

CryoPreservation Case Report:

Patient A-2059

by Todd Huffman and Tanya Jones

Patient A-2059 first contacted Alcor about the sign-up process in early December of last year. His wife was encouraging him to arrange for his cryopreservation, as he had a terminal form of stomach cancer that was proving increasingly difficult to treat. In 1999, he had a total gastrectomy, and his cancer went into remission until 2003. By the time they contacted us, the cancer was inoperable, and his health was deteriorating rapidly. Shortly after completing his arrangements, the patient came to Scottsdale for a visit. He toured the lab in a wheelchair, as his strength was significantly reduced from his battle with the cancer. His wife pushed, and they both asked a few questions before leaving to examine nearby hotels.

They moved to Scottsdale from the southern California region approximately one month before the terminal event. While in Scottsdale, the patient was introduced to a hospice that regularly works with Alcor and seen by a local physician. In this early period, the patient and his wife traveled between Arizona and Southern California several times to visit with friends and family.

During the planning stages of this case, Alcor's relationship with the local hospice was tested and refined in several key areas. Clarifications were needed on both sides with regard to what information is provided to a potential patient and what those patients will typically expect when interacting with hospice personnel. Among the specific issues discussed were: what medical procedures Alcor would like to see implemented by the hospice and which of those the hospice is actually able to provide; what Alcor could do to make the hospice workers more comfortable with our procedures; clarification of financial responsibilities and medical arrangements on the part of Alcor or the patient; and a general agreement that hospice personnel will be included in case planning sooner. While this planning will help Alcor's members in future suspensions, they were not particularly useful to A-2059, as he ultimately did not spend his final days in their care.

The patient was seen periodically by the hospice staff and physicians, but never quite settled enough to be admitted for 24-hour care. In early March after consulting with their doctor, he and his wife decided to make one last return home to provide comfort and closure prior to admission. Balancing the requirements for cryonic suspension and personal comfort is often a difficult issue for members as their health declines, since it is natural for people to want to be at home, surrounded by family and friends at that time; but such measures are complicated when a patient chooses to optimize the cryopreservation circumstances by relocating. Compounding the issue are the difficulties in ac-

curately predicting the state of someone's health, an imprecise art for even the most astute of physicians. This final trip to LA proved to cause problems for this patient.

After making the long drive from Phoenix to the Los Angeles area, our patient suffered cardiac arrest in his sleep during the night of his return. The exact time of death is not known, but post-case analysis indicates 8 in the morning (all times are in Arizona time) is a reasonable estimate. At approximately 10:00 AM, the patient was discovered by his wife, who promptly called both 911 and Alcor.

By 10:40 the police and ambulance services had been to the home. The patient's wife informed them of her husband's cancer and his desire to be cryopreserved; and they determined resuscitation measures were contraindicated. Shortly thereafter, Tanya was informed by the LAPD the death would be ruled a natural one, bearing no additional risk of autopsy. The patient's physician was extremely helpful and agreed to sign the death certificate immediately upon presentation, with time of death listed at 09:11 PST. Because the patient's physician and family were well informed on Alcor's procedures, many unnecessary and damaging delays were avoided.

In accordance with instructions from Alcor, the patient's wife placed ice around the head of the patient. A temperature reading was taken prior to the administration of the ice, but when the patient's wife failed to get the probe under the tongue, an axillary temperature was taken and found to be 31.6 degrees C.

While communication with the LAPD and the patient's physician was taking place, the team leaders of the Southern California Transport Team were contacted and dispatched to the patient's home. Preparedness was high, given the existence of another pending case in the area. The team arrived at approximately 12:48 and immediately obtained intravenous jugular access on the patient to allow for the administration of stabilization medications. The first set of medications was introduced into the patient, and then he was transferred into the ice bath for surface cooling and a round of chest compressions. The next set of medications was delivered; and by 14:00, the patient was transferred into the van.

The decision was made to bring the patient directly to Phoenix. In past cases there have been positive results in driving directly to Alcor, rather than exposing the patient to the complications and delays associated with remote washout. Performing a field washout in the LA area has been known to delay transport significantly (on the order of double digit numbers of hours), so driving straight through was considered to be an attractive option.

Timelines and Overview

| Time | Significant Times | Time since pronouncement | |
|----------------|---------------------------------|--------------------------|-------|
| 3/3/2004 ~8:00 | Estimated cardiac arrest | -2:11 | h:min |
| 10:11 | Pronouncement | 0 | h:min |
| 12:50 | Medications Started | 2:39 | h:min |
| 13:54 | Medications Complete | 3:43 | h:min |
| 13:00 | Surface Cooling Started | 2:49 | h:min |
| 13:05 | Cardiopulmonary Support Started | 2:54 | h:min |
| ~14:00 | Transport Started | 3:49 | h:min |
| 21:19 | Transport Complete | 11:08 | h:min |
| | | | |
| 23:19 | Blood washout started | 13:08 | h:min |
| 23:40 | Washout complete | 13:29 | h:min |
| 23:40 | Cryoprotection started | 13:29 | h:min |
| 3/4/2004 08:40 | Cryoprotection complete | 22:29 | h:min |

| Cryoprotection Data | | |
|----------------------------------|-------|-------|
| Target concentration | 49.4 | brix |
| Final concentration, R Jugular | 49.6 | brix |
| Final concentration, L Jugular | 50.1 | brix |
| Perfused at target concentration | ~3:45 | h:min |



| Temperature History | | |
|----------------------------|---------|-------|
| Initial temperature, °C | 31.6 | °C |
| Time until first 10° drop | unknown | |
| Time until first 100° drop | 26:52 | h:min |
| Time until -196° | ~110:00 | h:min |

| Significant times | | | and differences | | |
|------------------------------------|-------|-------|--------------------------------|------|-------|
| Arrest until notification of Alcor | ~2:00 | h:min | | | |
| | | | Notification until acquisition | 2:50 | h:min |
| Arrest until patient acquisition | 4:50 | h:min | | | |
| | | | Acquisition until transport | 1:00 | h:min |
| Arrest until transport | 5:50 | h:min | | | |
| | | | Transport until arrival | 7:19 | h:min |
| Arrest until arrival | 13:09 | h:min | | | |
| | | | Arrival until start of surgery | 0:31 | h:min |
| Arrest until burr holes started | 13:40 | h:min | | | |
| | | | Burr holes until ramp | 2:20 | h:min |
| Arrest until ramp started | 16:00 | h:min | | | |

Surgical Timeline

| | |
|-------|--|
| 21:19 | Remote team arrives at Alcor |
| 21:23 | Patient transferred from van to surgical table |
| 21:25 | Patient prepared for surgery |
| 21:49 | Bur holes in place |
| 22:05 | Surgeon prepares makes initial neck incisions |
| 22:22 | Left carotid isolated |
| 22:27 | Incisions made on right side |
| 22:35 | Right carotid isolated |
| 22:41 | Right artery cannulated |
| 22:43 | Left artery cannulated |
| 22:52 | Neuro separation begun |
| 23:09 | Separation complete |

Bypassing field washout is an option only feasible for areas reasonably close to Alcor, where it may be faster to transport than to establish remote surgical facilities.

The paperwork was being processed in parallel with the field team. As expected, the doctor declared the death a natural one and signed the paperwork promptly, and our local mortician was brought on to assist in the processing of the transit permits.

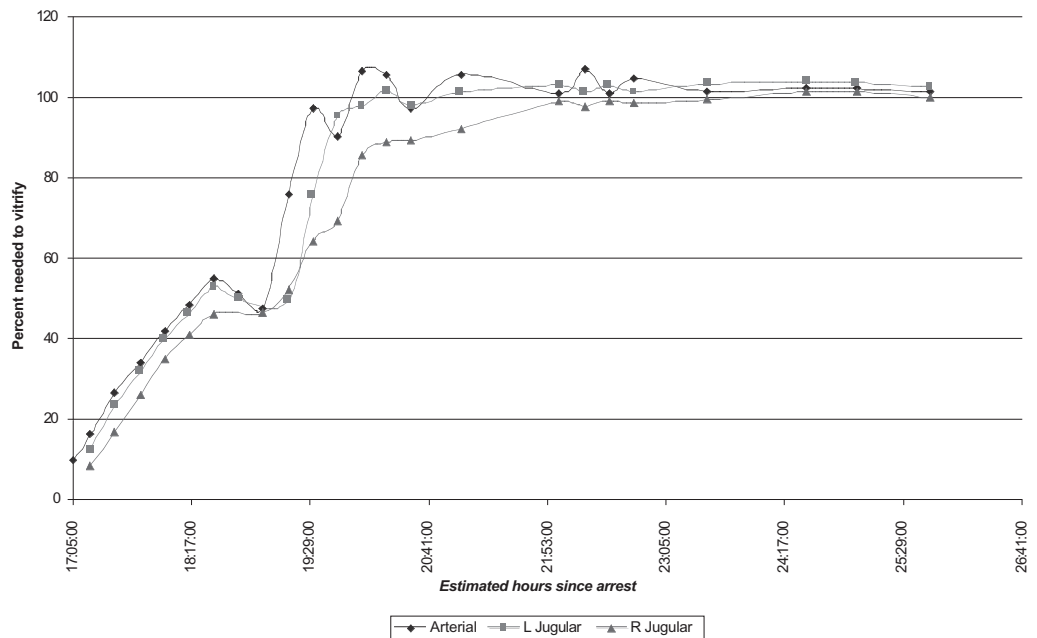
On the procedural side, the temperature recording equipment fell into the ice bath and got wet during transport, which caused it to malfunction and lose temperature data. The equipment is in a water resistant case, but is not immune to total submersion. Other than this one problem, the transport went smoothly given the circumstances.

Arrival at Alcor

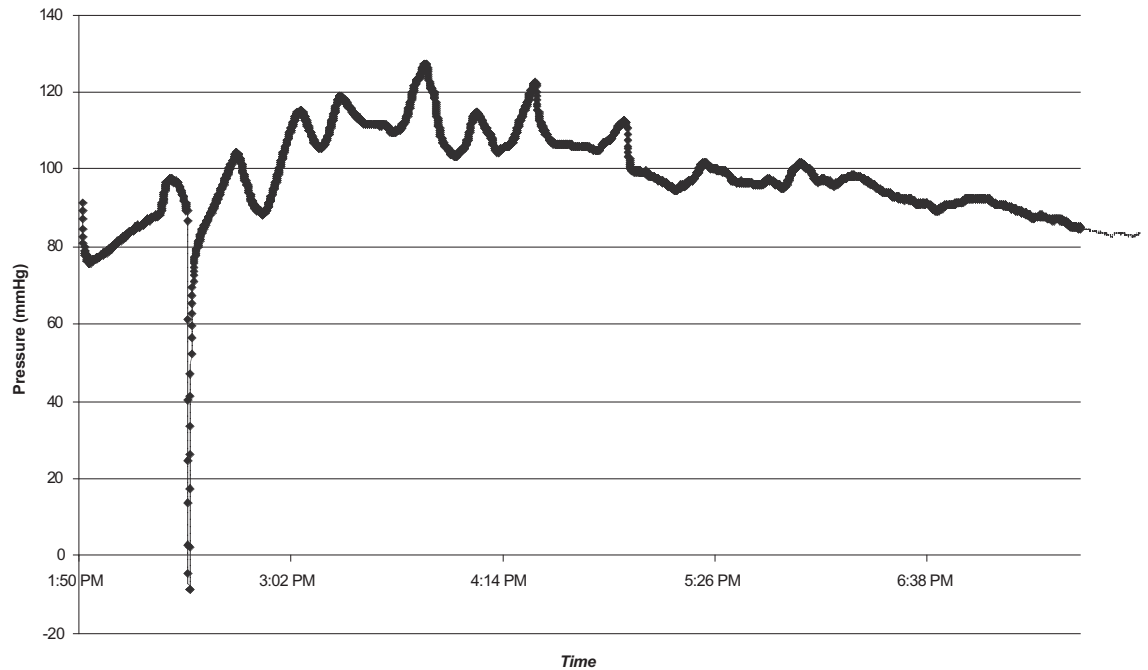
The team arrived at Alcor at 21:19, and the patient had cooled to a nasopharyngeal temperature of 6 degrees C. The patient was on the table and being prepped for bur holes at 21:29. Alcor has since improved its speed in getting patients from the ambulance and into the operating room substantially over the last several cases, often difficult because of the number of people and pieces of equipment that must be synchronized. Further work needs to be done to streamline the process, especially in coordinating the patient’s estimated time of arrival with the operating room staff.

Operating room procedures started with the transfer of the patient from the portable ice bath to a bed of bagged ice atop the surgical table. Surgical sites on the head and neck were prepared with betadine, the head shaved and cleaned, and bur holes opened. The surgeon isolated the carotid arteries, inserted perfusion

A-2059 Cryoprotection



A-2059 Perfusion Pressure



nula, and secured them to the site. The left artery was abnormally small, and the cannula had to be switched to a smaller size.

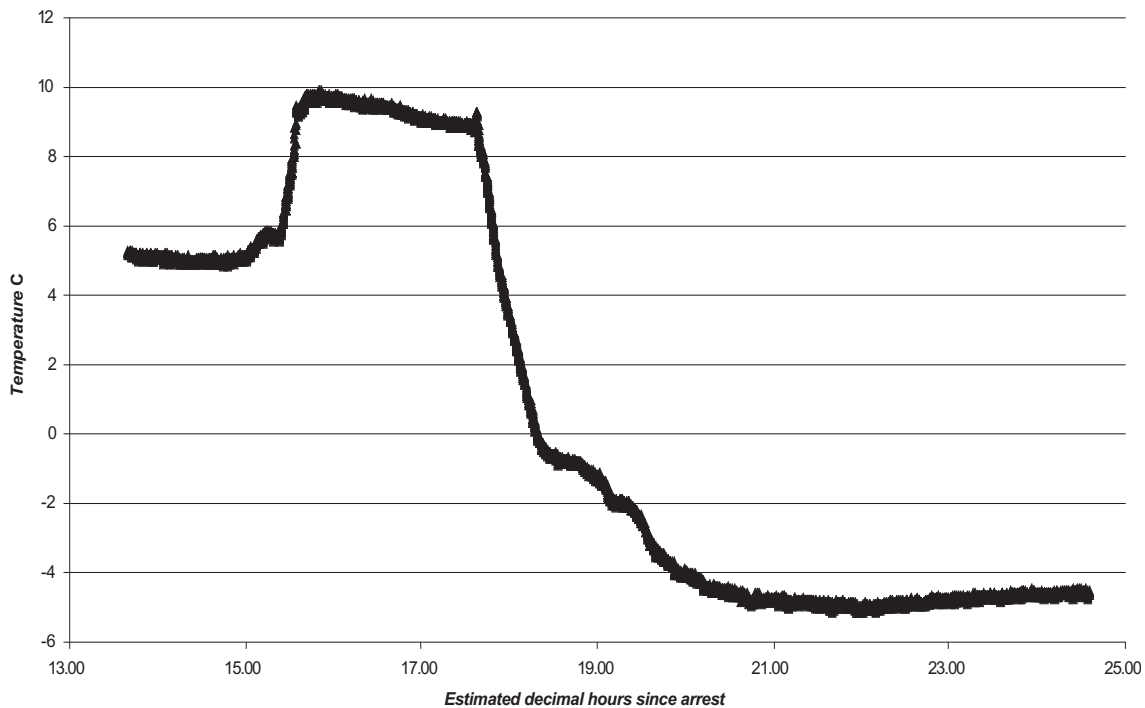
Once the vessels were secured the surgeon performed the neuro separation and placed the patient in the cephalon enclosure. Once the perfusion was initiated, a temperature sensor and crack-phone elements were inserted between the dura and the skull to facilitate later monitoring.

The perfusion revealed several sub-optimal conditions, most

likely due to the delay between cardiac arrest and the administration of Alcor's medication protocol. Indications of damage included the observation of several small clots, higher than average vascular resistance, and asymmetrical brain shrinkage.

Clots were first observed being flushed from the left vertebral artery, and later from the right vertebral artery. The clots were small, approximately the size of pin heads. Clots form if a patient does not receive the 'clot busters' and anticoagulants in

A-2059 Perfusion Temperature



Perfusion Timeline

| | |
|-------|--|
| 23:12 | Patient placed inside cephalon enclosure |
| 23:19 | Cannula connected to circuit and washout begun |
| 23:23 | Several small clots observed from left vertebral artery |
| 23:24 | Several small clots observed from right vertebral artery |
| 23:31 | Thermal probes and sample sites secured in veins |
| 23:34 | Vertebral arteries clamped |
| 23:46 | Thermal probe and crack-phone elements placed between dura and skull (right inserted 3", left inserted 5") |
| 23:55 | Washout complete, circuit closed, and ramp started |
| | Washout length: 9 minutes |
| 23:58 | Nasopharyngeal temperature 10 degrees C |
| 4:00 | Target concentration reached in left jugular effluent |
| 6:30 | Target concentration reached in right jugular effluent |
| 8:40 | Perfusion ended |

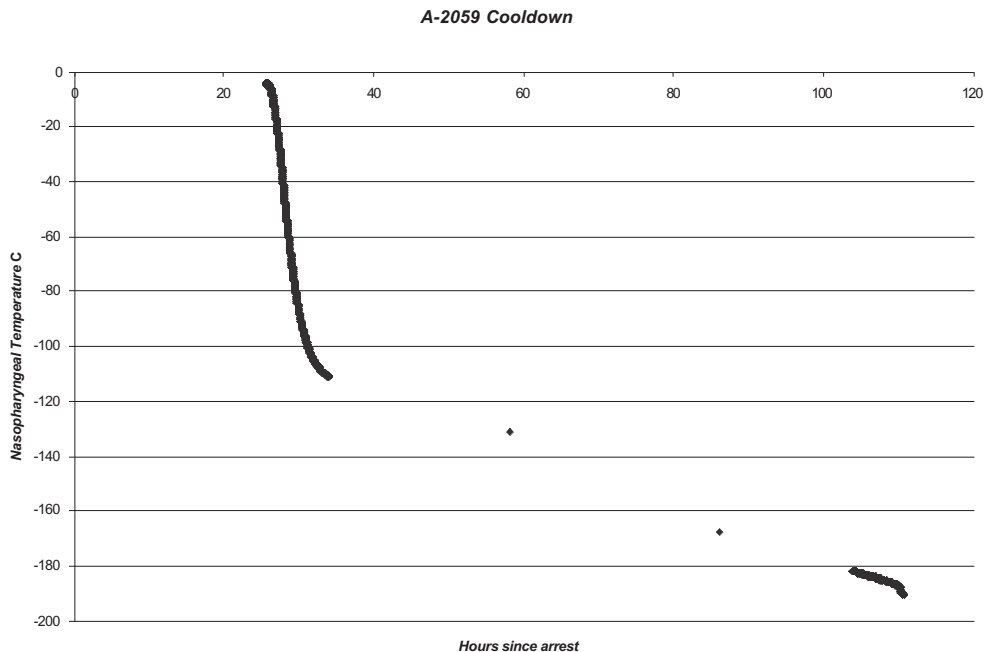
canAlcor's medication protocol in a timely manner. Even when clot busters are administered later the blockages in flow reduce their effectiveness.

The vascular resistance of a patient can be inferred by looking at the pump speeds and pressures needed to achieve adequate flow rates. A normal pressure used in suspensions is around 110 mmHg, and in this case it was necessary to raise the pressures to above 120 mmHg on several occasions. The vascular resistance of a patient varies because of a large number of variables, ranging from atherosclerotic plaques to ischemic oxidation of vessels. The initial temperature at which the cryoprotectants are introduced is 10 degrees C, which is why the patient's temperature can be seen to have increased several degrees. Based on results from the sources discussed it is believed the patients left hemi-

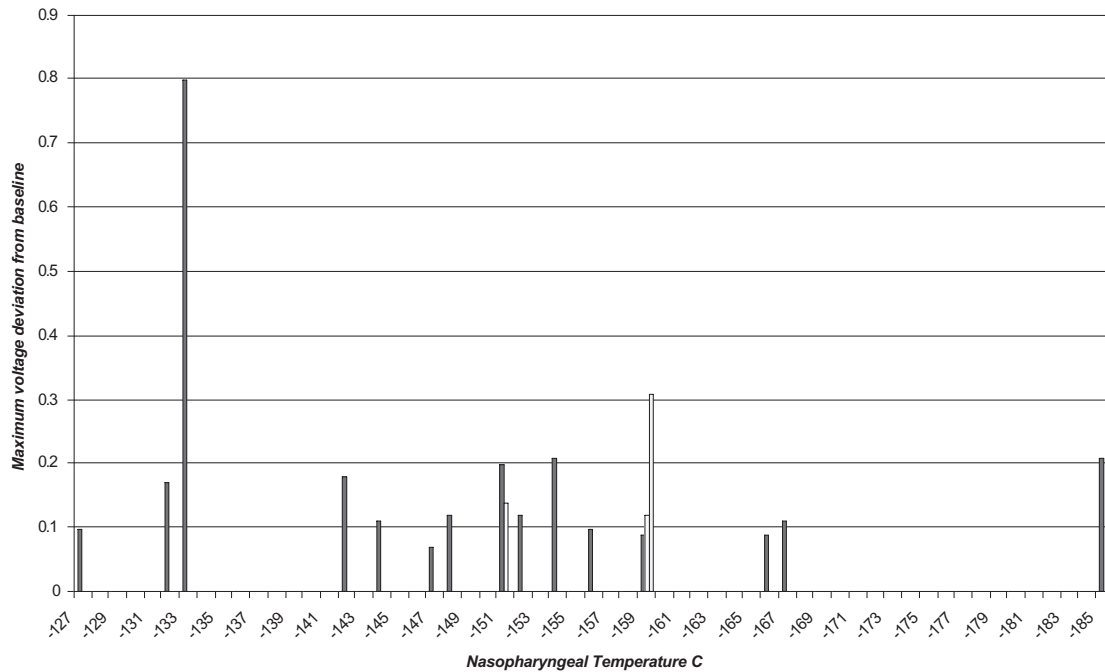
sphere perfused better than the right. This belief is supported by the qualitative observation of temporary edema on the patient's right hemisphere, which later shrunk to expected levels

The patient entered cooldown at 09:25 on March 4, 2004. Cooldown was carried out using the standard protocol, which was a plunge to -110 degrees C, then a hold for a period of time, followed by a 1 degree/hour temperature descent to -196 degrees C. This procedure was performed by R. Michael Perry, who directed the entire cooldown process.

Another significant loss of recorded data occurred during this cooldown. A power supply failure caused temperature records to be lost between saves. An electric device was plugged into the uninterruptible power supply supporting the cooldown equipment and overloaded the system, causing a breaker to be thrown.



*Time of arrest estimated



Since the procedure was being monitored, this failure affected the computer only temporarily, and did not affect the patient’s condition. However, safeguards have been put into place to prevent further power disruption. Patient temperature data is recorded using two methods, and the missing points reflect the computer failure during the cooldown. Mathematical analysis of the remaining data suggests the cooldown equipment followed the desired curves, a belief which is supported by Mike Perry’s manual temperature recordings.

Eighteen acoustic fracturing events were recorded, which is on the high side of the normal range for a case of this type. The first event occurred at -127 degrees C and the final event occurred at -185 degrees C. In the graph above, the Y axis indicates the maximum voltage the acoustic event caused the crack-phone element voltage to deviate from baseline; and the X axis indicates the temperature at which the events were observed.

Once the patient arrived at the boiling temperature of liquid nitrogen, he was transferred to long-term storage in one of our Bigfoot dewar. Transfers all occurred without incident, and the patient now rests in liquid nitrogen with fellow cryonicists.

“Indications of damage included the observation of several small clots, higher than average vascular resistance, and asymmetrical brain shrinkage.”



Surgical team prepares patient for cryoprotective perfusion.