed include scientific, technological, and financial concerns. Alcor's facility cryoprotection procedures are designed to closely replicate laboratory research protocols that have shown published efficacy for brain cryopreservation. They are based on established principles of organ cryopreservation for minimizing osmotic and cryoprotectant injury while eliminating ice formation. To what extent do simplified and shorter open-circuit field cryoprotection protocols compromise cryopreservation quality? Alcor's facility infrastructure includes computerized control and recording of multiple perfusion parameters, and personnel for observation and note-taking. To what extent will field cryoprotection quality suffer because of decreased perfusion parameter control, decreased data recording, and resulting decreased quality control feedback? Can a patient be shipped on dry ice without risking ice formation during transport to the cryonics facility? What is the easiest and safest surgical approach? How many concentrations of the vitrification agent need to be used? Can we lower the cost of our procedures by embracing field cryoprotection? Perhaps the most difficult question of all is: At what distance and transport time from Alcor do the disadvantages of current field cryoprotection procedures (especially no cryoprotection for the body of whole body patients) become outweighed by the advantages of avoiding long transport times at 0°C? There are some who worry that simplified field cryoprotection procedures with limited monitoring are driven by a desire to reduce costs, complexity and oversight rather than strict improvement of care and cryopreservation outcome. Yet clearly there are distances for which even the simplest field cryoprotection protocols are beneficial, such as locations with multi-day transport times.

A sensible approach to evaluate these issues is to ask whether the primary aim of field cryoprotection is improvement of patient care or simply reduction of cost. While it is indisputable that the elimination of two separate deployments can lower the costs associated with Alcor's procedures (assuming field cryoprotection protocols that are deliverable by current standby teams), these different perspectives can lead to different views on how to conduct field cryoprotection. If field cryoprotection is primarily advocated as a means to improve patient care the most likely implementation for Alcor right now is to request its standby provider (currently Suspended Animation for non-local cases) to add field cryoprotection to its washout procedure. While it would be simplistic to argue that this would just involve simply adding a few bags of perfusate to the washout procedure, it should be recognized that an organization that employs professional surgeons to establish surgical access and professional perfusionists for running the pumps should be able to perform this procedure without formidable challenges. If the aim, on the other hand, is to just reduce cost and involve Alcor staff and volunteers in field cryoprotection, the most conservative surgical protocols and cryoprotection protocols would need to be followed to reduce errors.

In the opinion of the author, it is not possible to have a sensible discussion about the nature and scope of field cryoprotection without asking the question *who* is going to perform it. If Alcor entrusts the conduct of remote blood washout to qualified independent contractors then concerns about the absence of relevant surgical and perfusion skills may not be all that relevant. If field cryoprotection is seen as a replacement of these contracts, however, Alcor would be making a challenging leap into the unknown.

ALTERNATIVES FOR FIELD CRYOPROTECTION?

The only credible alternative for field cryoprotection would be to validate and introduce organ preservation solutions aimed at securing viability of the brain, or at least perfusability of the brain, for much longer than is possible with Alcor's current organ preservation solution (MHP-2). In essence, this would require the design and successful validation of "brain preservation solutions" that can preserve cerebral viability for up to 24 or 48 hours of cold ischemia. While the cryobiology company 21st Century Medicine has made a number of breakthroughs in organ preservation solution design that permit securing viability of the brain for much longer periods than is possible with MHP-2, these protocols require either continuous or intermittent perfusion of the patient (or the patient's brain) en route to the main cryonics facility. This fact by itself necessitates ground transport of the patient under supervision of qualified staff, which in some cases could involve many days.

Another concern with continuous perfusion protocols is that there is little information available on their effects in cases of preceding warm ischemia. Prior research in the art would indicate, however, that continuous perfusion in an ischemic patient, especially in a whole body patient, will produce severe edema over a long period of time. This edema could prevent any meaningful cryoprotective perfusion at the main facility, defeating the main objective of blood substitution.

In conclusion, the most basic question is rather straightforward. If cryoprotectant perfusion can be done competently in the field without much sacrifice in quality, and with much better outcomes in terms of elimination of cold ischemia and ice formation, why continue the tradition of transport on ice after remote washout? In the long term, there is no theoretical reason that everything currently done in Alcor's facility operating room couldn't be done at remote locations. However the cost of establishing such infrastructure would be very high, raising the question of how sophisticated field cryoprotection really needs to be to be beneficial at various distances. ■

HOW TO CRYOPRESERVE EVERYONE:
A BIG HAIRY AUDACIOUS GOAL FOR CRYONICS

By Ralph Merkle

The opinions expressed herein are those of the author and do not necessarily reflect those of Alcor or its Board.

INTRODUCTION

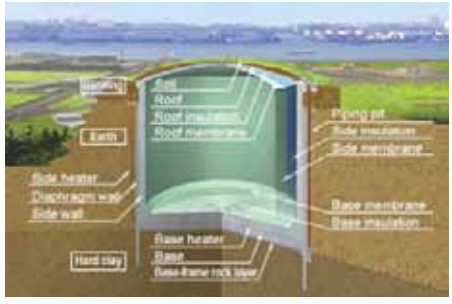
To succeed, an organization needs a vision which is at once challenging, achievable, and above all, compelling.[1] Alcor's vision is a future in which everyone alive today can enjoy good health and a long life in a world of material abundance for all. While it has been clear for some time that advances in technology will eventually make this future a reality, the problem has always been how people alive today could bridge the decades until that future world becomes reality, and even more, how to bridge that gap economically so that more than just a handful of people might benefit.

Cryonics does the job, but the obvious problems are (1) how to reduce the long term patient care costs and (2) how to reduce the cost of the upfront procedure.

REDUCING COSTS

The simplest way to reduce long term patient care costs is to increase the scale of operations and to rely on the fact that surface area (and therefore thermal losses) increase as the square of the linear size, while volume increases as the cube. Larger refrigerators have lower cooling costs per unit volume. The economies of scale can be quite remarkable.

We look at an example where costs are well known: the natural gas industry, which builds 100,000+ kiloliter -162° Centigrade LNG storage tanks. Alcor could adapt this technology to provide long term patient care facilities for everyone in the world who needed our services. At this scale costs would be so low everyone could afford it. Capital costs could be tens of dollars per person, and annual operating costs could be $1 per person or less.



Shimizu's 250,000 kiloliter LNG storage facility in Yokohama

FIELD CRYOPROTECTIVE PERFUSION (FCP)

The second major problem is providing cryopreservation services at a cost that most people can afford. Alcor's recent introduction of a simple Field Cryoprotective Perfusion (Alcor's FCP) protocol for overseas cases suggests a way to achieve this goal.

Field Cryoprotective Perfusion (FCP) means replacing blood with cryoprotectant (by perfusion) and cooling to at least dry ice temperature in the same locality that legal death occurs rather than transporting to a dedicated cryonics facility to begin these procedures. State-of-the-art cryoprotectant perfusion and cooling to cryogenic temperatures is complex. Someday it may be possible to do procedures as complex as are currently done at Alcor in the field. However, in the meantime Alcor has developed a relatively simple FCP and dry ice cooling procedure for use at distant locations that otherwise would require freezing to dry ice temperature without cryoprotectant. This procedure, Alcor's FCP, is a low cost method for introducing cryoprotectant into the brain which can be carried out by (1) a trained Alcor coordinator,[2] (2) a health care professional (or other culturally acceptable official) trained to carry out specific surgical tasks (cannulate the carotids, separate the cephalon from the body and, if needed, cannulate the vertebrals after this

Cost Category	Potential cost per use at scale (neuro)	Potential cost per use at scale (whole body)
Alcor Coordinator	$250	$250
Healthcare Professional	$250	$250
Assistant	$100	$100
Surgical kit	$100	$100
Perfusate (10 bags)	$250	$250
Facility	$200	$200
Dry ice	$50	$500
Dry ice shipper	$50	$500
Shipping	$100	$300
Total	**$1,350**	**$2,450**

separation), and (3) a third person to provide general assistance (though this person is not absolutely required). They require (4) a surgical kit including disposable supplies, (5) 10 2-liter bags of pre-mixed perfusate,[3] (6) a place to work, (7) enough dry ice (a few hundred pounds)[4] to cool the cephalon and keep it cool during shipment to Alcor, (8) a neuro dry ice shipper and (9) shipping costs.

The 9 categories are shown in the table on the previous page with a rough guess at possible future costs.

Alcor's FCP is amenable to systematic cost reductions and quality improvements, as examination of items 1-9 above should show. Development of a field deployable temperature/pressure/flow regulator would further improve the quality of Alcor's FCP. Economies of scale would be enormous if large numbers of cryopreservations were being performed.

Alcor's FCP as currently implemented works best for neuro patients, for whom access to both carotid and vertebral arteries is possible. However Alcor's FCP can also achieve cryoprotection of the brain of whole body patients if either (a) cannulation of the vertebrals is unnecessary (because the Circle of Willis is intact), or (b) cannulation of the vertebrals is necessary and cephalic isolation and separate storage of the trunk is acceptable. Cephalic isolation exposes the vertebrals, after which their cannulation is relatively easy. Cannulation of the vertebrals in a whole body patient without cephalic isolation requires a highly skilled vascular surgeon. Such surgeons are both rare and costly. An intact Circle of Willis makes cannulation of the vertebrals unnecessary, but not all patients have an intact Circle of Willis.[5]

Labor costs today are higher than need be because cryopreservations are not scheduled events. Even though the patient might be terminal, heavily sedated to control pain (not always with complete success), wanting to be cryopreserved as soon as practicable, and having no other hope for survival except cryopreservation, only a few jurisdictions give the patient autonomy to take the obvious action.

Today, we are forced to carry out expensive "standbys" which, as the name implies, consist largely of highly trained people standing by, waiting for legal pronouncement of death to occur before they can apply their skills.

A world with mass use of cryopreservation is likely to be a world which accepts cryopreservation as a medical procedure, a world which would no longer force us to carry out expensive and unnecessary standbys. The combined impact of high volume and legalized advance scheduling should have an enormous impact on the labor (and other) costs involved.[6]

The cost of the surgical kit on a per-patient basis would primarily be the cost of cleaning the kit for the next use and the cost of replacing the disposable supplies.

While the cost of perfusate for Alcor's FCP is currently ~$1,500, that cost should drop substantially in large volume, both because licensing costs on a per-patient basis could be reduced, and because lower cost production methods could be developed when justified by sufficiently high volume. Note that this cost is for both neuro and whole body, as Alcor's FCP anticipates straight freeze of the trunk. The focus is on cryopreservation of the brain.

The facility cost is little more than the cost for a room with a high ceiling[7] for a few hours. Particularly if the facility is in constant use, the actual cost per patient for the square footage actually used would be modest.

The dry ice and the dry ice shipper might not be needed if the long-term patient care facility is close enough to the surgical facility. Shipping costs will obviously vary dramatically depending on the distance to the long term patient care facility. If this is nearby, shipping costs could be quite small. In a world with mass use of cryonics, the distance is unlikely to be too great.

In the remainder of this article, we focus on how to provide low cost long term care. FCP is further reviewed elsewhere.

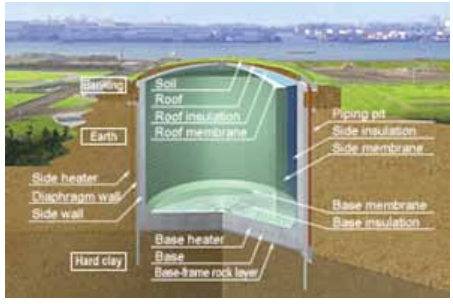
A REALLY BIG DEWAR (RBD)

The annual mortality for the planet is ~55M people per year. A spherical dewar 30 meters in radius would comfortably accommodate 5.5M neuros. Building ten such dewars a year would be enough to accommodate everyone in need.

The radius is 30 meters

Assuming we use neuro (just the brain, retaining the cephalon for physical protection) and assuming that we use a spherical-close-packed arrangement with 0.3 meters (one foot) center-to-center

A view of the sky from about 60 meters underground; the tank will have a storage capacity of 250,000 kiloliters, an inner diameter of 72.0 meters, and a depth of 61.7 meters (photo taken in Summer 2010).



Cutaway of the tank. The tank was completed in 2013.

spacing of the cephalons, then the total volume of a Really Big Dewar (RBD) will be the volume of each cephalon-containing-sphere (= 4/3 π $(0.15)^3$ ≈ 0.0141) x the number of cephalons (= 5.5M) x the packing inefficiency for the spherical-close-packed arrangement (= sqrt(18)/π ≈ 1.35) with the grand total coming to 0.0141 m3 x 5.5M x 1.35 = 1.05 x 105 m3 = a sphere of radius 29.3 meters, which we'll round up to 30 meters.[8]

While the RBD can hold 5.5M neuros, it could also be used to hold 0.55M whole body patients, or any mix of neuro and whole body patients where the number of neuros plus ten times the number of whole body patients sums to 5.5M. As the cost for long term care using this approach is quite low, many people might be willing to pay the additional cost required to maintain a whole body. The major concern would then become the cost of the cryoprotective perfusion.

It costs $11M to fill with LN2

An RBD of 30 meters radius has a volume of 113,097 m^3, or ~113K cubic meters, or 113M liters. This is similar in size to many

LNG facilities that have been built today. Liquid nitrogen in bulk costs ~$0.10/liter, so the total cost of filling an RBD the first time would be $11M (neglecting the cost of cooling the RBD's insulating surface, which is designed to be insulating and therefore should not cause a substantial error in this approximate estimate).

Boil off is less than a penny per patient per year

Thereafter, the cost of keeping it cool would depend on thermal losses. Thermal losses will depend on the thickness of the walls and their insulative properties.

If we use perlite, which has a conductivity of 0.00137 W/(m K) when a modest vacuum is maintained (see https://en.wikipedia.org/wiki/List_of_thermal_conductivities), then our energy loss, assuming one meter thickness of perlite, becomes ~ (300-77)K * 4 π 30^2 m^2 / 1 m * 0.00137 W/(m K) = 3.5 x 10^3 W. It takes ~3.48 x 10^5 Joules to boil a liter of liquid nitrogen and bring the resulting gaseous N2 to 300K[9], meaning the boil off rate of an RBD is ~ 1 liter every 100 seconds. As 1 liter costs ~$0.10 to replace, our cost for maintaining our patients is ~24*60*60*0.01*$0.10 = $86/day, or ~$32K/year. There will be 5.5M patients, so this comes to $32K/5.5M/year per patient, or $0.006/year per patient, or less than one cent per person per year for liquid nitrogen.

If we assume a higher Boil Off Rate (BOR) of 0.05 vol%/day (achievable by modern tank designs[10]), annual costs of liquid nitrogen on a per-patient basis would be about $0.35/year. At a conservative 2% per year interest, this would require $17.50 in the Patient Care Fund to provide liquid nitrogen for the indefinite future. Additional costs (maintenance of the RBD) might reasonably triple this to ~$1/year, requiring $50 in the Patient Care Fund to provide long term care for the patient for the indefinite future. The equivalent cost for a whole body patient would be ten times this, or $500.

We have here assumed the use of boiling liquid nitrogen, which provides a simple method of providing a very stable temperature of 77K. The great thermal mass of an RBD would allow selection of essentially any operating temperature. A temperature closer to 148K might be advantageous.[11] The use of such higher temperatures should reduce thermal losses. A closed-circuit cooling system, which cools and reliquefies evaporated gases when their temperature is only slightly above the temperature of the liquid refrigerant, might further improve efficiency. These kinds of efficiency improvements become feasible in very large scale systems.

There will be other operating costs

If we want improved insulation and reduced BOR as compared with existing tank designs, there will be some additional cost for maintaining the soft vacuum for the perlite. Presumably, the insulating perlite is divided into relatively small sections (perhaps 10 m x 10 m in size), so that if vacuum is lost in one section it does not cause problems in other sections. Perlite has the advantage that its conductivity only increases by about a factor of ten even when vacuum is lost, which will merely increase energy loss in a damaged section until it is repaired. As the total surface area is 4 π 30^2 m^2 = 1.13 x 10^4 m^2, one or two sections losing vacuum should not have a significant impact.

The simplest operating procedure would be to lower individual patients into a small opening in the top. Each neuro would be separately packaged to provide protection, and to achieve neutral buoyancy. The spherical close-packed arrangement is one that would be achieved spontaneously by approximately spherical objects, such as neuro patients appropriately protected, when allowed to settle, although a more systematic packing system might be desirable. Whole body patients would likely require a more systematic packing method. Maximum cost reduction would suggest the use of minimal packing mechanism in a facility sited in a highly geologically stable area and built with sufficient redundancy to ensure a high probability of survival during a conservative design lifetime. If some additional cost is acceptable, then additional mechanism can be provided to facilitate selective retrieval.

Capital costs are only tens of dollars per patient

Costs of $150M to $160M for a 138,000 m^3 tanker, or $150M for a 95,000 m^3 land-based facility to be finished in 2015, are typical.[12,13] A modern tank design can have a boil off rate of 0.05 vol%/day. Better insulation for this application should be feasible. The cost of perlite is not a limiting factor.[14]

If tanks cost this much, the amortized capital cost per patient will be $24 to $32. Again, multiply these costs by 10 for whole body patients, giving $240 to $320 for each whole body patient. At these costs, cryopreservation would be affordable even by the very poor and could proceed on a mass scale.[15]

The RBD should ideally be sited in a geologically stable location. Underground siting might be advantageous. It need not be exactly spherical, cylindrical shapes are more common in practice. The site at Yucca Mountain has been extensively studied.[16] Purchase would have to be negotiated.

CONCLUSION

Cryonics can easily scale, and could in fact scale to a size able to handle everyone on the planet. To do this, we could build Really Big Dewars (RBDs) for long-term patient care by adapting methods used to build existing LNG storage tanks. RBD's able to hold ~5M patients each are well within the state-of-the-art. To literally handle all 55M people who die each year, we would have to build a new RBD about once a month. An RBD might cost $150M to $200M. Ongoing care costs should be small, possibly $1/year per patient.

The cost of Alcor's Field Cryoprotective Perfusion (Alcor's FCP) for neuro patients can drastically reduce the up-front surgical costs of cryonics. The surgical skills required can be greatly simplified as we require only (a) cannulation of the carotids, (b) cephalic isolation, and sometimes (c) cannulation of the vertebrals following cephalic isolation. The cost for supplies is limited to the cost for the surgical kit, which can be minimal, and the cost for 10 2-liter bags[17] of perfusate, which can be reduced by using bulk preparation methods. Dry ice is also not intrinsically expensive. Custom development of a low-cost field-deployable temperature-pressure-flow regulator would significantly further improve the quality of Alcor's FCP. This custom development would likely have a high capital cost. When operated at scale, Alcor's FCP could be substantially cost reduced.

Total one-time cost for Alcor's FCP plus long term patient care for neuro patients can likely be driven below $1,500 if volume is high enough (many millions of patients annually). For whole body patients, total one-time cost for Alcor's FCP plus long term patient care can likely be driven below

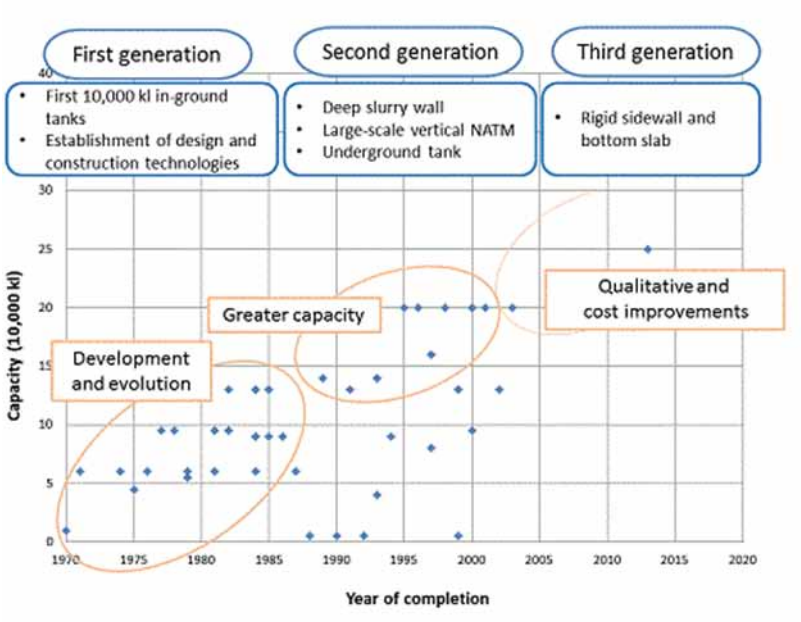
$3,500. By comparison, Alcor currently charges $80,000 for neuro and $200,000 for whole body.

Extensive exit interview data at Alcor, gathered over decades, strongly supports the view that cost is the single biggest factor that causes existing members to end their membership. It is very likely the single biggest factor in limiting the growth rate of cryonics. Adopting procedures and protocols that can deliver good quality cryopreservation and long term care in a manner that can be substantially cost-reduced is crucial to our long-term growth and success.

These cost reductions require either high volume or substantial subsidies to reduce the per-patient costs of cryonics. Achieving them using evolutionary methods appropriate for existing or anticipated near-term patient caseloads does not appear likely.

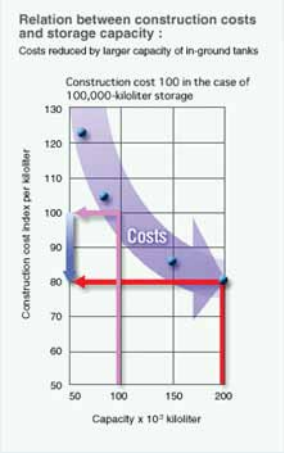
High volume is unlikely unless some large organization decides to adopt cryonics en masse. Such an organization would likely be predisposed to technological solutions, understand the concept of exponentially growing technological capabilities, have a centralized decision making structure, and place a high value on the lives of its members.

Alternatively, a capital-intensive approach that pursued a balanced reduction in both the cost of the up-front procedure (possibly by investing in some variant of Alcor's FCP) and the cost of long-term patient care by building a larger dewar (possibly not as large as the RBD discussed here, but large enough to provide significant economies of scale) might bring down the cost of cryonics enough to reach a larger community of potential members. ■



Overview of Tokyo Gas's in-ground LNG tanks. The 250,000 kiloliter tank can be seen as the rightmost small blue dot (the only Third Generation storage tank).

Construction costs for larger tanks are smaller per unit volume, as indicated below:



The proposed RBD is 60 meters in diameter, about the same size as many existing LNG storage tanks.

APPENDIX

For a general discussion see http://www.tokyo-gas.co.jp/lngtech/ug-tank/. For examples, see http://www.shimz.co.jp/english/theme/spotlight/2011/spotlight02.html.

The Tokyo Gas Ohgishima LNG Terminal in the waterfront area of Yokohama supplies city gas to the Tokyo region, and consists of three underground LNG storage tanks, each with a capacity of 200,000 kiloliters. Driven by growing demand for clean and safe natural gas, plans called for a fourth tank, which has been under construction since April 2009, with Shimizu handling all design and construction activities. On completion, this will be the world's largest-capacity underground LNG storage tank, with a storage capacity of 250,000 kiloliters. The construction project adopts a soil-covered roof in which part of the tank's domed top will rise above the surface of the ground and be covered in soil. This method achieves considerable cost savings by keeping costly underground excavation to roughly the same depth as that required for a 200,000-kiloliter tank and by using excavated earth as banking.

In February 2011, work proceeded over four consecutive days and nights on the most challenging part of this project: concrete placement for the eight-meter-thick base of the tank. Requiring a total of 39,050 cubic meters of concrete, this became the largest continuous concrete placement project ever attempted in Japan.

NOTES AND REFERENCES

1. Big Hairy Audacious Goals are sometimes abbreviated BHAGs. A BHAG "is a strategic business statement similar to a vision statement which is created to focus an organization on a single medium-long term organization-wide goal which is audacious, likely to be externally questionable, but not internally regarded as impossible.

   The term 'Big Hairy Audacious Goal' was proposed by James Collins and Jerry Porras in their 1994 book entitled *Built to Last: Successful Habits of Visionary Companies*. A BHAG encourages companies to define visionary goals that are more strategic and emotionally compelling." https://en.wikipedia.org/wiki/Big_Hairy_Audacious_Goal

2. The Alcor Coordinator could also take on the role of the trained health care professional and carry out the surgical procedures, depending on the circumstances.

3. The perfusate has a shelf life of several years when stored in an ordinary refrigerator. Alcor's purchase price for the ingredients in all 10 2-liter bags of perfusate, including M22, is ~$1,500. The concentration of M22 increases by a factor of 1.67 between bags, except that the last 3 bags have the same terminal concentration. While 10 bags is sufficient to achieve the desired terminal jugular cryoprotectant concentration, 16 bags were prepared for the initial trial (the final 9 bags having the same terminal concentration) to ensure that enough bags were available to achieve terminal jugular cryoprotectant concentration. http://www.alcor.org/Library/pdfs/casereportA2357.pdf.

4. Dry ice can be purchased retail for $2/kg or less. A reasonable cost per metric tonne of compressed liquid CO_2 in bulk is $25 or less (http://cdn.globalccsinstitute.com/sites/default/files/publications/14026/accelerating-uptake-ccs-industrial-use-captured-carbon-dioxide.pdf). Commercial products to convert liquid CO_2 to dry ice, without the need for other power or electricity, are available. When liquid CO_2 is released from a pressure vessel and becomes a gas, it undergoes substantial cooling. This principle assists CO_2 fire extinguishers, which both smother and cool the fire. "The DILVAC Portable Dry-Ice Maker … is compact and lightweight, requires no electrical power and is safe and simple to use. … The DILVAC Portable Dry-Ice Maker produces a block (not slush!) of approximately 2.2Lbs (1KG) in weight in about 1 minute. Yield from a 75 lbs liquid cylinder - 5 to 6 blocks at room temperature." If 75 pounds of CO_2 produces 5 blocks (11 pounds) of dry ice, then CO_2 at $25/tonne produces dry ice at $170/tonne. A neuro case would use <$30 worth at this price.

5. Our knowledge of the actual statistics requires further investigation. Experience in Alcor's OR with neuro patients suggests cannulation of the vertebrals is seldom required, but the sample size is small. It is well known that a significant fraction of patients do not have an intact Circle of Willis, but we are asking a more specific question: we are perfusing both carotids, and want to know if this results in adequate flow through the Circle of Willis to the regions of the brain served by the vertebrals.

6. Even heart surgery can be dramatically reduced in cost. "In the US a heart surgery costs perhaps 20 or 30 times what it costs here [in the Narayana Hrudayalaya in Bangalore, the largest heart surgery hospital in the world]. We are able to do a complex heart surgery for $1,800 (£1,140), and we want to bring it down to $800." "Despite the huge volume of operations, mortality rates are comparable with or better than those in Britain and the US, and costs are much lower." *'Production line' heart surgery.* BBC News, Health, 2 August 2010, http://www.bbc.com/news/health-10837726. See also India's Secret to Low-Cost Health Care, Harvard Business Review, Oct. 15, 2013, http://blogs.hbr.org/2013/10/indias-secret-to-low-cost-health-care/. FCP is relatively simple in comparison, so it should be more amenable to cost reductions when practiced on a mass scale.

7. The high ceiling is required because gravity feed is used to provide pressure for perfusion. This method is simple, reliable, low cost, and provides very stable perfusate pressure to the cannulae from the bags of perfusate.

8. 1 liter is 0.001 m^3. 1 kiloliter is 1 m^3. 1 kiloliter is 1 kl. 1 liter is 1 l. 1 meter is 1 m. 1,000,000 is 1M. 1 Kelvin is 1K. 1 Watt is 1 W. 1 Joule is 1 J. 1,000 Joules is 1 kJ. 1,000,000,000 is 1B. 1 kilogram is 1 kg.

9. http://www.uigi.com/nitrogen.html. 199.1 kJ/kg + (300-273)K * 1.04 kJ/(kg K)) * 0.808 kg/liter = 348 kJ per liter.

10. Development of the World's Largest Above-Ground Full Containment LNG Storage Tank, 23rd World Gas Conference, Amsterdam 2006, http://large.stanford.edu/publications/coal/references/docs/add10896.pdf

11. *Systems for Intermediate Temperature Storage for Fracture Reduction and Avoidance,* by Brian Wowk, *Cryonics*, 3rd Quarter 2011, http://www.alcor.org/Library/html/IntermediateTemperatureStorage.html

12. "Construction costs have dropped from $280 million in 1995 (for a 138,000-cubic-meter-capacity ship) to $150 to $160 million today—still more than double the cost of a crude oil tanker. Most added costs relate to the construction of insulated tanks. LNG shipping costs vary based on the ship's operating and amortization costs, the size of the cargo, and the distance transported." http://energy.gov/sites/prod/files/2013/04/f0/LNG_primerupd.pdf

13. "Desfa SA, a Greek natural gas grid operator, invited international investors to bid for the design and construction of a third liquefied natural gas storage tank at its Revithoussa LNG terminal facility near Athens.

    The tank, expected to cost as much as 115 million euros ($150 million), will have capacity of 95,000 cubic meters and will increase the facility's total LNG storage to 225,000 cubic meters, Athens-based Desfa said in a statement today." http://www.bloomberg.com/news/2012-03-14/greece-s-desfa-calls-for-bids-to-build-third-lng-storage-tank.html.

14. Total cost for 1.13 x 10^4 m^3 of perlite (the total surface area of the RBD times its one meter thickness), at $0.20/L (a typical commercial price), would be ~$2.3M.

15. If we assume a 113,000 m^3 RBD has a cost similar to the cost of the 138,000-cubic-meter-capacity ship, that is, $160M, then the capital cost per patient for an RBD will be ~$160M/138,000 * 113,000 / 5.5M = $24/patient. If we assume it has a cost similar to a 95,000 m^3 $150M land facility, then the capital cost will be ~$150M/95,000 * 113,000 / 5.5M = $32/neuro patient.

16. Yucca Mountain nuclear waste repository. https://en.wikipedia.org/wiki/Yucca_Mountain_nuclear_waste_repository

17. The existing data supports the idea that 10 bags of perfusate is sufficient for a satisfactory cryoprotective perfusion. Further discussion and evaluation of the benefits of a larger volume of perfusate is likely. The exact number of bags and the volume thereof can be adjusted as further data becomes available.

18. *Toward more safe and secure products: In-Ground LNG Tank.* http://www.tokyo-gas.co.jp/techno/stp3/03a5_e.html

Small Animal Whole Body Cryopreservation:

Past and Future Part III

By Chana Phaedra

After successfully reanimating rats from deep body temperatures of 0–2°C and subsequent respiratory and cardiac arrest, Radoslav Andjus allowed the survivors to live for many months afterward in order to observe any long-term effects of hypothermia. What he noticed, beyond temporary weight loss and a couple of rats with impaired temperature regulation, was that animals that had been cooled did not appear to suffer any gross or debilitating effects. Although food intake and sexual behavior were initially diminished, the rats regained healthy appetites within a few days and went on to produce normal offspring within 3 months of cooling.

Andjus, having pioneered a method of resuscitation of rats from ultraprofound hypothermia, also had occasion to take the first look at the effects of hypothermia on learning and memory. In his brief 1955 *Nature* publication, "Effects of Hypothermia on Behaviour,"[1] Andjus first compared the ability of cooled (0–1°C) vs. untreated (control) rats to learn a serial problem-solving task. Next, he compared two groups of rats cooled to different temperature ranges (0–1°C and 13.4–18.5°C) to controls in a classical maze-learning paradigm. Rats were trained on the maze, cooled, tested for retention, and finally trained on a serial problem-solving task.

The results showed a significant impairment in problem-solving ability in rats cooled to 0-1°C compared to controls, but not in rats cooled to 13.4–18.5°C. However, the effect was only temporary, as demonstrated by the fact that impairment decreased as the interval between cooling and testing increased. And though memory retention was also affected by hypothermia, Andjus stated that "the differences among experimental and control groups were very small, and in no instance were they statistically significant," indicating that even severe hypothermia does not produce permanent long-term physical or behavioral changes.

These initial results were supported in another experiment by N. Mrosovsky in 1963[2], who reported that severe hypothermia did not affect the response of rats to a conditioned avoidance task when cooling was begun only 15 minutes after animals were trained to criterion. In this task, rats were placed in an apparatus with electrified wire flooring such that either side of the cage floor was capable of shocking the animal. To facilitate one-session avoidance learning, the rats were first taught that they could escape from shock by undergoing 20 shock trials at varied time intervals (30, 60, 90, and 120 seconds) in random order. Then they were conditioned to avoid the shock (conditioned response) by responding immediately to a light (conditioned stimulus) that came on inside the dark experimental room 8 seconds before the shock. The light stayed on until the rat crossed the dividing line between the two sides of the apparatus. When they reached the criterion of six successive avoidance responses, experimental animals were returned to their home cages for 15 minutes before cooling was initiated and rewarming was carried out under a bench lamp. Control animals remained in their home cages until retesting.

Both experimental (cooled) and control (untreated) groups were retrained in the avoidance task 13 days after hypothermia. On Day 14, after three successive avoidance responses, training was continued, but the shock came on in the opposite side of the box at the same time as the light (both were on for 8 seconds). The rat was successful in this "reversal procedure" if it stayed on its side of the apparatus while the light was on six consecutive times.

He reported no significant differences in initial learning, citing a median number of trials to criterion of 9.5 for cooled animals and 11.0 for controls on Day 13 retesting. The median number of shocks received was also similar (3 vs. 2) in both groups. There were also no significant differences in reaching criterion on Day 14 re-testing, nor in the reversal procedure.

Mrosovsky wisely points out in his interpretation of these results that

> *It must not however be assumed from the lack of evidence that hypothermia readily disrupts retention that behavior is unaltered. In the work of Andjus et al. (1956) and that of Sudak and Essman (1961), while retention was not changed, the ability on problem solving and habit reversal were decreased, even several weeks after the cooling.*

He goes on to mention that the "motivating conditions" of those experiments are different from his own, which may explain differences in results, but also says that it may be possible that initial learning is more likely to be altered than retention after hypothermia. According

to this hypothesis, he classes hypothermia along with anesthetics in the category of agents having mild retroactive effects on learning and memory (i.e., those affecting memories consolidated immediately before the interfering event).

After spending a few years perfecting Andjus' technique for resuscitating rodents (rats and hamsters) from ultraprofound hypothermic and high subzero temperatures, Audrey Smith upped the ante and attempted the same feat in larger mammals. In her 1957 publication, "Problems in the resuscitation of mammals from body temperatures below 0°C[3]," she detailed the results of such experiments performed on Dutch rabbits and small primates of the species Galago crassicaudatus agisymbanus.

"Andjus, having pioneered a method of resuscitation of rats from ultraprofound hypothermia, also had occasion to take the first look at the effects of hypothermia on learning and memory."

Smith used a modified version of the closed vessel technique to anesthetize and initiate cooling in the rabbits, then placed them in ice water for further cooling. Respiration ceased between 13 and 21°C and the heart stopped beating a couple of minutes later when temperatures were 3 or 4 degrees lower, at which point the rabbits were immersed in -5°C baths. Due to larger body mass, it took much longer for deep body temperature in rabbits to drop from 15 to 10°C than it had in hamsters, though the rabbits' extremities froze quickly. Smith wished to avoid this discrepancy, so she attempted to speed cooling by injecting a cold, creamy saline and serum mixture into the stomach and rectum. Cooling was certainly faster, but unfortunately the gastric mucous membrane was damaged and sometimes the stomach ruptured, forcing her to abandon this method. Further investigation finally led her to determine that thoroughly wetting the undercoat to remove all insulating air from the fur and vigorously stirring the -5 degree bath led to a fall in deep body temperature to the freezing point of plasma within 20 to 40 minutes of extremities freezing. Galagos were cooled similarly. Their extremities had been freezing for around 40 minutes by the time internal organs began to freeze.

James Lovelock built a larger microwave diathermy apparatus for Smith's rabbit and primate experiments on the assumption that larger body masses simply needed more magnetronic power. Initial warming attempts resulted in severe superficial burns before the rest of the animal had been thawed. Compensating for this effect resulted in the next few animals' visceras being cooked. Finally, a technique was determined for warming from -0.6° to 10 or 15°C within a minute.

Fifteen rabbits and two galagos underwent this treatment and resumed heartbeat and pink mucous membrane coloring when temperature reached around 15°C. Between 20 and 30°C they began breathing and diathermy and artificial respiration was stopped while gentle warming was continued under a heat lamp or in an incubator, while a few rabbits were left at room temperature. Smith describes the results:

> *Muscle tone improved and the animals made spontanous movements. Some of them, including the two galagos, sat up and moved around. Within about an hour, however, the reanimated rabbits and galagos all collapsed and died. At post mortem the only obvious lesion was a severe haemorrhage in the upper part of the stomach. This is the part of the stomach which secretes hydrochloric acid.*

Smith had noticed similar lesions in the stomachs of hamsters she had frozen which had died shortly after resuscitation, also from the acid-secreting portion of the stomach. She theorized that lowering body temperature disabled the function of mucous-secreting cells (which protect the stomach from acid) by increasing their permeability to hydrochloric acid and causing the acid in the stomach to diffuse and injure blood vessels. Smith tested this theory by neutralizing stomach acid with sodium bicarbonate during cooling but before freezing. This time, after resuscitation, there was no sign of gastric hemorrhage. Sadly, the rabbits undergoing this treatment still did not live more than 4 hours, and two galagos which seemed to make an excellent recovery died within 24 hours. Though their stomachs were normal, these animals were found to suffer from pulmonary edema and one had bloody fluid in the duodenum and jejunum.

Other topics investigated and reported within her manuscript were the effects of freezing on the hamster placenta and studies on the isolated heart. Observations made on the placentas of hamsters frozen on the 9th, 10th, and 11th days after fertilization of the egg (when the hamster placenta undergoes rapid growth and freezing disrupts fetal development) indicated that bleeding may also be induced by circulatory disorders. Smith speculated that it may be due to derangement of cardiac muscle tissue itself.

This compelled her to experiment on isolated hamster hearts. Interestingly, although whole hamsters did not survive freezing for 3 hours, isolated hamster hearts resumed beating for several hours when perfused in vitro after freezing for 3 hours. She also found that the isolated rat heart recovered completely after freezing at -2°C for 1 hour, but failed to recover from temperatures below -5°C. Further investigations involving perfusion of hamster hearts with glycerol led to resumed beating of hearts after lowering to -20°C, many of which established a regular beat. These results indicated that the heart may not have been the limiting factor in resuscitating whole animals from subzero temperatures, and that improved methods of cryoprotection might be developed for resuscitation of whole animals from subzero temperatures.

In 1982, P.D. Rogers and G.P. Webb published some of their observations (based on previous papers and a Ph.D. thesis) after carrying out a classroom demonstration of suspended animation in which they cooled rats and then resuscitated them after 30 minutes at 0°C[4]. The demonstration was performed

as a means to stimulate discussion among students regarding the characteristics and diagnosis of death, the effects of hypoxia during cooling, and the limitations of ECG measurements.

Because the "Giaja method" of cooling employed by Andjus and Smith induced hypoxia and hypercapnia, the authors were interested in comparing resuscitation rates in hypoxic vs. non-hypoxic animals. They did so by anesthetizing rats and immersing them (except for limbs, tail, and head) in crushed ice and water to induce ultra-profound hypothermia, as measured by rectal temperatures. During the cooling process some animals were artificially ventilated until cardiac arrest (respired rats) while others were not (unrespired rats). After 30 minutes of cardiac arrest at temperatures near 0°C, all rats were ventilated during rewarming in a 40°C water bath until heartbeat returned and reached 60 beats/min, at which point they were removed from the bath and warming was continued under a 100 W lamp. ECG was recorded throughout.

"After spending a few years perfecting Andjus' technique for resuscitating rodents...from ultraprofound hypothermic and high subzero temperatures, Audrey Smith upped the ante and attempted the same feat in larger mammals."

Rogers found that approximately 90% of respired rats began breathing spontaneously during rewarming and 100% regained heartbeat. On the other hand, less than 10% of unrespired rats recovered spontaneous respiration during rewarming, and when the heart did restart (it often did not), heartbeats were erratic and did not circulate blood due to severe vasodilation assumed to be caused by the combination of hypoxia and hypothermia. Rogers found that he was able to resuscitate 70-90% of unrespired rats by means of abdominal compression (i.e., "abdominal pumping"), but even this method was only successful when the heart restarted.

Though it is easy to assume that hypoxia is the cause of more difficult and less successful resuscitation of unrespired vs. respired rats, Rogers and Webb point out that respired rats may simply be benefiting from the protective effects of hypocapnia on pH changes during hypothermia. They discuss at length the question of "what is the optimal pH in the hypothermic animal," which remains unanswered.

An interesting phenomenon known as "heart block" was also demonstrated by these experiments. ECG recordings obtained from unrespired rats often showed a QRS complex during rewarming, which most people would assume to indicate that the heart had restarted. However, because ECG is simply a record of electrical activity, this is not always the case:

> *The observation that a QRS complex occurs in the absence of cardiac output illustrates the limitations of ECG measurements. The ECG is a record of electrical activity within the heart, and any conclusions about mechanical events are extrapolation, though usually with sound theoretical and empirical foundation. In fact, when the chest cavity is opened in unrespired animals with temporarily restarted hearts, it is possible to record QRS complexes in the absence of any apparent heartbeat, i.e., dissociation between excitation and contraction.*

Suggestions for further hypothermia experiments in rats include measuring blood pressure during cooling and rewarming, removing blood samples for pH and gas analysis during the experiment, and monitoring electroencephalogram (EEG). Having discovered in previous experiments that unrespired rats suffered from a collapse in blood pressure during cooling prior to cardiac arrest, while cardiac arrest and blood pressure collapse occurred simultaneously in respired rats, Rogers also wonders whether this pre-arrest collapse can be prevented with vasoactive medications and whether this would improve resuscitation rates in unrespired rats. Answering questions such as these would have far-reaching implications in the treatment of accidental hypothermia in humans.

"Smith...theorized that lowering body temperature disabled the function of mucous-secreting cells...by increasing their permeability to hydrochloric acid and causing the acid in the stomach to diffuse and injure blood vessels."

The method that was used by Rogers et al. to resuscitate rats from ultra-profound hypothermia appears superior in terms of animal welfare and equipments needs. Because hypothermia is not induced by methods that induce hypoxia (as in the experiments of Andjus and Smith), the need for specific warming protocols are greatly lessened. The use of anesthetics and ventilation during cooling allows the researcher to exclusively focus on the mechanisms of cold circulatory arrest and investigate methods (such as administrations of medications or complete blood substitution) to prolong the period rats can tolerate ultra-profound circulatory arrest and even subzero temperatures. ■

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Every Thing Must Go

Metaphysics Naturalized

Review of *Every Thing Must Go: Metaphysics Naturalized* by James Ladyman and Don Ross, with David Spurrett and John Collier *(Oxford: Oxford University Press, 2007)*

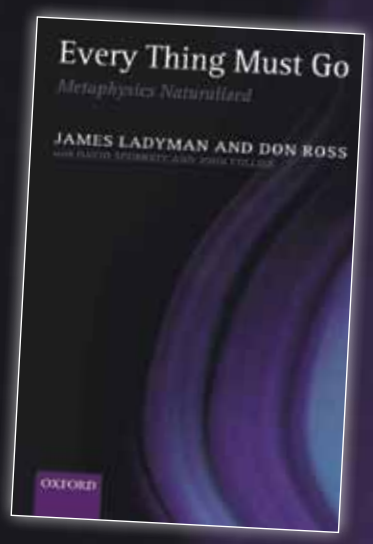
BOOK REVIEW BY R. MICHAEL PERRY

As immortalists we hope to be in the world for a good long while, thus we are interested in the nature of reality. Reality determines, among other things, what our prospects are for our own longterm survival. We wish to know under what conditions the original self can be said to survive. For example, does the self survive if the original body perishes but an exact, functioning copy is made, or if something is created that functions very similarly but is physically different, such as a mind upload? Cryonicists will also wonder if there is any problem if extensive repairs to their physical remains are necessary, so long as something closely resembling their original self is reconstructed and brought to healthy consciousness. The volume here reviewed, though not directly concerned with cryonics or immortalism, offers the position that it's the pattern that counts rather than the material substrate, and in fact, strictly speaking, material objects don't exist. If this is accepted, the metaphysical outlook improves for survival through such means as mind uploading or imperfect cryonics.

Do material objects exist? How do we find out? Though science is certainly crucial in telling us about the world we inhabit, a vital role is also reserved for philosophy, which addresses such issues as what scientific principles and methods should merit our trust and what values and goals should be served by our developing, science-based technology. Metaphysics in particular, concerned with "what actually exists" and among other things, with unifying science, would seem to have a vital role to play. As the volume here reviewed points out, however, metaphysics now is rather moribund and seems in danger of dying, mainly because it has not kept pace with modern science.

"The volume here reviewed... offers the position that it's the pattern that counts rather than the material substrate, and in fact, strictly speaking, material objects don't exist."

The authors propose, quite reasonably, "that the only kind of metaphysics that can contribute to objective knowledge is one based specifically on contemporary science as it really is, and not on philosophers' a priori intuitions, common sense, or simplifications of science." To carry out the development of such a metaphysics is a tall order. Contemporary science presents a very strange, hard-to-fathom view of reality, through quantum mechanics accompanied by general relativity. In addition, science is a moving target, which raises the prospect that one's best efforts will sooner or later be obsoleted even as previous scientific theories are found to be, strictly speaking, invalid and not descriptions of reality as it really is.



The authors accept this challenge and construct a metaphysics which takes account of modern science both in its depth, as seen in physics, and also its diversity, seen in such fields as biology and economics. The book will be a difficult read if you, like me, are not someone who is well-versed in the works of contemporary philosophers who have themselves grappled at length with the main issues of this book. In fact a great deal of text is taken up throughout with referencing these other thinkers and their often conflicting opinions. This was sometimes hard to follow but many interesting ideas still were reasonably intelligible. (I had the feeling that a more popular-style book that used more illustrations from everyday life with more accessible treatment of the strange anomalies of physics would be in order.)

"The authors are cautious enough to allow that their proposed system will not necessarily be found valid in the end, but might need replacement."

Two principles inform the authors' work throughout as ground rules for their project. The *principle of naturalistic closure* (PNC) requires, roughly, that a new metaphysical claim must be grounded in fundamental physics and must in addition lead to a first-time or improved scientific explanation for one or more phenomena, a betterment that would not occur in absence of the claim. The *primacy of physics constraint* (PPC), on the other hand, requires that sciences other than physics must conform in their principles to physics, while physics is not similarly required to respect the principles of these other sciences.

Both principles thus are based around physics yet the authors do not take the view that other sciences are necessarily reducible to physics, only that they must never conflict with physics. Physics in turn presents a bizarre world view, in comparison to familiar notions from the past. Most notably, the existence of individual things is called in question by such observable phenomena as particle entanglement. If two photons far apart can have their properties instantly affected by each other, do they possess individual natures? Do they really exist as "things" at all? Entanglement can and does occur between other particles including atoms, and extends to larger material objects. Do these things really exist? While it may be possible to uphold the existence of particles and material objects more generally as things or "particulars" in traditional fashion, the authors submit that this approach now seems highly artificial and problematic at a serious philosophical level. What they propose instead is "relations all the way down"—there are relations between what appear to be objects or things (subatomic particles for instance) but these "objects" are virtual only and resolve into further relations, whose "objects" or relata in turn resolve into further relations, ad infinitum. As the title proclaims, *every* thing *must* go.

If this is taken seriously, material objects are nonexistent, and all that actually does exist is "structure"—relations between virtual objects, or in other jargon, "real patterns." The authors propose the term Ontic Structural Realism (OSR) for their system of real patterning as it applies to fundamental science (physics), while the application to special sciences they label Rainforest Realism (RR). Putting the two together yields their comprehensive system known as Information Theoretic Structural Realism (ITSR). The real-patterns approach in particular is shown to avoid one basic pitfall, that of being dependent on specific details of particular scientific theories. Patterns can persist and retain validity if new discoveries replace one fundamental theory with another one, within limits. The authors are cautious enough to allow that their proposed system will not necessarily be found valid in the end, but might need replacement. Meanwhile its robustness in the face of possible changes in scientific theories is a plus.

"The idea of patterns or information as the substrate of reality will fit well with the hopes of those immortalists who believe in substrate-independent minds and are hopeful of one day uploading their essence—captured in information—into a computational device."

The idea of patterns or information as the substrate of reality will fit well with the hopes of those immortalists who believe in substrate-independent minds and are hopeful of one day uploading their essence—captured in information—into a computational device. (A great way, perhaps, to free oneself of the ills of a bodily existence, including the aging process.) Cryonicists should similarly not worry about anything beyond information loss in assessing their chances of resuscitation. Inasmuch as the metaphysical basis of this thinking is grounded in modern physics, we must at least take the patternist view seriously, and it can serve as the basis of cautious optimism about our future prospects for transcending our present limitations. ■

ALCOR DEPLOYS FIELD CRYOPROTECTION (FCP) TECHNOLOGY FOR OVERSEAS CASES

By Max More

For decades Alcor has welcomed members residing overseas, and pledged to attempt to cryopreserve members who suffer legal death while traveling outside the United States. However, options for responding to overseas cases have been very limited. Historically there has been a choice between shipping on water ice near 0 degrees Celsius (with or without blood replacement) and attempting subsequent cryoprotective perfusion at Alcor to eliminate or minimize ice formation, or so-called "straight freezing" to dry ice temperature of -79 degrees Celsius without cryoprotective perfusion and shipping to Alcor.

Cryoprotective perfusion after a prolonged period of cold ischemia is usually compromised, typically leading to the difficult decision to "straight freeze" overseas cases to dry ice temperature prior to shipping. Freezing without cryoprotectant is extremely damaging to tissue. About all that can be said for it is that it is better than the alternative of not being cryopreserved at all.

There is now a better alternative. As described in this issue of *Cryonics*, Alcor has developed a simple system for perfusing cryoprotectant solution in a remote field setting instead of requiring patients to first arrive at Alcor's facility. After completion of this field cryoprotection, patients can be cooled to dry ice temperature (-79 degC) for shipment to Alcor with less time urgency and a slower rate of biological damage than at 0 degrees. Once at Alcor, cooling is resumed to the temperature of liquid nitrogen (-196 degC) at which temperature tissue is stable for practically unlimited lengths of time.

Alcor's initial implementation of field cryoprotection is still crude compared to cryoprotective perfusion in Alcor's operating room. Temperature and pressure control are limited, the cryoprotectant concentration rises more rapidly than is ideal, and the perfusion time is comparatively brief. Very importantly, the present field cryoprotection procedure only perfuses the head and brain with cryoprotectant, so the body of whole body members receiving field cryoprotection will still be frozen without cryoprotectant. However, this is obviously a better outcome than the entire body, including the brain, being frozen without cryprotectant.

UPGRADED CANADIAN AND EUROPEAN RESPONSE

The logistical challenges of implementing field cryoprotection internationally are substantial. Only future experience will reveal whether we are able to apply FCP in a majority or a minority of international cases. Here is the current situation: The Alcor board has authorized the use of FCP for cases taking place outside the United States. We have stationed a kit in Canada in the Toronto area, and another one in London, England. The contents of the two kits is similar, with minor differences that depend on supplies already present locally.

The Toronto kit includes stabilization equipment and the equipment, supplies, and solutions for FCP. Although the perfusate can be stored indefinitely when refrigerated, we will check its condition every six months by ensuring that a visual inspection is performed locally.

In England, we will conduct a training session with members of Cryonics-UK on November 15, and hope to conduct an additional training session the day before in London with the international morticians where the FCP kit is currently stored.

Having a kit located in Canada means that we can respond to Canadian members needs without worrying about essential supplies being held up in customs. This is equally important in England. The England kit may also be used to respond to members throughout Europe. Even so, we aim to eventually store another kit in Continental Europe, perhaps in Germany.

Who responds to a critical member in England or elsewhere in Europe? The answer depends on how much advance warning is available. In some cases, we would expect our Medical Response Director to fly to London and pick up the FCP kit and take it to the location where a standby or immediate stabilization is required. If time is too short, we may make use of the staff of the international mortician where our kit is stationed, including their highly skilled embalmer. A third option is to call upon the trained members of Cryonics-UK. Of course, we may use two or all three of these options, as circumstances indicate.

We are still in the very early stages of using field cryoprotection. However, assuming that we respond quickly, our Canadian and European members should benefit from a very substantial improvement in the quality of their cryopreservation, should they need it. Our first priority is to ensure that all necessary items of the FCP technology are in place and that local persons are adequately trained in using them (in case we cannot reach them quickly enough). Beyond that, we would like to position new kits in more locations. We would also like to improve the FCP technology to address some of the shortcomings of this approach in comparison to conducting closed-circuit cryoprotection in Alcor's operating room. For instance, we may be able to improve chilling of the perfusate, and improve control over flow rate and pressure. ■

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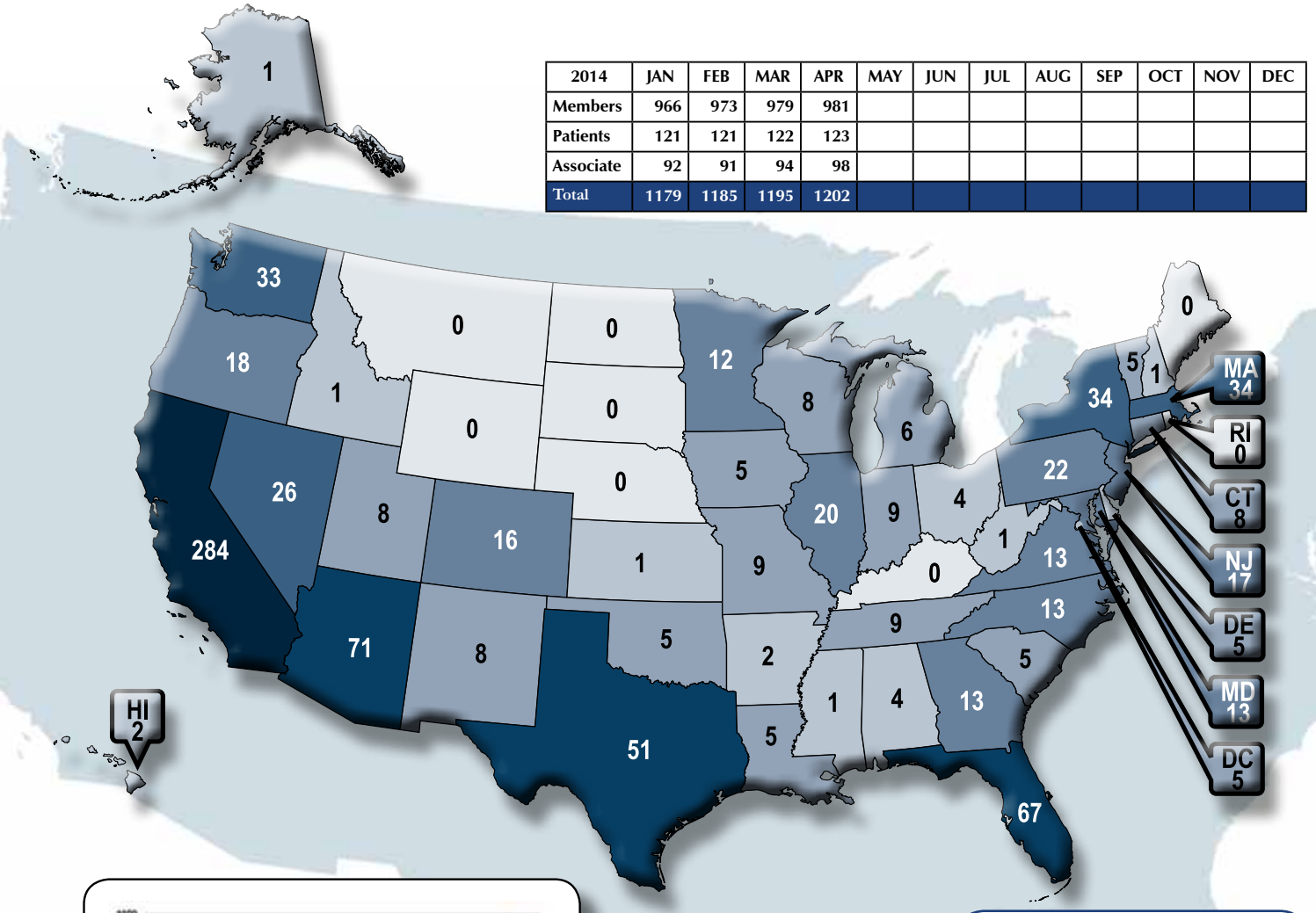
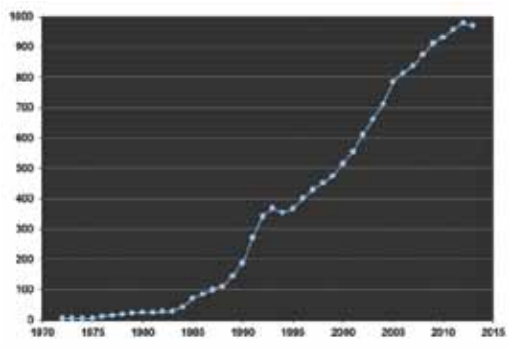
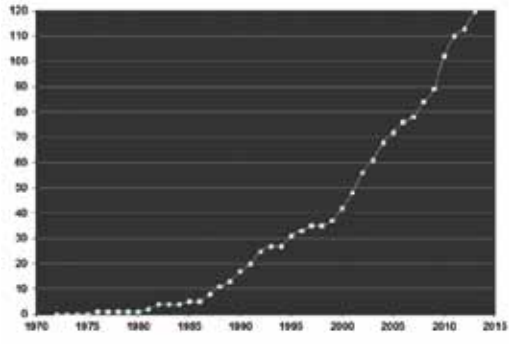
2014	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Members	966	973	979	981								
Patients	121	121	122	123								
Associate	92	91	94	98								
Total	1179	1185	1195	1202								





Number of Alcor members



Number of Alcor patients

- 0 Members
- 1–4 Members
- 5–9 Members
- 10–24 Members
- 25–49 Members
- 50–74 Members
- 75+ Members

International

Country	Members	Patients
Aruba	2	0
Australia	11	3
Canada	42	2
Germany	4	0
Israel	1	1
Italy	2	0
Japan	1	0
Lebanon	1	0
Mexico	4	0
Monaco	1	0
Netherlands	2	0
New Zealand	3	0
Norway	1	0
Portugal	4	0
Singapore	1	0
Spain	3	1
Thailand	3	0
United Arab Emirates	1	0
United Kingdom	19	2
TOTAL	**106**	**9**

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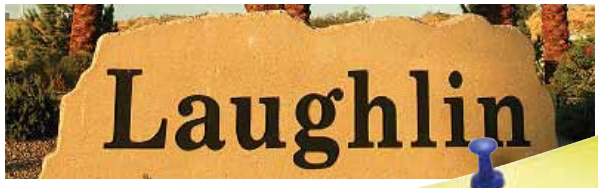

This Year's Cryonics Convention

This year marks the 50th anniversary of the publication in 1964 of *The Prospect of Immortality,* by Robert Ettinger, the book which started the cryonics movement. If you want to find the best information from authoritative sources about the current and foreseeable state of the cryonics movement as of this year, you have an excellent opportunity this coming November. The Society for Venturism is announcing its second Cryonics Convention at Don Laughlin's Riverside Resort in Laughlin, Nevada, to be held November 7, 8 and 9, 2014 at the Resort's Starview Room, a conference facility which offers a panoramic view of the Colorado River and the desert mountains beyond. The Starview Room also has space for the attendees' dining and for exhibition tables.

The convention will feature speakers who will discuss developments of interest to cryonicists, transhumanists, futurists and life extensionists. Some scientists who work in cryobiology and in the science of aging will report on their cutting-edge research. Other speakers representing Alcor and other cryonics organizations will report about developments at their respective organizations. Yet other speakers with long involvement in cryonics will discuss the history and philosophy of the cryonics movement on its 50th anniversary, the movement's current status, and where we would like to see it go in the coming years. And Mr. Laughlin himself will appear to take questions from the audience about anything, which he will answer with his humor and shrewd business sense, just like he did at last year's convention. The Society for Venturism will publish a list of speakers and their presentations in about a month at the Venturists' website: http://www.venturist.info.

Mr. Don Laughlin, a longtime cryonicist, has worked with the Society for Venturism to make the convention very convenient and affordable. The registration fee, payable to the Society for Venturism, is only $75. You have to reserve your own room accommodations through the Riverside Resort (details to be announced) at special low rates by mentioning that you are coming to the convention. Mr. Laughlin has arranged to provide all the meals for the attendees at special discounted rates inside the Starview Room so that you don't have to go down to the busy casino for your meals. The Starview Room also has a cash bar to provide beverages.

Attendees who have appropriate products or services they would like to offer or sell to cryonicists—books, T-shirts, supplements, CD's, magazines, etc.—will also be able to reserve free table space at the convention.

So mark your calendars in November for this event, and keep on the lookout for the updated information about the convention at the Venturists' website, http://www.venturist.info. If you would like more information, email Mark Plus, Secretary of the Society for Venturism at mark.plus@rocketmail.com. You can also call him at (928) 273-8451. ■

Why Should You Join the Venturists?

The Society for Venturism is one of the oldest organizations (established in 1986) which defends the rights of cryonicists to be cryopreserved.

Membership in the Society for Venturism offers the following benefits:

1. Venturist members receive the Venturists' Religious Objection to Autopsy card. This offers possible protection from an autopsy which would compromise the quality of your cryopreservation.

2. The Venturists have a Backup Trust which could offer possible protection of your cryopreservation in case your cryonics organization can no longer keep you cryosuspended.

3. The Venturists offer possible Constitutional protection of your right to cryopreservation because of their church status.

4. The Venturists hold regular, affordable conventions which are open to everyone in the cryonics community. These offer excellent opportunities to hear talks by scientists about their research into cryonics and life extension; they also provide a way to meet and network with cryonicists, transhumanists and life extensionists from around the world.

Membership in the Society for Venturism is very affordable, with an annual donation starting at $25 a year. Full membership requires being signed up with a recognized cryonics organization, and affirming the Venturists' Principles: (1) To try to do what is right; and (2) To work for the worldwide conquest of aging and death. You can find the membership application and ways to donate on the Venturists' website, www.venturist.info. For more information, contact Mark Plus, Secretary of the Society for Venturism: mark.plus@rocketmail.com, phone (928) 273-8451. Or write to: Society for Venturism, 11255 S. Highway 69, Mayer, AZ 86333, USA. ■

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Caution: Do not take if you have gallbladder problems or gallstones. If you are taking anti-coagulant or anti-platelet medications, or have a bleeding disorder, contact your healthcare practitioner before taking this product.

These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.

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MEETINGS

ABOUT THE ALCOR FOUNDATION

The Alcor Life Extension Foundation is a nonprofit tax-exempt scientific and educational organization dedicated to advancing the science of cryopreservation and promoting cryonics as a rational option. 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 specially trained technicians and customized equipment in Arizona, northern California, southern California, and south Florida, as well as many additional certified technicians on-call around the United States. Alcor's Arizona facility includes a full-time staff, and the Patient Care Bay is personally monitored 24 hours a day.

ARIZONA

FLAGSTAFF:

Arizona without the inferno. Cryonics group in beautiful, high-altitude Flagstaff. Two-hour drive to Alcor. Contact eric@flagstaffcryo.com for more information.

PHOENIX
VALLEY OF THE SUN:

This group meets monthly, usually in the third week of the month. Dates are determined by the activity or event planned. For more information or to RSVP, visit http://cryonics.meetup.com/45/ or email Lisa Shock at lisa@alcor.org.

AT ALCOR:

Alcor Board of Directors Meetings and Facility Tours—Alcor business meetings are generally held on the first Saturday of every month starting at 11:00 AM MST. Guests are welcome to attend the fully-public board meetings on odd-numbered months. Facility tours are held every Tuesday and Friday at 2:00 PM. For more information or to schedule a tour, call Marji Klima at (877) 462-5267 x101 or email marji@alcor.org.

CALIFORNIA

LOS ANGELES:

Alcor Southern California Meetings—For information, call Peter Voss at (310) 822-4533 or e-mail him at peter@optimal.org. Although monthly meetings are not held regularly, you can meet Los Angeles Alcor members by contacting Peter.

SAN FRANCISCO BAY:

Alcor Northern California Meetings are held quarterly in January, April, July, and October. A CryoFeast is held once a year. For information on Northern California meetings, call Mark Galeck at (650) 969-1671, (650) 534-6409 or email Mark_galeck@pacbell.net.

FLORIDA

Central Florida Life Extension group meets once a month in the Tampa Bay area (Tampa and St. Petersburg) for discussion and socializing. The group has been active since 2007. Email arcturus12453@yahoo.com for more information.

NEW ENGLAND
CAMBRIDGE:

The New England regional group strives to meet monthly in Cambridge, MA—for information or to be added to the Alcor NE mailing list, please contact Bret Kulakovich at 617-824-8982, alcor@bonfireproductions.com, or on FACEBOOK via the Cryonics Special Interest Group.

PACIFIC NORTHWEST

A Yahoo mailing list is also maintained for cryonicists in the Pacific Northwest at http://tech.groups.yahoo.com/group/CryonicsNW/.

BRITISH COLUMBIA (CANADA):

The contact person for meetings in the Vancouver area is Keegan Macintosh: keegan.macintosh@me.com.

OREGON:

The contact person for meetings in the Portland area is Aschwin de Wolf: aschwin@alcor.org

See also: https://www.facebook.com/portland.life.extension

ALCOR PORTUGAL

Alcor Portugal is working to have good stabilization and transport capabilities. The group meets every Saturday for two hours. For information about meetings, contact Nuno Martins at n-martins@n-martins.com. The Alcor Portugal website is: www.alcorportugal.com.

TEXAS
DALLAS:

North Texas Cryonauts, please sign up for our announcements list for meetings (http://groups.yahoo.com/group/cryonauts-announce) or contact David Wallace Croft at (214) 636-3790 for details of upcoming meetings.

AUSTIN/CENTRAL TEXAS:

We meet at least quarterly for training, transport kit updates, and discussion. For information: Steve Jackson, 512-447-7866, sj@sjgames.com.

UNITED KINGDOM

There is an Alcor chapter in England. For information about meetings, contact Alan Sinclair at cryoservices@yahoo.co.uk. See the web site at www.alcor-uk.org.

If you are interested in hosting regular meetings in your area, contact Alcor at 877-462-5267, ext. 113. Meetings are a great way to learn about cryonics, meet others with similar interests, and introduce your friends and family to Alcor members!

What is Cryonics?

Cryonics is an attempt to preserve and protect human life, not reverse death. It is the practice of using extreme cold to attempt to preserve the life of a person who can no longer be supported by today's medicine. Will future medicine, including mature nanotechnology, have the ability to heal at the cellular and molecular levels? Can cryonics successfully carry the cryopreserved person forward through time, for however many decades or centuries might be necessary, until the cryopreservation process can be reversed and the person restored to full health? While cryonics may sound like science fiction, there is a basis for it in real science. The complete scientific story of cryonics is seldom told in media reports, leaving cryonics widely misunderstood. We invite you to reach your own conclusions.

How do I find out more?

The Alcor Life Extension Foundation is the world leader in cryonics research and technology. Alcor is a non-profit organization located in Scottsdale, Arizona, founded in 1972. Our website is one of the best sources of detailed introductory information about Alcor and cryopreservation (www.alcor.org). We also invite you to request our FREE information package on the "Free Information" section of our website. It includes:

- A fully illustrated color brochure
- A sample of our magazine
- An application for membership and brochure explaining how to join
- And more!

Your free package should arrive in 1-2 weeks. (The complete package will be sent free in the U.S., Canada, and the United Kingdom.)

How do I enroll?

Signing up for a cryopreservation is easy!

Step 1: Fill out an application and submit it with your $90 application fee.
Step 2: You will then be sent a set of contracts to review and sign.
Step 3: Fund your cryopreservation. While most people use life insurance to fund their cryopreservation, other forms of prepayment are also accepted. Alcor's Membership Coordinator can provide you with a list of insurance agents familiar with satisfying Alcor's current funding requirements.
Finally: After enrolling, you will wear emergency alert tags or carry a special card in your wallet. This is your confirmation that Alcor will respond immediately to an emergency call on your behalf.

Not ready to make full arrangements for cryopreservation? Then **become an Associate Member** for $10/month (or $30/quarter or $120 annually). Associate Members will receive:

- *Cryonics* magazine by mail
- Discounts on Alcor conferences
- Access to post in the Alcor Member Forums
- A dollar-for-dollar credit toward full membership sign-up fees for any dues paid for Associate Membership

To become an Associate Member send a check or money order ($10/month or $30/quarter or $120 annually) to Alcor Life Extension Foundation, 7895 E. Acoma Dr., Suite 110, Scottsdale, Arizona 85260, or call Marji Klima at (480) 905-1906 ext. 101 with your credit card information. You can also pay using PayPal (and get the Declaration of Intent to Be Cryopreserved) here: http://www.alcor.org/BecomeMember/associate.html

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