Cryopreservation Case Summary:

The Cryopreservation of Patient A-2068

by Tanya Jones, Director of Technical Operations

We were contacted initially by the patient's son on the morning of May 13, 2004, when an application for membership was faxed to our office. The applicant was an 82-year-old woman in the hospital, suffering from transient ischemic attacks, renal failure, and septicemia, and not expected to survive long. Her son, who is a friend of at least one Alcor member and familiar with our procedures, submitted an application for whole body cryopreservation on her behalf. Next of kin consisted of two sons, both of whom were supportive of the cryopreservation efforts. Funding was provided in the form of prepayment for both the procedure and the associated standby. A consent form was provided, as signed by the patient, indicating her personal desire to be cryopreserved; and a full set of legal documentation was executed by the next of kin in under 24 hours.

State of Readiness

When this call came in, we were not entirely prepared for another case in Florida. The Regional Coordinator was still missing a couple of transport components that had not been replenished after the completion of the previous case. We were fortunate in that we had personnel in the area, as Joe Waynick and Todd Huffman were in Florida visiting the lab at Suspended Animation, Inc. (SAI). When negotiations began in this case, they were provided with access to an office, telephone and fax to facilitate preparations.

As the legal aspects of the cryopreservation resolved and it looked likely we would accept the case, the staff of SAI graciously offered their assistance in the standby and stabilization, when it became necessary. We accepted and also activated a few of our local medical professionals to fill out the team. The standby was launched on the afternoon of May 13, 2004.

Deployment Description

Joe Waynick and Todd Huffman were the first team members on site. SAI personnel arrived late that evening. A team member went in to assess the patient and found her on a ventilator with labored breathing. Her vital signs were weak but within normal ranges for patients in similar condition. Capillary refill was slow in some extremities and non-existent in others. Edema and clotting were noticed in her fingers and toes.

One unusual complication in this case is that we had three small teams coming together to work for the first time. Differences in protocols and training levels were evident, and communication was sometimes difficult. Exhaustion also became a factor during deployment.

In preparation for post-pronouncement needs, several members of the team mapped the exit route from the room by walking the hospital corridors to determine the shortest path from the building. The team was worried that if the patient's heart stopped during the small hours of the night, then many of the doors would be locked, and the team would need security personnel to open them. As a result, the chosen path would lead them through the main hospital lobby. At about this same time, medications and perfusion equipment were moved from a personal vehicle to SAI's ambulance; however, the equipment was not set up and the medications were not drawn due to the uncertainty of the time of eventual pronouncement.

Because we had been in the area recently for another patient, we had a funeral home that we hoped to work with again. When one of the SAI personnel attempted to drop off the perfusion equipment late that night, he was informed that he could not visit the mortuary at that time and that they did not want to be contacted until the patient had been pronounced. This lack of regard for the patient was unacceptable from a preparedness standpoint, and the team contacted another mortuary for assistance.

The next morning, the team was a little short-handed. One of the standby participants had to leave early for a doctor's appointment. Under normal circumstances, this would not be a problem, as that member was replaced with another transport team member; but in this case, the administrative overhead involved in a last-minute situation caused a problem. Another team member had left the hospital early to find a Kinko's, so that the final contracts could be faxed to Alcor. He took another of the team members with him to navigate, leaving only two at the hospital. Furthermore, a trip that shouldn't have taken very long lasted instead for a couple of hours due to complications in transmitting documents to Alcor central. While those two were away dealing with the paperwork, the remaining team members visited with the patient and her son.

A basic assessment was performed; and her vital signs were slightly improved, the edema was reduced, and clotting signs had receded from her fingertips. Despite the encouraging signs, it was only a couple hours later that a nurse informed our team that the patient was experiencing asystole (cardiac arrest). Unfortunately, the standby team was still at two people, and few of the advance preparations had been completed.

Pronouncement

When the team members arrived in the hospital room, they noticed small fibrillations on the heart monitor, and the nursing staff standing around the patient. While one team member ran down to the ambulance for the portable ice bath, the other spoke with the head nurse, asking that the patient's room be cleared of unnecessary equipment as quickly as possible. Offsite team members were also contacted and told to return immediately to the hospital. Pronouncement occurred shortly thereafter, at 11:22 am, while the team members were gathering their equipment.

Stabilization

Some time during the night, the SAI ambulance had been blocked in by another vehicle. The lift gate could not be lowered for equipment access, and the vehicle had to be moved before the ice bath could be removed. Furthermore, there were so many boxes in the back of the vehicle that some equipment had to be removed and then returned to the vehicle after the ice bath was extracted, and then the vehicle was re-parked before the team could return to the patient's side. This lack of preparedness caused a delay of at least 20 minutes in the start of the stabilization.

By the time they reached the patient, they discovered that none of the extraneous equipment had been removed from the room, the hospital staff was still standing around, and the patient was still connected to the ventilator. Typically, removal of the ventilator is a step that hospital personnel prefer to perform themselves, and they should certainly be encouraged to do so. One of the team members ultimately removed the ventilator tube.

Hospital staff did assist the two team members with transferring the patient from the bed to the portable ice bath, and so surface cooling was initiated while still in the hospital. Water was added to the ice bath so that a circulating device could be used to speed cooling. A mechanical cardiopulmonary support device ("Thumper") was also placed at this time. As they were leaving the patient's room, one of the team members noticed the Thumper's ventilator hose was missing. They stopped and went to look for it. Splitting up the team at this point slowed progress slightly, as one nurse quickly found and placed a ventilator hose, but the second team member was not aware of this and had another nurse working with him to find one.

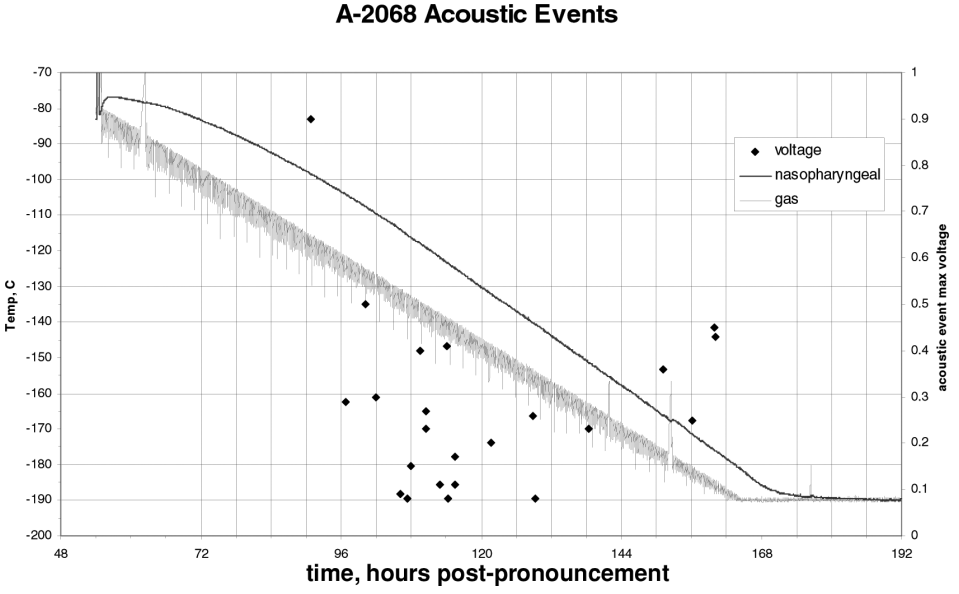
Finally, the team was on its way out the door. They stayed with the original plan, to exit through the main hospital lobby, despite the misgivings of the nursing supervisor. Unfortunately, those misgivings proved a reflection of reality when the ice bath snagged on a carpet in the doorway and caused a scene in the lobby.

As the patient was reaching the ambulance, the other team members returned from their Kinko's quest, and Todd Soard and his people arrived. They assisted with positioning the vehicle for loading, shuffling the transport kit cases out of the way, and raising the ice bath into the back. As the patient was being loaded, the Thumper struck the roof of the vehicle and pulled half off of the sidebar mounts of the PIB and began compressing the chest at an angle. This impact also shifted the patient.

Administration of the medication protocol did not begin until the patient was in the back of the ambulance. The meds had not been prepared in advance, so two of the team members perched in the back and were forced to both draw and administer during transit. Ultimately, all but one medication was given prior to the patient reaching the funeral home after a 45-minute drive.

Shortly before the patient reached the funeral home, another issue arose. The Thumper, which had been damaged during the loading process, had been held in place by one of the team members. This was a poor initial solution, because of the pressure of the compressions and the unsafe manner in which one of the team members had to travel, so cloth was substituted as a tie-down to fair success. Shortly after this was remedied, the Thumper began to run out of oxygen, which powers the compressions and supplies ventilation.

When the Thumper began to slow, the driver pulled to the left side of the road so that the oxygen tank could be switched to a full one. This involved a team member exiting the vehicle and climbing over a highway divider to reach the controls. A successful, if risky, maneuver was completed, which allowed the patient to reach the funeral home with no significant lapse in cardiopulmonary support.

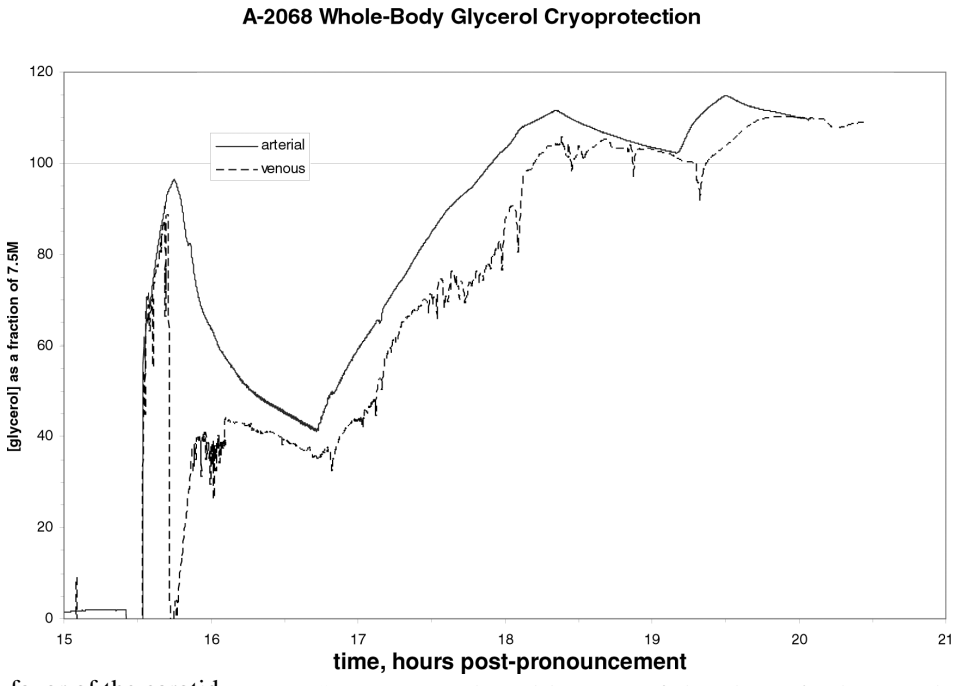


Washout

When the team reached the funeral home, they found the preparation room was not ready. While waiting for the room to be cleared, the patient was removed from the ambulance to the mortuary garage, where she sat for 20 minutes with no cardiopulmonary support until the room was available.

Everyone lent a hand in preparing the tubing pack, and it was discovered that the flow meter was damaged and had to be removed. The circuit was eventually set, but the DuaLogR could not be found, so no temperature data was collected during this stage. Because there was no ice on hand at the mortuary at this point, the washout was carried out at higher temperatures than normal. The heat exchange portion of the perfusion system was also not used. Furthermore, team members were splashed with perfusate during the priming of the circuit, because some connectors near the patient (for temperature data collection) lacked proper caps.

The funeral director began the surgery to raise the femorals for cannulation, and he discovered that the patient suffered from extensive sclerosis. The femoral arteries were then bypassed in favor of the carotid artery. Shortly thereafter, the washout was started. Following the start of the washout, the funeral director managed to clear the femoral vein enough to allow perfusion.



Perfusion continued for an hour; and the patient showed signs of good circulation, losing color and becoming cooler. Even her earlobes showed signs of washout solution distribution. Some volume was lost to the leaking caps, but more volume was ultimately lost in the patient, as she apparently was suffering from internal bleeding.

Airline arrangements were made using a charter aircraft, because conventional airline schedules required an extensive delay to change planes. Once the arrangements were made, the patient was prepared for shipment. Upon loading the patient in the SAI ambulance, the team found the electric shut-off switch had been left in the "on" position; and the vehicle's battery was dead. Twenty minutes and one jump later, the vehicle was ready and the team headed to the airport.

Cryoprotection

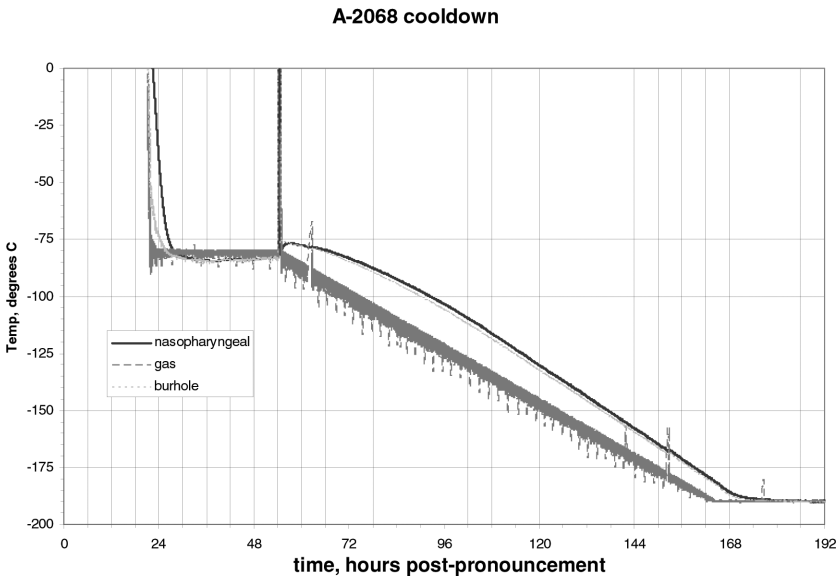
The patient landed at the Scottsdale Airport at 22:10 and was picked up by our local funeral director. One of our volunteers picked up the staff and equipment that accompanied the patient. By 22:25, the patient was being moved to the operating table, packed in ice and prepped for surgery.

As a whole body patient, we used open heart surgery to access the circulatory system, and our glycerol-based cryoprotectant was used. The operating room and surgeons were ready when the patient arrived, and surgery moved quickly. By 22:35, the heart was exposed for cannulation, and the surgeons noticed pulmonary adhesion and a large amount of plaque in the aorta. In an attempt to avoid doing excessive damage to the fragile heart, the decision was made to insert the cannula just above the aorta. The patient's temperature at this time was 11.35°C.

Surgery was slowed because of the plaque in the vessels and because the standard-sized cannula were too large for this patient. Smaller ones were obtained and used. Cryoprotective perfusion began at 23:32, and then the surgeons turned to the preparation of the burr holes. During the craniotomy, the perforator broke. Fortunately, this did not cause any damage to the brain, as we discovered the dura intact after removing the bad bit. The bit was replaced, and the burr holes were completed.

At 23:47, we encountered problems with the perfusion. We were pumping solutions into the patient, but too little of it was returning through the venous system. The venous cannula was backed out of position and replaced with a slightly smaller cannula. Unfortunately, this was not the source of our leak. We also did not see any signs of the patient bloating or otherwise filling with fluid. At 00:07, we switched to cryoprotection because of the loss in washout volume, still without a clear understanding of where the volume was going. It was an additional five minutes before we located the source: an unusual surgical site used during the field washout. No one in the operating room had been informed by the transport team that a carotid incision had been made in the field, and the patient had been covered in ice so the surgical team did not notice. Typically, femoral vessels are used exclusively during stabilization, and the surgical team saw that both of those had been accessed during the field operations. Furthermore, the carotid incision had not been closed properly and was the source of a large volume of fluid leaking to the operating room table. By the time everything was finally secured and the perfusion circuit properly closed, we had lost nearly 14 liters of washout solution and cryoprotectant.

Despite the problems, we began seeing signs of glycerol penetration in the tissues by 00:40. A few moments later, we noticed a new and different leak underneath the aorta. We continued perfusion, using a cardiotomy suction unit to recover the fluid. Over time, the lungs began to swell, as they also



accumulated excess fluid; but observation of the brain indicated retraction, so the edema was limited in scope.

At 04:58, cryoprotection was halted, with the target cryoprotection having been achieved. The chest was successfully closed, though with some difficulty due to the swelling of the lungs. All sensors and plumbing were secured, and the patient was transferred to the cool down area for the next phase.

Cooling

Temperature probes were placed in the nasopharyngeal cavity and in both burr holes; we also monitored gas and ambient temperatures directly. Because this was a whole body glycerol perfusion, first-stage cool down was a plunge to -80°C and was started at 05:47. We deployed a whole body vapor cooling system built by Hugh Hixon some time ago. It worked, but it used a lot of liquid nitrogen. Despite the nitrogen consumption, this was a much cleaner and less hazardous method for cooling patients than the previous silicone oil system, which possessed significant slip risk for the staff involved.

Second stage cooling was carried out at the rate of 1°C/hour from -80° to -200°C, beginning at 15:26 on May 15th. The vapor cooling system performed as intended, but the overall cool down was marred by the lack of a working dewar scale, which tells us when it is time to swap out the cylinders. As a result, the cylinder ran dry twice during second-stage cooling. In the first incident, the gas temperature raised 20°C, but the patient's temperature (at -77.9°C) was unaffected. The same held true in the second incident, where the ambient temperature raised 21°C, but the patient (at -167.8°C) was similarly unaffected.

During the cooling process for this patient, we also placed several bottles of effluent perfusate in the bottom of the chamber. It was a crude attempt to see if the cryoprotectant would vitrify or freeze. The effluent did vitrify and not freeze.

Twenty-three fracture events were recorded, with the first occurring at -98.5°C and the last at -176°C.

Conclusion

Some things went well in this last-minute case, like the support of the family and the alacrity with which the legal documents were signed and the funding secured. The transport personnel submitted the most detailed transport report we have seen, and the introduction of the vapor cooling system for whole body patients went well. This case still suffered from many logistical problems, starting with Florida being under-stocked with transport supplies, the attempts to merge three separate groups into an effective transport team on the spur of the moment, a lack of experienced field personnel, poor communication on the part of transport personnel, and the lack of a functional scale during the cooling. (The scale has since been repaired and as our vigorous training program continues, we anticipate a number of the other issues will also improve.)

Despite all the problems, the patient achieved target cryoprotection and experienced a normal amount of acoustic events during the course of the cool down. We appreciate the willingness of Suspended Animation, Inc. to assist us with this last-minute case and their generous commitment of time, personnel and equipment.

A-2068: PATIENT PROFILE

- 82-year old female
- Died of old age
- Residing in Florida
- Last minute case with sympathetic next of kin

A-2068 Acoustic Events		
time, hours	Temp, C	max V
90.811	-98.5	0.9
96.733	-106.1	0.29
100.17	-107.6	0.5
101.956	-109.6	0.3
106.112	-114	0.09
107.429	-115.5	0.08
107.998	-116.3	0.15
109.521	-117.8	0.4
110.488	-118.9	0.27
110.488	-118.9	0.23
112.846	-121.7	0.11
114.171	-123.4	0.41
114.25	-123.7	0.08
115.576	-124.9	0.17
115.576	-124.9	0.11
121.782	-132.1	0.2
128.918	-140.3	0.26
129.302	-140.7	0.08
138.354	-151.3	0.23
151.269	-166.3	0.36
156.227	-171.7	0.25
159.928	-175.9	0.45
160.076	-176	0.43
# events = 23	-98.5 to -176	sum = 6.35