Alcor A-1700
Case Report

LIFE EXTENSION FOUNDATION
The World's Leader in Cryonics

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Alcor A-1700 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.

Member A-1700 was an 88-year-old male with neuropreservation arrangements. Per the death certificate, the patient had been pronounced legally deceased in January at 19:58 hrs on T-0 days at a Massachusetts hospital after suffering a cerebral hemorrhage at home. He had a history of chronic kidney disease, hypertension, chronic obstructive pulmonary disease, status post abdominal aortic aneurysm and sepsis. The cause of death on the death certificate was intraparenchymal hemorrhage of the brain due to thrombocytopenia.

This case was a cryopreservation without cryoprotection (straight freeze). After delays in locating the patient, cooling to dry ice temperature began on T+3 day at 15:00 hrs (estimate). The patient arrived at Alcor at dry ice temperature (-79˚C) at 08:18 hrs on T+6 days. Cryogenic cooldown from dry ice temperature to liquid nitrogen (LN_2) temperature (-196°C) was initiated at 13:18 hrs the same day. The patient was transferred to long-term maintenance in liquid nitrogen at 15:25 hrs on T+29 days.

2. Patient Recovery and Transport

This report was written in 2020 but the case took place in 2016; some details are no longer available.

T+1 days

The patient reportedly experienced cardiac arrest in a hospital 36 hours after suffering a cerebral hemorrhage in his home. Since the patient's family was not well versed with his arrangements, Alcor was not contacted. Alcor learned of this member's death at 17:01 hrs on T+1 days from an Alcor member who knew the member personally, and who had seen an obituary in a newspaper.

The patient had specified in his membership paperwork that Alcor should cryopreserve "any part of the brain possible". Alcor's Medical Response Director (MRD) was deployed to recover the patient by using the binding authority of the patient's legal documents for cryopreservation and to do so before possible autopsy or cremation might occur. Legal counsel assisted Alcor by sensitively communicating the patient's wishes to the family in their time of grief and arranging for the family to have a final viewing before dry ice cooling was begun.

T+2 days

The Alcor paperwork, including the patient's Last Will and Testament, stating Alcor's right to take possession of the patient under the Uniform Anatomical Gift Act (UAGA), was faxed to the hospital and Alcor's legal representative called and spoke with the hospital as well.

The contracted funeral director took possession of the patient at the hospital at 20:08 hrs. The patient was kept in their mortuary cooler (the cooler temperature was not recorded) until dry ice could be obtained the following day.

T+3 days

The funeral director placed dry ice on the patient at approximately 15:00 hrs. Alcor's MRD had flown to Massachusetts with Alcor's neuro shipper. The cephalic isolation had been delayed to give the family time for a private viewing and thereby gain their cooperation. Cephalic isolation was estimated to have been initiated by the MRD (the time was not recorded) at approximately 19:45 hrs, with a hand-held saw from the field kit and completed at approximately 19:50 hrs (the cephalon was not weighed). The cephalon was again covered with dry ice. The thermocouple temperature record was started at 19:55 hrs.

T+4 days

The general rule of thumb was that dry ice temperature of the cephalon would be achieved at 24 hours after the cephalon was covered with dry ice and therefore the cephalon would be held for 24 hours to see if additional dry ice needed to be added to the shipper before shipping the cephalon. As there was no need for additional dry ice, the cephalon was then shipped via FedEx "White Glove" service to Alcor.

T+5 days

The courier service was to check the dry ice volume when the shipper arrived at a mid-way change of planes. While doing so at 09:08 hrs the next flight was missed, and the patient had to wait an additional day before being sent on to Alcor.

3. Cooling to Liquid Nitrogen Temperature

T+6 days

The patient arrived at Alcor at 08:18 hrs. As the base of the cephalon was slightly exposed, the dry ice level was checked. The patient was at dry ice temperature. The appropriate computer program was used at 13:18 hrs to initiate cryogenic cooldown from dry ice temperature (-79°C) to LN_2 (-196°C).

T+8 days

A stuck valve on the cooldown system resulted in runaway nitrogen fill from approximately -112˚C at about 00:00 hrs and the cryogenic cooldown was terminated at 03:50 hrs (see the discussion section).

T+27 days

CT scans of the patient's brain were made at liquid nitrogen temperature (-196°C) at 11:00 hrs.

T+29 days

The patient was transferred to long-term maintenance at liquid nitrogen temperature at 15:25 hrs.

4. Timeline and Time Summaries

Timeline

January, T-0 days

19:58 Time of legal death per the death certificate

T+1 days

17:01 Notification of legal death

T+2 days

20:08 Remote funeral director contracted and sent the neuro shipper

T+3 days

15:00 (est) Initiation of dry ice cooling (time not recorded)
19:45 (est) Initiation of cephalic isolation

T+4 days

15:00 (est) Dry ice temperature achieved (estimated at 24 hours after initiation) and patient shipped from a remote location (time and carrier not recorded)

T+5 days

09:08 Dry ice shipper delayed in Indiana

T+6 days

08:18 Arrival of the patient at Alcor

13:18 Initiation of cryogenic cooldown from -79°C to LN_2 (-196°C)

T+8 days

03:50 Cooldown system failure; Termination of cooldown to LN_2

T+27 days

11:00 (est) CT scans of cephalon at LN_2 temperature

T+29

15:25 Transfer of patient to long-term maintenance at LN_2 temperature

Time Summaries

hrs: mins

132:20 From pronouncement of legal death to patient arrival at Alcor: 19:58 hrs on T-0 days to 08:18 hrs on T+6 days

56:17 From pronouncement of legal death to start of cephalic isolation: 19:58 hrs on T-0 days to 19:45 hrs on T+3 days

00:05 From the start to the end of the cephalic isolation: 19:45 hrs to 19:50 hrs

67:02 From pronouncement of legal death to start of cooldown: 19:58 hrs on T-0 days to 15:00 hrs on T+3 days

5. Discussion

The location and acquisition of this patient were problematic due to the lack of cooperation by the patient's family, and because they could not be contacted on short notice. The patient had only limited discussions with his family about his Alcor arrangements. The MRD had to call hospitals individually to locate the patient. An Alcor attorney was instrumental in getting the patient's family to cooperate in their time of grief by arranging for the family to have a final viewing before cephalic isolation and dry ice cooling were initiated.

During the transport of the cephalon to Alcor, the courier service was to check the dry ice volume when the shipper arrived at a mid-way change of planes. While doing so at 09:08 hrs the next flight was missed, and the patient had to wait an additional day before being sent on to Alcor. The graph titled "A-1700 ship on dry ice" shows the vapor temperature in the shipper rising during the dry ice level check, however, the patient's temperature under the dry ice would not have been significantly affected.

The stuck solenoid valve that caused the runaway fill event during cooldown led to the replacement of the single solenoid valve with a redundant quadruple solenoid design (invented by an engineer at a cryobiology laboratory in California) that protects against any single valve failures in either a "stuck open" or a "stuck closed" position.

The current cooldown system solenoid valve design features two LN2 solenoid valves arranged in-line. The secondary solenoid valve is held open during normal operation and will de-energize (close) in the event of a downward temperature excursion. A building-wide alarm is triggered. The current protocol is for staff to remain on-site 24/7 during cooldowns. A remote cooldown warning notification system is being worked on as well.

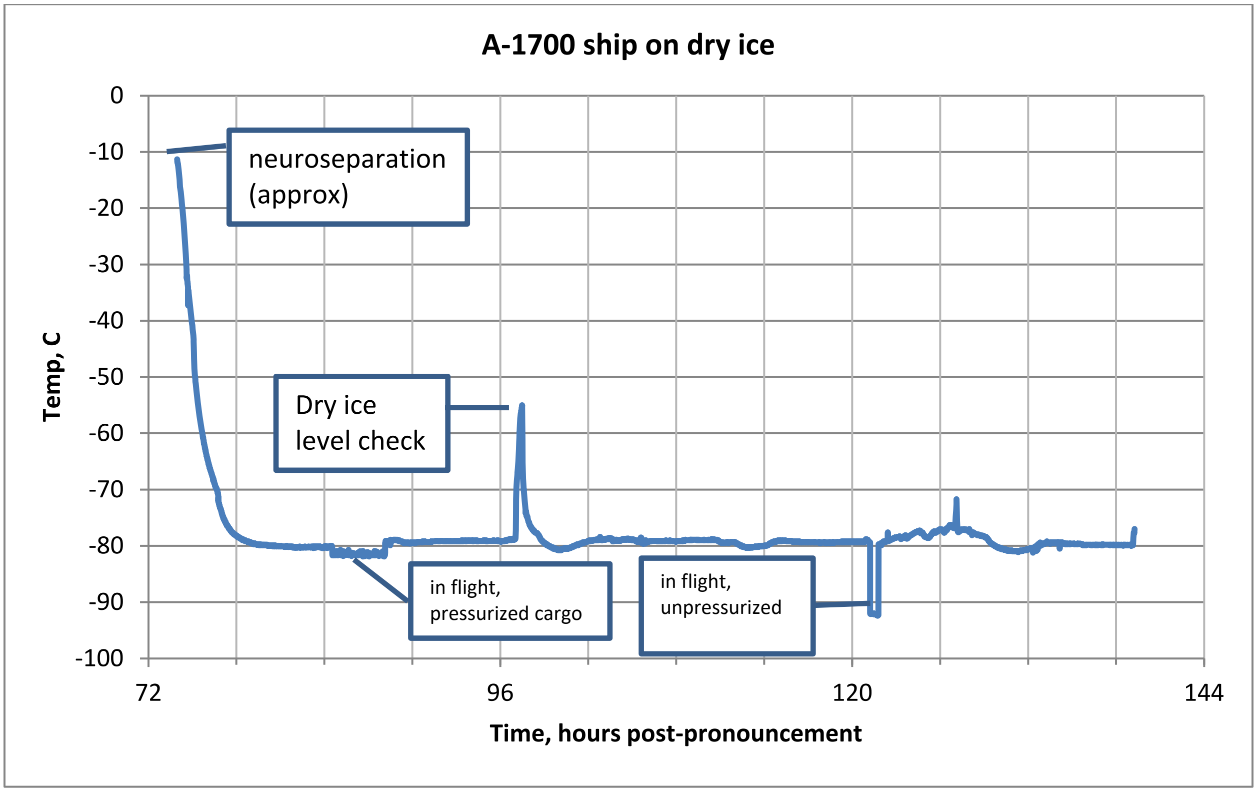
In a (low temperature) alarm condition the secondary valve would remain closed until the temperature rose back to the temperature set at the lower limit of the TWarn window. The TWarn window is the temperature range above and below the set temperature upon which the alarm is triggered. The cooldown system will effectively continue to function with a failed primary valve, with the temperature bouncing along the lower boundary of the TWarn window because the TWarn window is only a few degrees off the set temperature. As soon as the system cools below the TWarn window, the alarm will trigger, and the secondary valve will close again. In any event, if a valve fails during cooldown, the entire valve assembly would be replaced with a spare. It only takes a few minutes to swap out.

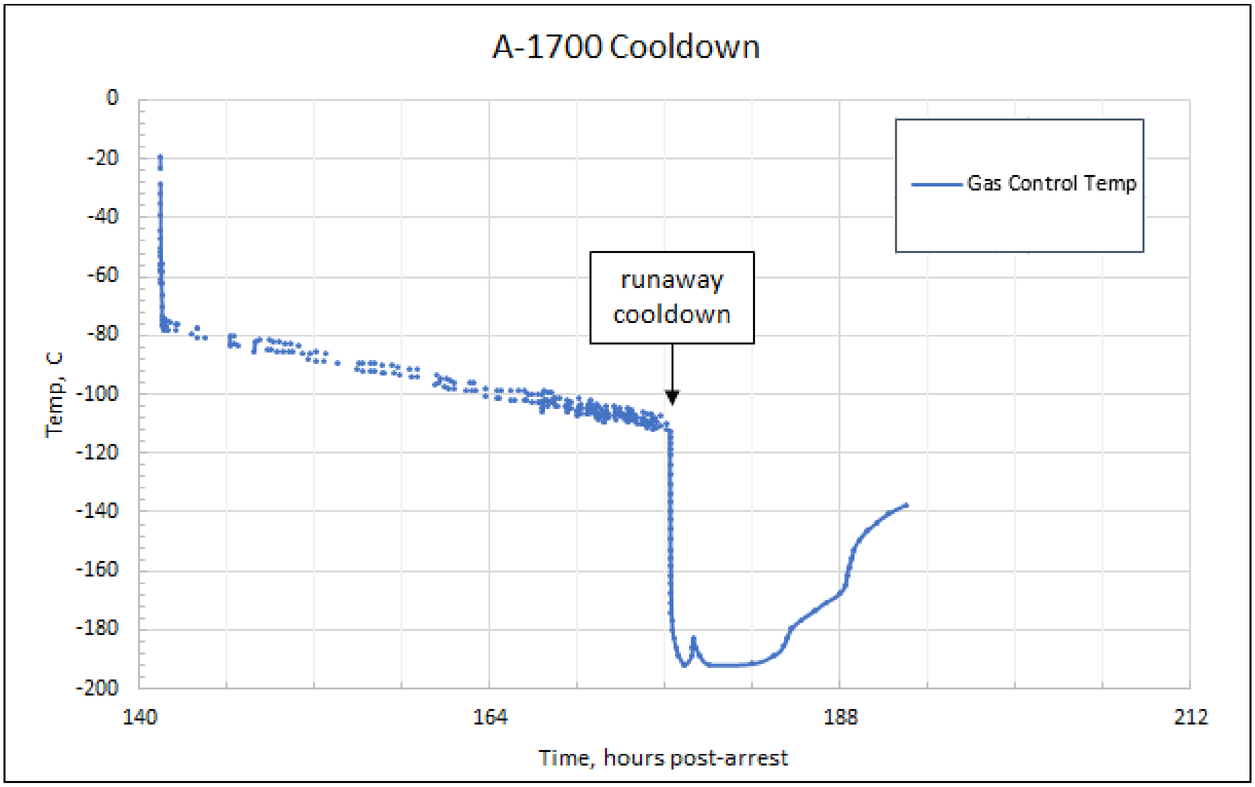
Solenoid valves that are pulled from service are inspected for wear patterns. Typically, a worn steel plunger experiences 'stiction' which causes the plunger to remain in the open position after being energized. To ensure that no LN2 valve exceeds its service life, an incrementing counter was recently started to track solenoid valve actuation events. There have been no valve failures since implementing the counter but note that a valve will actuate approximately 1,000,000 cycles after just 5-7 cooldown procedures. A solenoid valve is not likely to become stuck in the closed position and only rarely do they stick in the open position.

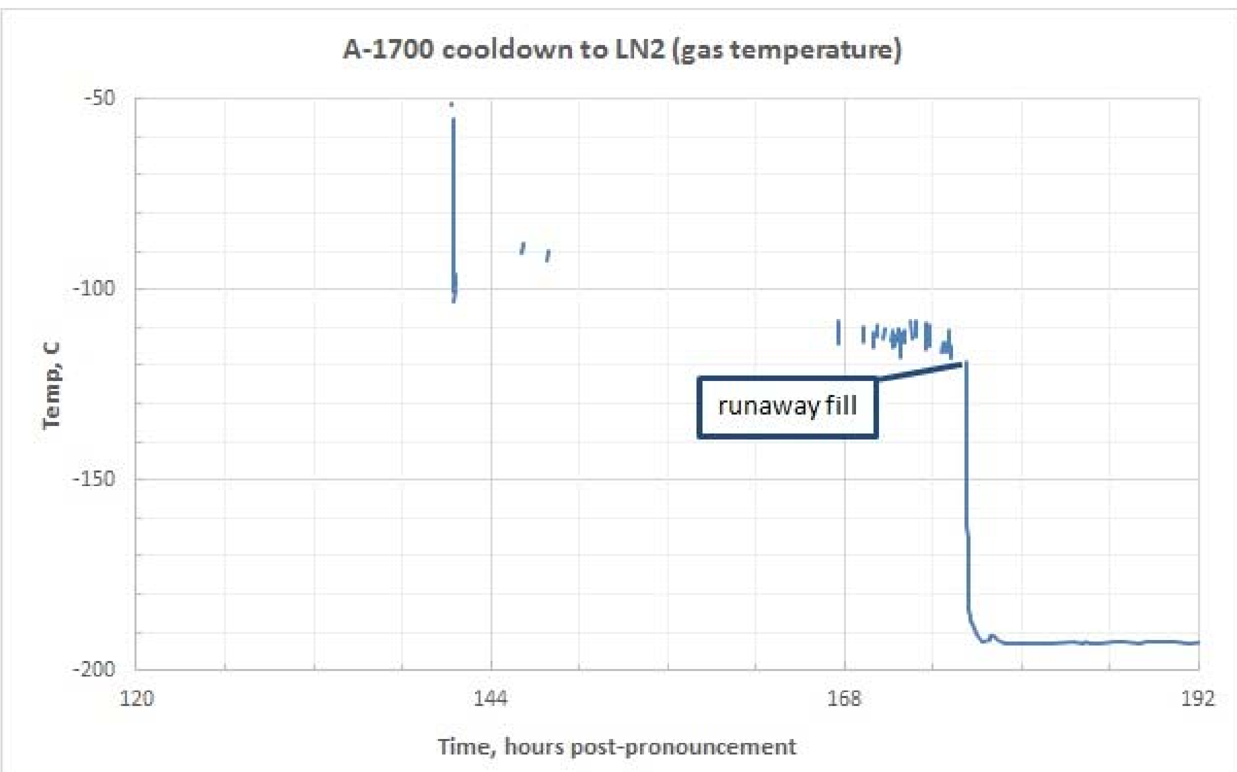
There was considerable missing data from the cooldown computer log and this resulted in a compromised graph of the cooldown. This patient was cooled down using the backup cooldown system. Our primary cooldown system was busy with A-2878. The backup cooldown system available at the time of this case was the DR-DOS-based system, running on a Win95 PC. After this case it was a priority to duplicate the primary Labview-based cooldown system and mothball the DOS system.

In the modern system, no comparable errors have been experienced. It is strange that the old system continued to function with such intermittent data. Injection burst times were calculated based on the difference between the measured and the target temperature. Without continuous temperature measurements, the system should have entered an alarm state. This is the case with our current cooldown system – if the thermocouple is unplugged, it reads NaN, which is always outside the allowable values so the system will instantly enter an alarm state.

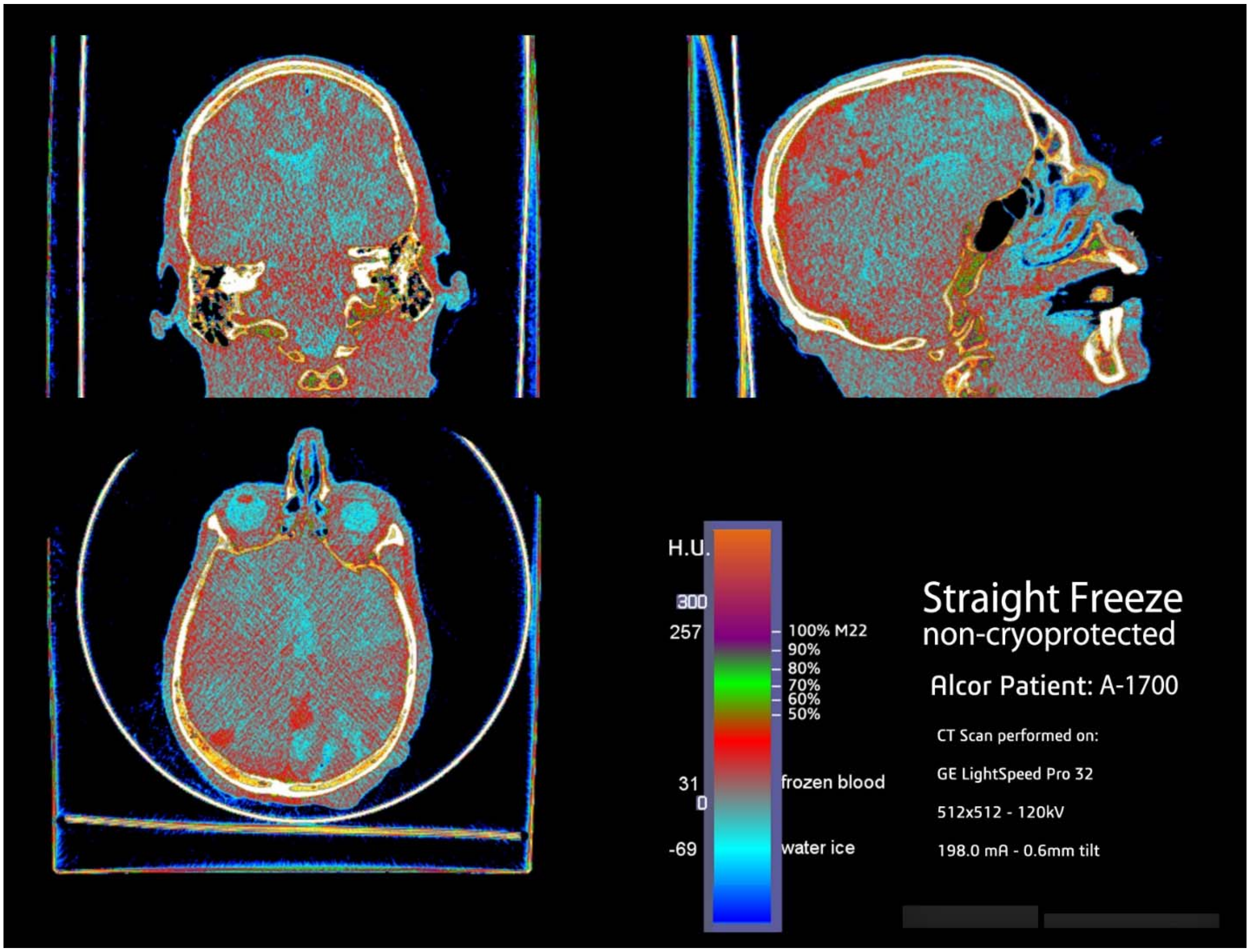
5. Graphs and CT Scans




A-1700 Cooldown
Gas Control Temp
runaway cooldown
Temp, C
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
140
164
188
212
Time, hours post-arrest


A-1700 cooldown to LN2 (gas temperature)
runaway fill
Temp, C
-50
-100
-150
-200
120
144
168
192
Time, hours post-pronouncement

Cryoprotectant Distribution



The CT scans were made on T+27 days, at liquid nitrogen temperature (-196°C).