General Introduction to Procedures for Alcor Transport Technicians

Prepared by Charles Platt for Alcor Foundation
Revised February 2004

1. Challenges and Rewards for Team Members

The Mission

Cryonics uses techniques that are relatively new and are still evolving. The procedure remains controversial, and the chance of success is unknown. We believe this endeavor is worthwhile because it remains the only option for any patient who hopes to recover from a condition which is considered terminal by doctors today.

Each member of a cryonics organization ideally wishes to be resuscitated by future science, perhaps 50 to 100 years from now. Since future science eventually should cure all currently known diseases and should enable an enhanced lifespan, a successfully resuscitated cryopatient may reap unimaginable benefits. The mission of a standby team member is to see that the patient has the best possible chance of receiving those benefits, which are far greater than the benefits offered by conventional medicine today. This is a very significant responsibility.

Early cryonics organizations lacked the resources to deploy personnel and equipment to a patient's beside where they might wait for many days for legal death to be pronounced. In any case, most cryonicists didn't believe that such heroic measures were necessary. They were counting entirely on some unknown form of future science to undo the freezing damage that occurred after inadequate perfusion with simple glycerol-based cryoprotectant. No one could even guess how much damage would be reparable and how much would be fatal.

During the 1980s, Jerry Leaf and Mike Darwin rethought the basic principles of patient care and evolved the concept of a premortem standby that would be followed by intervention immediately after legal death. Their purpose was to minimize cellular damage that normally occurs after the heart stops beating and the blood stops flowing. Brain cells require a constant supply of oxygen and glucose; the cells consume their reserves of oxygen within a few seconds, causing the patient to lose consciousness. After five to ten minutes the last reserves of glucose are gone, and harmful chemical reactions begin, literally poisoning the cells.

This process, sometimes known as the "toxic cascade," can be delayed with a combination of medications, cooling, and cardiopulmonary support. Alcor performs these interventions and then transports the patient as quickly as possible to a location such as a mortuary where the blood can be replaced with an organ preservation solution. A series of dog experiments at Cryovita Laboratories validated the solution which Alcor now uses, based around hydroxy-ethyl starch.

Also during the 1980s, Eric Drexler outlined the concept of nanotechnology and proposed future techniques for cell repair. Drexler's vision encouraged some cryonicists to continue believing that immediate intervention after legal death was unnecessary. However, so long as nanotechnology remains a speculative future science, we feel very strongly that we have an obligation to minimize damage from the moment of legal death to the time when the patient enters long-term preservation.

Resuscitation medicine has proved beyond any possible doubt that:

1. *Cell damage begins within minutes after cardiac arrest, but*
2. *The damaging processes can be minimized if we act extremely quickly.*

This is why we continue to expend large amounts of time, money, and labor on the standby/transport phase of cryonics. At the time of writing (Februrary, 2004) Alcor is the only organization that maintains a full standby capability. We are also the only organization that provides formal training for our members who volunteer to do standby/transport work. We believe that while nanotechnology does indeed have the theoretical capability to undo cellular damage, we cannot foresee the limitations, and some types of repairs may be so challenging or unusual that nanotechnologists in the future will have little personal or commercial interest in perfecting them. A patient who has suffered massive damage may have to wait decades or even centuries longer for resuscitation than a patient who has been optimally treated.

This is why we believe our work is vitally important.

Problems Facing the Standby Team

Cryonics team members in the field have to deal with logistical problems on a very small budget. They lack the backup and resources that are typically available from a hospital or ambulance company. Team members must be patient and philosophical during long waiting periods, yet must be level-headed, quick-thinking, and innovative under stress.

Moreover, cryonics care-giving requires multidisciplinary knowledge and skills. Ideally, the team leader on a remote standby should be one-part hospice nurse, one-part paramedic, one-part surgeon, one-part lawyer, and one-part diplomat. She or he may face opposition from doctors, nurses, hospital administrators, and other medical professionals. Federal and state regulations, air schedules, national holidays, equipment failures, personnel problems, and sheer bad luck may interfere with moving the patient promptly, causing potentially disastrous brain damage as a result of prolonged ischemia. Relatives may try to obstruct the procedure, and since cryonics tends to attract members who are stubborn and rebellious, cryonics patients themselves may create difficulties.

Even if the patient receives prompt treatment and a rapid transport back to the cryonics facility, the real outcome of the case will not be known until future science attempts resuscitation. Thus, a cryonics team will also feel some uncertainty, which may detract from the usual feelings of closure and satisfaction that conventional medics experience when a patient is cured of an illness or disability.

Unique Rewards

Fortunately, cryonics work provides unique emotional and intellectual rewards.

While we cannot see the outcome of each case, we can assess the outcome indirectly via diagnostic tools, and we can judge the success of one case relative to another. Thus, we can enjoy some satisfaction when all the indicators are positive, and we may enjoy the knowledge that we have helped one of the very few people in the world who has gambled on a chance to regain life in an unimaginable future world. Team members can rightfully feel that they are helping people who have been abandoned by orthodox medicine. Team members may also feel that they are using the most advanced techniques available to defy death itself.

In addition, since cryonics organizations deal with very few cases compared with conventional medical institutions, cryonics personnel can give each patient an amount of care and attention that has become rare in a modern hospital where no one has enough time. Also team members enjoy unprecedented freedom from institutional and organizational strictures that have become endemic in medicine. Team members can refine existing procedures, use their initiative, innovate, learn, and educate others. Cryonics is such a young field, there is ample opportunity to make a significant positive contribution to its development.

Alcor plays a unique role in this endeavor. Our transport team members are not just the best at what they do, they are the only people in the world who can do what they do. In the future, if orthodox medicine redefines death as a function of brain viability, today's transport teams may be viewed as pioneers or even visionaries.

2. Preliminary Requirements

Consent

Alcor requires three assurances before it can accept a cryonics case. An appropriate person must provide informed consent, contracts must be signed, and financial arrangements must be made. People under 18 will require a legal guardian to sign documents on their behalf. Where an adult is not mentally competent, Alcor can only accept that person if he or she has given durable power of attorney, at some time in the past, to another adult who will sign the paperwork; or if next-of-kin can provide evidence that cryopreservation is consistent with the preferences of the patient. Legally, next-of-kin may execute cryonics paperwork if the patient is unable to do so.

Alcor is reluctant to accept last-minute cases involving nonmembers. Funding usually is a problem, because the person who is near death obviously will be unable to obtain life insurance. The person to be cryopreserved may be unconscious or even legally dead, forcing Alcor to deal with friends or relatives who claim to speak on the patient's behalf. Under these circumstances no one may be able to determine whether the patient really wanted to be cryopreserved. This is an ethical problem and could be a legal problem if Alcor is perceived as taking advantage of grief-stricken relatives who are too emotionally distressed to make carefully balanced decisions.

Another common risk in last-minute cases involving nonmembers is that the pressure to make a quick decision may allow insufficient time for Alcor to discover a hostile relative who objects to the procedure and may challenge it legally in the future.

While transport team members should not normally be involved in a decision to take a case, they should be alert to notice any of the potential problems described above. Staff at Alcor Central depend on transport team members for reports and advice.

The Uniform Anatomical Gift Act

Alcor receives patients under the Uniform Anatomical Gift Act. Human organs and remains legally cannot be owned, but the Gift Act enables people to donate their organs after death to an appropriate institution, such as a hospital or laboratory, which takes possession.

All members of Alcor have signed a document stating that they wish Alcor to take possession of the head alone or the head and body under the Uniform Anatomical Gift Act. Alcor's right to act in this way has been tested and affirmed in a California court.

Cryonics is legal in all of the United States and in many other countries in the world. Whenever a team goes out to collect a patient, it takes with it a copy of the patient's signup documents, including the Uniform Anatomical Gift Act donor form.

Payment

Early in the history of cryonics, some organizations accepted patients on a pay-as-you-go basis. Storage costs were to be paid by relatives or friends of the deceased.

Quickly the organizations discovered that this was not a sound financial policy. In every case, after a year or two, the payments for long-term maintenance would stop, and the cryonics organization would be put in an impossible position. Either the organization had to maintain a patient at its own expense, as a charity case, or the organization had to betray its fundamental principles and surrender the patient for conventional burial or cremation.

To avoid this situation, cryonics organizations today demand that all patients should be pre-funded. A member of the organization must pay in advance, or must provide some other financial arrangement such as life insurance. (Bequests are not accepted because relatives can easily contest a will, with unforeseeable consequences.) Alcor prefers to own each member's life insurance policy, so that Alcor will be informed if a member falls behind on life-insurance payments.

Alcor cannot take action unless proper financial arrangements have been verified. Verification can be performed by our membership administrator, but in her absence, other people at the Alcor facility have access to files where each member's financial arrangements are recorded.

A standby team cannot be deployed unless:

> *1) The patient is an Alcor member whose financial arrangements have been verified, or*
>
> *2) The patient is a nonmember, and three Alcor officers unanimously agree that Alcor should take the case. It may be necessary also for the Alcor board of directors to approve a last-minute case.*

3. Basic Concepts and Procedures

Life and Death

Alcor's primary objective is to save lives. Paradoxically, an Alcor member must be pronounced legally dead before the team can take action; but in fact the pronouncement of death is not necessarily an indication that life processes have ceased irrevocably.

Usually in a hospital or hospice, a terminal patient is pronounced dead when a physician can detect no pulse or respiration. Such patients may have been assigned DNR status, meaning "Do Not Resuscitate" if breathing and heartbeat should cease. The existence of the DNR classification is clear evidence that in many cases, resuscitation could be effective if it is applied, but is considered undesirable by medical staff, perhaps because the patient is suffering an incurable disease that is in its final stages, and the patient's quality of life has deteriorated.

What does this tell us about the nature of death?

> *1. Regardless of whether legal death has been pronounced, the brain may still be viable and resuscitation may still be possible, and*
>
> *2. Resuscitation should be considered impossible only in cases where significant brain damage has occurred.*

The key factor is viability of the brain.

While orthodox medicine gives up on a patient whose condition is incurable, Alcor takes a longer view. Just because a condition is incurable now, does not mean it will be incurable in the future. Ideally, the patient should be able to enter a state of suspended animation until medicine evolves new techniques of treatment, at which point the patient can be revived and cured.

Of course this is worthwhile only if we can preserve the brain well enough so that the patient is resuscitated with memories, intelligence, and personality intact. Therefore, maintaining brain viability is our number-one objective.

Cardiac Arrest and Brain Viability

If paramedics attempt resuscitation after more than ten minutes of ischemia (lack of blood flow), the outcome often is poor. The patient may enter a vegetative state in which the lower brain regains its ability to control heartbeat and respiration, but higher brain functions are permanently damaged. In simple terms, the patient continues breathing but "never wakes up." In other cases the patient does regain consciousness, but the toxic cascade causes reperfusion injury that can lead to death or a vegetative state within the next 12 to 36 hours.

We must intervene immediately to preserve brain viability after cardiac arrest.

The Power of Hypothermia

As previously noted, cardiac victims seldom survive after more than 10 minutes without a heartbeat. Yet resuscitation literature often describes cold-water drowning victims who have been resuscitated after an hour or more with no vital signs. Most cold-water drowning cases who are successfully revived tend to be children, because the ratio of skin area to body mass is higher in a child than in an adult, and consequently a child will cool more rapidly when skin is exposed to very cold water.

Rapid cooling causes a lowered body temperature, often referred to as hypothermia. This is the key to successful resuscitation after a long period of downtime. It works because all chemical reactions occur more slowly at lower temperatures, as described by the Arrhenius equation, which was derived more than a century ago.

Since the toxic cascade is a series of chemical reactions, a lowered temperature inhibits this cascade. Moreover, hypothermia also tends to counteract the inflammatory response that we believe is a factor in ischemic injury. In simple terms, cooling the brain helps to avert damage in much the same way that we would treat a sprained ankle with a cold compress.

One task of the cryonics standby team is to cool the patient immediately after legal death. Alcor has developed various techniques including a portable ice bath and forms of lavage, including the future prospect of liquid ventilation via the lungs.

Chemical Intervention

After legal death has been pronounced, the patient is of no interest to conventional medicine. Consequently, innovative interventions are possible. Alcor's science advisors may devise the best possible protocol to preserve the brain and body while minimizing injury.

Alcor is affiliated with two California laboratories that are world leaders in resuscitation research and cryobiology research respectively. We receive frequent updates from these labs based on their research, and we use this information to upgrade our protocol as soon as we feel confident that the outcome will be beneficial.

The first and most essential drug that we administer is heparin. We cannot hope to preserve the brain effectively unless we can cool it and medicate it from within, via the circulatory system. Therefore we must keep the circulatory system open by preventing the blood from clotting. Heparin has been used as an anticoagulant for many decades.

Like all of our meds, heparin must be administered intravenously. This can be problematic in a patient who has experienced cardiac arrest. Even experienced health-care personnel can have difficulty finding a vein when there is no pulse and negligible blood pressure. We attempt to administer medications using the following techniques in order of preference:

1. *Intravenous access via a previously implanted IV such as a Portacath, or*
2. *Intravenous access via a peripheral IV (drip), or*
3. *Intravenous access via a subclavian stick.*

In most cases where the patient has received hospital or hospice care prior to death, some kind of IV access will have been installed. **A high priority for the team is to ask medical personnel not to remove this IV access.**

In cases where there is no IV access, or if IV access has been removed despite our requests, team members may attempt to gain vascular access via a subclavian stick. This procedure can be practiced on a medical dummy.

Subsequent medications include other anticoagulants, antioxidants, vasoconstrictors, and agents that prevent "sludging" which can block small capillaries. All of these medications must be circulated through the patient by squeezing the heart. This is done by the conventional procedure of applying chest compressions. Alcor has a mechanical CPS system, but if this is unavailable team members may use a hand-held "cardiopump" with a suction cup that allows personnel to pull up as well as push down on the chest, greatly enhancing the efficiency.

Metabolic Support

After cooling and medication, the third technique for maintaining viability of the brain is to resupply brain cells with oxygen and glucose to enable metabolic support. Glucose can be included in the medications, but oxygen must be administered orally. This will be effective if the patient can be intubated, a standard process used by paramedics to insert a tube into the trachea so that the lungs can be supplied directly with oxygen.

Blood Washout

Sometimes a health-care facility will allow all the above procedures to be performed on-site. This is the optimal scenario. Other facilities may be less cooperative, and will demand that the patient is removed offsite even before heparin is injected.

If the patient is located near Alcor, a specially modified ambulance will transport the patient to Alcor's facility in an ice bath with cardiopulmonary support uninterrupted. If the patient is not close to Alcor, the patient must undergo blood washout and perfusion with tissue preservation solution, so that the brain may survive the subsequent delay during transport.

Typically blood washout is done at a nearby cooperative mortuary. We maintain Air Transportable Perfusion (ATP) kits which consist basically of a pump, a sterile tubing pack, and a sump pump which circulates ice-water through a heat exchanger to cool the patient's blood. In addition the team will need a supply of blood washout solution, which is carried in a separate case; and an ATP Support Kit containing surgical clamps, gloves, scissors, and other tools. These kits are designed for easy air transportation as personal passenger baggage, and can be deployed anywhere, so long as there is a local source of water and ice.

Ideally, the team has made prior contact with the mortuary and has placed its ATP there, with a substantial amount of ice. The team also should have had time to rent a van locally and convert it for transport. Some cases, however, allow very little time for preparations, and a mortuary removal service may be used to collect the patient from the hospital or hospice.

At the mortuary, if none of Alcor's surgeons is available, a mortician may be asked to perform a cutdown of the femoral vessels near the groin. Cannulae (tubes) are inserted. The washout solution is cooled and pumped through the patient at a carefully controlled flow rate, in a process known as perfusion. After this process is complete the patient is moved to Alcor's operating room for an entirely separate series of procedures to protect against the damage which would normally occur when the temperature of a human being is reduced below the freezing point of water. The transport to Alcor from a remote location is accomplished in a standard mortuary shipping container known as a Ziegler case, in which the patient is packed in bags of ice.

Cryoprotective Perfusion

Cryobiologists discovered many decades ago that when an unprotected mammal is frozen, water seeps out of the cells and forms ice between them. Ice crystals crush delicate cell membranes, disrupt the structure of organs such as the brain, and create damage that is irreparable by any current technology. (The science of cryobiology is named after the Greek word "kryos," meaning "icy cold," and was largely established in the 1950s.)

A few chemicals such as glycerol can act as an antifreeze, replacing some of the water in cells and minimizing ice damage. This procedure is sufficiently effective to allow single cells and very simple organisms to be preserved in liquid nitrogen at -196 Celsius. Sperm, ova, and very small human embryos haven been successfully rewarmed after being cryopreserved for periods of years. Liquid nitrogen is often used because it is relatively cheap and requires no refrigeration, since it can be delivered precooled in the liquid form and can be stored in insulated containers which minimize evaporation, or "boiloff," that occurs as heat gradually enters the vessel.

Unfortunately an organ with a complex structure, such as the brain, will still suffer extreme damage if it is frozen after being cryopreserved with glycerol. Some ice will still form, and will disrupt the structure. Since cryobiologists saw no way around this, they viewed cryonics skeptically, and one famous cryobiologist was quoted as saying that reviving a cryopatient would be like turning hamburger back into a cow.

Cryonicists have responded in two ways to these objections.

> *1. The future science of molecular nanotechnology (tiny machines, no bigger than bacteria) may be capable of repairing individual cells and undoing the damage caused by freezing. In effect, nanotechnology literally may be able to reconstitute a cow from hamburger. The chances of this being possible, and affordable, are unknown. Consequently, the chances of cryonics working for any individual patient are unknown, since all patients may experience some cellular damage in areas where cryoprotectant probably has not reached its necessary concentration. Still, the unknown chances for resuscitation of a cryopatient are better than no chance at all.*
>
> *2. During the past five years some cryobiologists have perfected the process of vitrification, in which a new form of cryoprotectant enables water to solidify at a low temperature without forming ice crystals. This means that ice damage can be eliminated almost completely—provided the vitrification solution reaches all areas of the brain.*

Most biologists are unaware that vitrification is now possible. Consequently they continue to state that the resuscitation of cryopatients is impossible.

At Alcor we have a contractual arrangement with a supplier of vitrification solution, and we have good evidence that under optimal conditions our patients are protected from ice damage. When the patient reaches our operating room, the process of cryoprotective perfusion circulates vitrification solution throughout the blood vessels in the brain in a process which lasts approximately 4 hours after surgical procedures to prepare the patient have been completed. When the procedure is complete the patient is moved to a cooldown bay where the temperature is reduced quickly at first, down to the “glass transition point” (sometimes known as Tg), which is where the vitrification solution solidifies into a glassy substance. After this, the patient is cooled much more slowly, to avoid thermal stresses, and finally enters long-term storage.

Summary

The objective of cryonics is to preserve a patient’s brain after legal death in such a way that resuscitation may be possible in the future. Although this is a speculative procedure, evidence from cold-water drowning cases and resuscitation research indicates that it is theoretically possible.

Alcor’s procedures are:

1. Affirm that the patient is a fully-funded member of the cryonics organization. If the patient is a nonmember, three officers must agree unanimously to take the case.

2. Deploy necessary equipment as close to the patient as possible.

3. Do not interfere in any way with premortem treatment.

4. After legal death is pronounced:
   Inject the Alcor meds, beginning with heparin.
   Use chest compressions to circulate meds.
   Initiate rapid cooling.
   Intubate and provide oxygen.
   Maintain mechanical cardiopumonary support while patient is moved.

5. If the patient is far from Alcor, a femoral cutdown will be performed, probably at a local mortuary, and an ATP will wash out the blood and replace it with an organ preservation solution. The patient will be packed in bags of ice inside a standard mortuary shipping container for transport to Alcor.

6. At Alcor, in the operating room, the patient is perfused with cryoprotective solution to prevent ice damage. The patient is then taken down to a very low temperature to prevent any deterioration for a century or more.

4. Terminology

After the concept of cryonics was introduced in the 1960s, it developed its own vocabulary, using words such as "suspension" to describe the process of placing a patient in suspended animation.

We prefer to avoid cryonics-specific terminology for two reasons:

1. *It creates the false impression that cryonics is a subculture or clique.*
2. *It inhibits communication, especially with medical professionals.*

However, some orthodox scientific terminology may itself be unfamiliar to general readers. Here is a quick summary of the most commonly used terms:

cryogenics: The general study of low temperatures. (From the Greek word "kryos," meaning "icy cold.")

cryonics: A set of procedures for preparing and maintaining a human being at a very low temperature.

cryopatient: A person who is undergoing or has undergone the procedures of cryonics.

cryopreservation: Preservation of any biological specimen by maintaining it at a low temperature.

cryoprotectant: A chemical which replaces water in human tissues, to prevent or minimize ice damage.

glass transition point: The temperature at which a vitrification solution solidifies into a glasslike substance. (This temperature is known as Tg, pronounced "tee-gee.") See *vitrification*, below.

hypothermia: Lowered body temperature.

ischemia: Zero blood flow (as occurs after cardiac arrest).

perfusate: a chemical that is introduced to the cardiovascular system.

perfusion: circulation of blood or a chemical agent through the patient's cardiovascular system.

perfusion, closed-circuit: a perfusate is introduced and then recirculated, although a portion may be drained while another portion may be added.

perfusion, open-circuit: a perfusate is drained from a vein after circulating once through the patient.

reperfusion injury: the series of damaging chemical events that occurs in the brain when the circulation of blood is restored after a period of cardiac arrest.

standby, remote: A procedure in which cryonics personnel wait for the predicted death of a member of a cryonics organization, at least 100 miles from the cryonics facility.

transport: Treatment of a cryopatient and relocation of the patient to the cryonics facility.

vitrification: A process by which water in the human body is transformed into a noncrystalline, vitreous form at a temperature below 0 degrees Celsius. By preventing ice crystals, vitrification mostly eliminates damage to biological cells and structures.

vitrification, CNV: The concentration of vitrification solution which is necessary to achieve vitrification.

Self-Test

After reading this booklet, you should be able to answer the following questions. If you can't, please check the text to find the answers.

Is the responsibility of a cryonics transport team member greater or less than the responsibility of conventional emergency medical personnel, such as paramedics?

How did the cryonics standby originate?

Do other organizations do standbys?

Do other organizations train their members?

Why not? Why do we do it?

When was nanotechnology suggested?

Will it repair cell damage?

Will all cryonics patients be revived at about the same time?

What are some ideal attributes for standby team members?

Why would anyone want to work in a standby team?

What are some typical obstacles facing standby team members? Who may interfere?

What is the primary objective of a standby team?

By what right to cryonics organizations take possession of a patient?

Has this right been upheld in a court?

Do they own their patients? How can they resist legal challenges from relatives who seek to take possession of cryopatients?

How are cryonics arrangements funded? Can a bequest be used? Is prepayment possible?

Under what circumstances will Alcor accept a new member?

Why does Alcor like to own life insurance policies?

Why is Alcor reluctant to take last-minute cases?

How is death defined?

What is a DNR order?

Under what circumstances will a cryonics patient want to be resuscitated by conventional medical personnel?

What is the toxic cascade? What is reperfusion injury?

What three techniques are used to delay onset of the toxic cascade?

Why is hypothermia helpful in cardiac victims?

How can we cool patients effectively?

What is heparin? Why do we use it? How do we administer it?

How are medications circulated through the body of a cryopatient?

What is a cardiopump?

What is intubation?

What is an ATP? What other supplies must be brought in with it?

What is the one resource that must be available locally with the ATP?

Where is an ATP normally used?

Where are the femoral vessels?

Why does the standby team need to rent a van?

What is a Ziegler case?

How is the patient transport to Alcor?

What happens when an unprotected brain is cooled below 0 degrees Celsius?

When was cryobiology established?

What is glycerol, and what does it do?

What living entities have been successfully revived after preservation in liquid nitrogen?

Why is glycerol insufficient to preserve organs such as the brain?

What is the chance of cryobiology repairing cell damage?

Do all cryopatients have some cell damage?

What is the chance of a cryopatient being revived?

What is vitrification?

Why do many biologists insist that the revival of cryopatients is impossible?

What is cryoprotective perfusion? How long does it take?

What is Tg?