Alcor A-1001
Case Report

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Alcor A-1001 Case Report Contents:

1. Summary

Information was derived from multiple sources and was all converted to Mountain Standard Time (MST). For de-identification, dates are not shown. T-0 represents the date of pronouncement of legal death, T-X represents occurrences before T-0, and T+X represents occurrences following T-0. Although it has been Alcor policy since 2020 to not identify patients in technical case reports going forward, this report contains some identifying information because the identity of this 1976 non-confidential patient has been previously published as part of Alcor history.

A-1001 was a 79-year-old male with neuro cryopreservation arrangements. The patient was the father of one of the founders of Alcor and became Alcor's first cryopreservation patient as well as a major donor to the building of Alcor in the early days.

The patient had been in a convalescent hospital for several years following a cerebral hemorrhage and had a history of general cardiopulmonary and renal decline. Following a severe case of pneumonia, he was pronounced legally deceased in California at 23:05 hrs on T-0 days in July of 1976.

The patient was stabilized at the convalescent hospital and then taken to the Alcor facility for cryoprotection. Cooldown with alcohol and dry ice was initiated at 14:48 hrs on T+1 days. The cephalon was placed in liquid nitrogen at 11:00 hrs on T+4 days. The patient was driven to Trans Time, Inc. in northern California for temporary maintenance at liquid nitrogen temperature as Alcor did not yet have storage capability. The patient was returned to Alcor and transferred to long-term maintenance at liquid nitrogen temperature.

2. Patient Assessment and Standby

This report was written in 2020 but the case took place in 1976; some details are no longer available.

T-0 days

The member had been living in a convalescent hospital for several years following a cerebral hemorrhage. Due to a severe case of pneumonia, he had been watched around the clock for several days by his family and the Alcor team, as well as being monitored electronically (see the Discussion section). But the member seemed to have recovered and was sitting up in bed after having had his dinner. The family and all but one team member decided to take this opportunity to go to dinner. At 23:15 hrs during dinner, their pagers sounded the alert that the member had gone into cardiac arrest and had been pronounced at 23:05 hrs.

3. Stabilization and Transport

T+1 days

One team member had remained at the hospital. When the patient went into cardiac arrest, the team member assisted the hospital staff with applying chest compressions and placing ice on and around the member. About half of the nine team members had arrived at the hospital by 00:05 hrs and took over the chest compressions. The other team members drove to the Alcor facility to retrieve the Alcor ambulance and equipment which arrived at the hospital at 00:45 hrs. An unidentified mechanical chest compression device (MCCD), as well as an airway connected to the oxygen ventilator of the MCCD, were placed and the patient was moved to the ambulance to be transported to the Alcor facility where additional team members had assembled to prepare the perfusion machine, heat exchanger, temperature monitoring equipment, and mix the cryoprotectant solution.

The patient arrived at the Alcor facility at 01:10 hrs and was placed on the operating room (OR) table. It was noted that the patient's head and shoulders were cool to the touch from the ice. Sheets had been wrapped around the patient to hold the ice in place during transport, with special attention to applying ice against the throat, covering the carotid arteries on both sides of the patient's neck.

4. Cryoprotectant Perfusion Surgery

After the patient was placed on the OR table at 01:30 hrs, a sodium bicarbonate drip of 31 drips/min was set up using the I.V. that had been left in place by the hospital staff. The MCCD continued to function, however, because the patient was very thin, and despite several attempts to adjust the face mask, air continued to leak from the seal of the mask. A thermocouple was placed in the rectum. The initial temperature reading was 35°C.

The MCCD was turned off for several seconds while thermocouples were inserted in the patient's nares. One thermocouple was inserted approximately 14 in. deep and the other approximately 7 in. deep. Later it was discovered that the deeper thermocouple had been coiled into the mouth. The temperatures were 35°C rectal, 21°C in the deep nare and 26°C in the shallow nare.

Additional ice was placed on the patient at 01:42 hrs using large plastic waste bags. Ice was placed in the heat exchanger bucket and batch #1 of the cryoprotectant solution (20 liters (L) of 15% DMSO) in a Collins carrier solution (see Discussion section) had been cooled to 8°C and was ready for use. The surgeon still had not responded to his pager.

The oxygen bottle used for ventilation and to supply power to the MCCD was down to 1250 lbs of oxygen remaining. It had 2000 lbs when the stabilization was initiated approximately l.5 hours

earlier. The nasopharyngeal temperature in the deep nostril had risen 1°C. The ice bags were adjusted, and the temperature began to slowly decrease again. This could have been either from the weight of the ice cutting off circulation or perhaps the contact of the ice to the patient's skin was poor. There were no signs of edema on the patient's face.

The surgeon arrived at 03:13 hrs and was briefed on the use of the perfusion machine and tubing circuit before he initiated the surgical procedure. Batch #1 of the cryoprotectant solution was filtered through a 35-micron filter at about 4-5 L/min. The oxygen bottle was down to 600 lbs. and .03 L of sodium bicarbonate was injected into the patient.
Although the original goal for the initiation of cryoprotectant perfusion was for the patient's temperature to be at 10°C, it was decided that due to the amount of time since cardiac arrest, there would be no further delay. The surgeon estimated that even though he was not experienced with the cannulation procedure, it would not take more than 30 minutes to 1 hour for the surgery. The plan was to cannulate the carotid arteries bilaterally for infusion and to cannulate the jugular veins to allow effluent to flow back into the circuit.

The MCCD was discontinued for a few minutes while the oxygen bottle was replaced. Chest compressions were then resumed. An additional 90 lbs of ice were purchased and brought into the OR. A new unit of sodium bicarbonate was readied for the I.V. and at 04:45 hrs 5000 I.U. of sodium heparin was added. It was observed that the patient's skin was still pink, indicating oxygenation. There was moderate rigor mortis indicated by tightening of the muscles and there was some blood pooling in the external parts of the ears.

The MCCD was discontinued at 06:20 hrs. The nasopharyngeal temperature was 14.7°C. The initial incision in the patient's neck was made at 06:30 hrs. The patient was draped and an incision was made about 1.5 cm below the mandibular angle. 3 L of DMSO was added to the carrier solution in the reservoir. The temperature of the heat exchanger had risen to 12°C. Ice and alcohol were added to the heat exchanger and the temperature dropped to 7°C.

It was noted that compared to typical embalmer's procedures, the vessels in the surgical field were exposed very cleanly and with great care. (There was no detailed description in the field notes of the surgical cannulation method used, but standard procedures would have been to cannulate carotid arteries for arterial perfusion, and cannulate jugular veins for venous drainage and effluent sample collection.). It was also noted that these tissues were very oxygenated indicating that the chest compressions and oxygenation had been effective.

The vessels were much deeper in the patient's neck than the surgeon anticipated, which resulted in the isolation and cannulation of the carotid arteries taking substantially longer than anticipated. A pH meter had been set up to monitor the acidity of effluent samples, but the batteries were dead and the samples had to be refrigerated and tested later. The first sample was taken at 10:22 hrs (see the table of values in the Discussion section).

5. Cryoprotectant Perfusion

At 10:27 hrs, following 4 hours and 7 minutes with no chest compressions, the carotid cannulae were finally opened to allow arterial flow at an arterial pressure of 30 mmHg. Arterial pressure was increased to 60 mmHg and then to 100 mmHg with a flow rate of 1.1 L/hr. The cryoprotectant perfusion was performed as an infusion of DMSO at stepped-concentrations of cryoprotectant (see below).

The temperature of the cryoprotectant solution was 10°C. A bilateral perfusion flow rate test was performed by first clamping the right carotid and then the left carotid. No measurable difference was noted. It was noted that at approximately 5 minutes after the initiation of cryoprotectant perfusion, the patient's throat area and face had turned a yellow color as a result of exposure to the cryoprotectant. The arterial pressure was reduced to 80 mmHg from 120 mmHg. The temperature of the perfusate was 4.4°C and the temperature in the bubble trap was 7°C. The arterial pressure was 92 mmHg.

Perfusion was paused at approximately 11:08 hrs when batch #1 of the cryoprotectant solution was expended. Batch #2 (15% DMSO, 5.67 L of base perfusate mixed with 3 L of DMSO) was prepared and filtered through paper towels when it was found that the inline filter was full of particulates and could no longer be used. Additional filters were not available to the team at that time. Cryoprotectant perfusion was again started at 12:46 hrs with arterial pressure at 60 mmHg.

The temperature of the perfusate was 18°C. Perfusion flow was good but was raising the patient's temperature. The temperature of the arterial perfusate had risen to 15.6°C. It appeared that DMSO was being absorbed by the tissues, but they were not able to lower the patient's temperature. It was speculated that they were fighting room temperature.

Approximately half the DMSO on hand had been expended at this point, the concentration of DMSO in the effluent was not recorded. The arterial pressure was 100 mmHg, the nasopharyngeal temperature was 8.3°C and the arterial perfusate temperature was 10.5°C. Facial edema was noted at 13:32 hrs. The effluent flow was slowing. Cryoprotectant perfusion was terminated at 13:36 hrs (the reason for termination was not discussed in the notes).

The below pH readings were taken on the effluent samples taken during the cryoprotectant perfusion.

Sample #	pH reading	Sample #	pH reading
1	6.6	8	7.42
2	6.5	9	7.42
3	7.0	10	7.35
4	7.1	11	7.4
5	7.25		
6	7.3		
7	7.32		

Eleven effluent samples were taken during the perfusion and were analyzed on T+18 days by Alcor's surgeon (see Discussion section).

6. Cephalic Isolation

Under the supervision of the surgeon, Alcor's Vice President and another team member worked, one on each side of the patient, to start the cephalic isolation at 13:40 hrs. The isolation was made at the 6th vertebra and went quickly. A glass Ringer's solution bottle was placed under the patient's neck to make transecting away the tissue easier. The cephalon was isolated at 13:53 hrs. The cannulae were left in place and the tubing was folded around the patient's face.

The cephalon was placed in a plastic bag and the temperature thermocouples were brought out of the bag through the opening. Three plastic ties were joined end to end and secured tightly around the stump of the cephalon to prevent loss of perfusate. Plastic ties were placed around the bag opening to hold the probes in place. The trunk was placed back into the body bag and the metal ID bracelet was removed.

7. Cooling to Liquid Nitrogen Temperature

T+1 days

One block of dry ice was placed into an LR-40 half-full with alcohol at 15:18 hrs. A thermocouple showed that the temperature of the alcohol was reduced to -5°C in two minutes. The nasopharyngeal temperatures were 10°C and 8°C.

T+4 days

The cephalon was taken out of the alcohol bath and prepared for immersion in liquid nitrogen. The thermocouples were wrapped around the cephalon, still inside the plastic bag. The cephalon was covered with aluminum foil and then wire was wrapped around the package to mold it into a single bundle with the thermocouples still exposed. An 18 in. section of a light-weight chain was then attached to the baling wire to lower the cephalon into the empty LN-40 dewar.

Liquid nitrogen was then added to the dewar by allowing it to directly flow against the aluminum foil. At first, the liquid evaporated quickly but eventually began to fill the rest of the dewar. When the cephalon was completely submerged, there was an on-going temperature gradient inside the dewar (this was noted but the temperatures were not recorded).

8. Timeline and Time Summaries

Timeline

T-0 days

23:05 Pronouncement of legal death
23:10 (est) Start of external ice cooling
23:12 (est) Start of manual chest compressions

T+1 days

00:45 Arrival of Alcor ambulance at the hospital
00:50 (est) Start of mechanical CPS and placement of airway
01:10 Arrival of the patient in the OR at Alcor (NPT 35°C)
01:30 Administration of first medication (sodium bicarb I.V. drip)
04:45 Administration of final medication (5000 IU heparin) as part of the sodium bicarbonate I.V. drip
06:20 Termination of cardiopulmonary support (NPT 14.7°C)
06:30 Start of surgery for cannulation
10:15 (est) Completion of cannulation
10:27 (est) Start of cryoprotectant perfusion
11:08 Perfusion paused at end of perfusate batch #1 due to perfusate filtration issue
12:46 Perfusion restarted with batch #2 of perfusate
13:36 Termination of cryoprotection (venous concentration of the perfusate not recorded)
13:40 (est) Start of surgery for cephalic isolation
13:53 (est) Completion of cephalic isolation (cephalon not weighed)
14:48 Start of patient cryogenic cool down with alcohol and dry ice

July, T+4 days

11:00 Start of patient cryogenic cooldown with liquid nitrogen (LN_2)

xxxx (time not recorded) End of cooldown at LN_2 temperature

xxxx (date not recorded) Transfer of patient to temporary maintenance in LN_2 at Trans Time

xxxx (date not recorded)Transfer of the patient back to Alcor for long term maintenance at LN_2 temperature

Time Summaries

Pronouncement and Stabilization

hrs: mins

02:05 From pronouncement of legal death to patient arrival at Alcor: 23:05 hrs on T-0 days to 01:10 hrs on T+1 days

00:07 From pronouncement of legal death to start of cardiopulmonary support: 23:05 hrs to 23:12 hrs

02:25 From pronouncement of legal death to start of medication administration: 23:05 hrs on T-0 days to 01:30 hrs on T+1 days

03:15 From the start to the end of the medication administration: 01:30 hrs to 04:45 hrs

05:40 From pronouncement of legal death to the administration of heparin: 23:05 hrs on T-0 days to 04:45 hrs on T+1 days

Cryoprotectant Surgery

hrs: mins

07:25 From pronouncement of legal death to start of cannulation surgery: 23:05 hrs on T-0 days to 06:30 hrs on T+1 days

03:45 From the start to the end of the cannulation surgery: 06:30 hrs to 10:15 hrs

05:20 From arrival at Alcor to the start of cannulation surgery: 01:10 hrs to 06:30 hrs

03:57 From the start of cannulation surgery to the start of the cryoprotection: 06:30 hrs to 10:27 hrs

07:06 From the start of cannulation surgery to the end of the cryoprotection: 06:30 hrs to 13:36 hrs

Cryoprotectant Perfusion and Cooldown

hrs: mins

11:22 From pronouncement of legal death to start of cryoprotection: 23:05 hrs on T-0 days to 10:27 hrs on T+1 days

09:17 From arrival at Alcor to the start of cryoprotection: 01:10 hrs to 10:27 hrs

03:09 From the start to the end of the cryoprotection: 10:27 hrs to 13:36 hrs

01:12 From the end of cryoprotection to the start of cooldown: 13:36 hrs to 14:48 hrs

15:43 From pronouncement of legal death to start of cooldown: 23:05 hrs on T-0 days to 14:48 hrs on T+1 days

13:38 From arrival at Alcor to the start of cooldown: 01:10 hrs to 14:48 hrs

9. Table of Medications Administered

TIME	MEDICATION	DOSE	PURPOSE
01:30 hrs	Sodium bicarbonate	Continuous drip Note 1	Buffer to restore the pH of the patient.
04:45 hrs	Heparin	5000 IU Note 2	Anticoagulant; prevents blood clot formation.

Notes:

1. A unit (the packaging amount was not in the case notes) of sodium bicarbonate was started at a rate of 31 drips/min at 01:30 hrs. This was done to restore the pH of the patient. Effluent samples were taken throughout the cryoprotectant perfusion to monitor this. An injection of 30 mL was administered at 03:13 hrs. New units were placed for I.V. administration at 03:25 hrs and 04:55 hrs.

2. Heparin was added to the I.V. drip at 04:45 hrs, five hours and 40 minutes after the pronouncement of legal death. The reason for not administering it earlier was not stated in the case notes.

10. Discussion

This was the first cryopreservation of a patient at Alcor. This was also the first non-mortuary procedure that marked the initiation of cryonics becoming an extension of emergency medicine. The member's family, who were the president and vice president of Alcor, and several team members from Alcor, provided a standby by alternating shifts. The member's heart was monitored and that information was electronically routed to an audio output above the nursing station some distance from the patient's room. This permitted the nursing staff to be aware of changes in cardiac activity as if he were being monitored in an ICU so that if there were any changes when no one was in his room, the nurses would be alerted. The staff at the convalescent hospital gave Alcor their full cooperation.

The member was not expected to survive this bout of pneumonia and was being watched by family members and other Alcor team members around the clock. But the member seemed to have recovered and was sitting up in bed after having had dinner. The family members, who had not left the hospital for approximately 36 hours, decided to take this opportunity to refresh and go to dinner.

During dinner, their pagers sounded the alert that the member had gone into cardiac arrest. This was the first Alcor case and the first instance of seeing the member rally at the end of life. Alcor's surgeon pointed out that a rally at the end of life is common. The failing body rallies all

its remaining strength in one last effort to survive, and then dies suddenly. Those on standby should be aware of this phenomenon and not leave the member alone at this critical time.

This was the first time the specially made perfusion machine had been used with a patient. Many problems had to be solved with different parts of the circuit, the heat exchanger, the filters, etc. (there are no further details). The perfusion circuit had been flushed with tap water first and then with distilled water before introducing the cryoprotectant solution. The OR team members were all wearing headsets to allow them to comment on the procedure as a way to record the events with a small number of team members.

The MCCD was turned off for several seconds while temperature thermocouples were inserted in the patient's nares. One thermocouple was inserted approximately 14 in. deep and the other approximately 7 in. deep. Later it was discovered that the deeper thermocouple had been coiled into the mouth, giving compromised temperature readings. There were no signs of edema on the patient's face. At 04:45 hrs 5000 I.U. of sodium heparin was added, five hours and 40 minutes after the pronouncement of legal death. The reason for not administering heparin earlier was not stated in the case notes.

At approximately l.5 hours into the procedure the nasopharyngeal temperature in the deep nostril had risen 1°C. The ice bags were adjusted, and the temperature began to slowly decrease again. This could have been either from the weight of the ice cutting off circulation or perhaps the contact of the ice to the patient's skin was poor. There were no signs of edema on the patient's face.

The surgeon still had not responded to pages. It was later learned that this was caused by him being at a meeting where a message could not be delivered to him. The decision was made to ask the participating mortician to raise and cannulate the carotid arteries but he was out of town. It was finally decided to have a team member who was a paramedic do the surgery if the surgeon could not be contacted in time. The surgeon arrived at 03:13 hrs and was briefed on the use of the perfusion machine and tubing circuit before he initiated the surgical procedure.

The right jugular vein was clamped to enhance venous return on the left side. The right side was not draining because of poor access (no further details were available in the notes). This did not seem to be effective. It was speculated that collateral circulation might have been due to flow through the vertebral arteries. There was concern that the circulation to the brain was minimal because the nasopharyngeal temperatures were not dropping as quickly as hoped. It is important to cool the whole body, thoroughly, because the warmer blood in the lower extremities can cause rewarming of the brain.

Toward the end of the surgery, most of the surgical team were no longer wearing their microphones resulting in the loss of information. It is important for team members to keep their headsets in place and to vocalize into them so that good notes can be made from the audiotapes.

During the cephalic isolation Alcor's Vice President and another team member worked, one on each side of the patient. Having two team members performing surgery in the same area proved to be dangerous, but no one was injured.

The carrier solution used in the cryoprotectant perfusate was not named in the field notes, but it is probable that it was Collins C-4 Solution, a balanced salt solution. The formula for Collins C-4 was discussed in the publication *Manrise Technical Review*, volume 1, number 1 in 1971.

The pH meter used for the readings on the effluent samples taken during the cryoprotectant perfusion was uncalibrated in three respects: 1) samples were taken at different temperatures from the standards; 2) the standards were old, they had not been recently prepared, and 3) measurements made so soon after the pH meter was turned on seemed to be on an electronic drift. All samples and standards were placed in a refrigerator to be used the following day after a suitable warm-up and calibration. The case notes do not have details of those second pH readings.

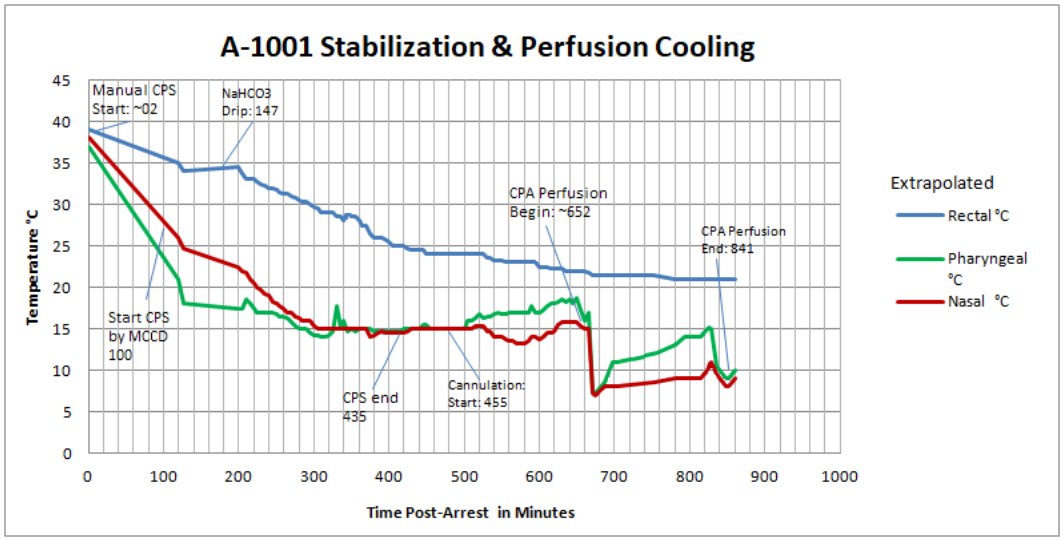
Eleven effluent samples were taken during the perfusion procedure to be analyzed for hemolysis. This analysis of two effluent samples was done by Alcor's surgeon on T+18 days. The below transcription was a best-effort approximation of handwritten notes. Hemolysis of the first and second samples was moderate but clear in the rest of the samples, with the exception that sample number 5 had slight hemolysis.

Effluent sample 1: Moderate hemolysis was determined by observation of the color of the sample. At 100x power, coagulation was apparent. At 400x power proteinaceous material, probably hemoglobin was observed.

Effluent sample 2: Hemolysis of red blood cells was observed on the bottom of the glass slide. The color was bright pink/red. The upper fluid was clear and slightly yellow; this could have been due to the perfusate or to fat. At 100x power, no clumping of the cells was observed, as with Sample #1. There was no matrix of proteinaceous material. The refraction of some cells made them look irregular rather than disk-like.

Based on the recommendation of the scientific advisor, the temperature descent would be 1°C/min with a pause at -30°C for several hours to allow the tissues to equilibrate and then to place the cephalon into liquid nitrogen (LN_2) (-196°C) even though all the tissues may not have already been at dry ice temperature (-79°C). Total crystallization would not take place until liquid nitrogen temperature was reached. The actual steps taken were not described in the case notes.

11. Graph


A-1001 Stabilization & Perfusion Cooling
Manual CPS Start: ~02
NaHCO3 Drip: 147
CPA Perfusion Begin: ~652
CPA Perfusion End: 841
Start CPS by MCCD 100
CPS end 435
Cannulation: Start: 455
Temperature °C
Time Post-Arrest in Minutes
Extrapolated
Rectal °C
Pharyngeal °C
Nasal °C