

Alcor A-2858

Case Report



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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 on dates before T-0, and T+X represents occurrences on dates following T-0.

A-2858 was a 65-year-old member with whole-body cryopreservation arrangements. The death certificate showed the cause of death to be malignant neoplasm of the duodenum with metastases to the liver and bile duct. The time of pronouncement of legal death was unknown and it was not shown on the death certificate. Cardiac arrest took place in July in Minnesota before a hospice nurse arrived for her daily check-in at 11:30 hrs on T+1 days and was estimated to have been 12 hours earlier, or 23:30 hrs in July of 2021 on T-0 days.

Due to the amount of time from estimated cause of death to arrival at Alcor, this was a cryopreservation with no cryoprotection (i.e., a straight freeze). After being packed in dry ice, the patient was air transported to Alcor for cryogenic cooldown. The patient arrived at Alcor on T+4 days at 19:45 hrs. The cryogenic cooldown was initiated on T+6 days at 13:05 hrs and terminated at 19:45 on T+11 days after which the patient was transferred to long-term maintenance.

2. Patient Assessment

T-0 days

The member did not feel well and was getting worse and reported this to the Alcor Check-In service at 09:00 hrs; hospice personnel were on-site. After hearing from the Check-In service, Alcor's MRD called the member at 10:00 hrs to speak directly with the member, who reported experiencing mind fog and asked the MRD to speak with the emergency contact, who would be attending a hospice consultation later in the day and would be able to provide an update on the member's medical condition. A message was left for the emergency contact at 10:15 hrs urging a call back as soon as possible regarding the member's condition.

T+1 days

Having not heard from either the member or the emergency contact, the member was called at 07:00 hrs. The member did not answer, so a voicemail was left urging her to call back as soon as possible with an update. At 09:00 hrs the member did not answer the daily Alcor Check-In call.

At 11:30 hrs a hospice nurse notified Alcor that when she arrived at the home of the member to do a daily check, she found the member deceased and in rigor mortis. The nurse estimated cardiac arrest to have been approximately 12 hours prior (23:30 hrs on T-0 days). The time of pronouncement was estimated to be 11:30 hrs as it was not recorded.

At 11:35 hrs the MRD deployed Alcor's strategic partner, International Cryomedicine Experts (ICE), to the patient's location for post-mortem retrieval. A funeral director located near the patient who had been previously contacted was called at 12:00 hrs.

At 13:00 hrs the MRD confirmed with Alcor Staff and a Scientific Advisor that this case would be a straight freeze procedure due to the time between estimated cardiac arrest and expected time of arrival at Alcor.

3. Patient Retrieval and Preparation

The funeral director initially contacted seemed cooperative and friendly, but over the course of several phone calls the MRD became concerned that the funeral director would not cooperate with Alcor in the ways required for the safety of our member.

It was learned at 13:30 hrs that the funeral director was delaying the retrieval of the patient from the patient's home. The funeral director had called the medical examiner and refused to touch the patient until cleared by the medical examiner, which could take hours to accomplish. The MRD and the hospice nurse both explained to the funeral director that this action on his part was not necessary and was harmful to the patient, but the funeral director would not change his course of action.

At 14:30 hrs the MRD had located a funeral director further away from the patient's location but was interested in assisting Alcor. At 15:00 hrs the new funeral director agreed to drive two hours to the member's location, taking water ice to begin cooling as soon as he arrived. The funeral director informed Alcor that the local airport could not be used to fly the patient to Alcor, but that all human remains had to be flown out of Minneapolis, which would cost the patient additional transport time and ischemic damage.

At 16:57 hrs, 500 pounds of dry ice had been ordered to be delivered to the funeral home by the time the patient arrived. The funeral director arrived at the patient's location at 18:30 hrs, packed her in the water ice he brought with him and began the transport of the patient to his funeral home.

The ICE team member arrived in Minnesota at 22:01 hrs, was picked up by the funeral director in his vehicle and arrived at the funeral home at 23:00 hrs. The patient was in a Ziegler case. The funeral director had purchased 500 lbs. of dry ice in advance and approximately 30% (~ 150 lbs.), had been placed in the Ziegler case around the patient's head and upper torso, although there was still open space above the patient. The remainder of the dry ice was kept for use the following day.

At 23:15 hrs a nasopharyngeal thermocouple was placed and secured with surgical staples. The initial temperature reading was 5.6°C. After securing the thermocouples, approximately 150 lbs. of dry ice were added to completely fill the Ziegler case.

T+2 days

At 10:43 hrs the patient's nasopharyngeal temperature (NPT) was -15.6°C . An additional 150 lbs. of dry ice were added to the Ziegler case and the ICE team member then built the Alcor dry ice shipping container per Alcor's instructions. At 11:30 hrs the patient's temperature was -22.8°C . Another 200 pounds of dry ice was ordered to be delivered later that day.

T+3 days

The NPT was -70.3°C at 08:47 hrs. Minimal dry ice had been consumed. An additional 50 lbs. of dry ice were added while waiting for the patient to reach dry ice temperature (-80°C). A 10-degree warmup was noticed during the approximate 10 minutes while the lid of the Ziegler case was removed to evaluate, to add dry ice, and to maximize the packing of the dry ice. An effort was made to minimize the time the Ziegler lid was off the case.

4. Patient Transport

T+5 days

The NPT at 08:55 hrs was -71.2°C . Again, minimal dry ice had been consumed since the last check. The airline cargo office would not ship on a weekend. A flight was arranged at 08:55 hrs that would leave Minnesota on Monday at 14:39 hrs and arrive in Phoenix, Arizona at 17:57 hrs.

The dry ice shipper was topped off with dry ice at 09:30 hrs and sealed. It was a very humid day resulting in more dry ice consumption than previously observed. Fog was generated during the time the lid was off and the resulting NPT was -67°C . The dry ice shipper was secured for shipment. Dry ice temperature had not yet been achieved (see the Discussion section). The total weight was 424 lbs.

The cargo office at the airline did not initially accept the shipper and several trips were required to satisfy their requirements (see the Discussion section). The patient departed for Alcor at 14:46 hrs.

The flight arrived in Phoenix, Arizona at 16:58 hrs. The patient was picked up by Alcor's funeral director and transported to Alcor. The patient arrived at Alcor at 19:45 hrs.

At 20:28 hrs an additional 75 lbs. of dry ice was added to the shipper. Due to the late hour, and since the patient was covered with dry ice, the cooldown team would not be called in for cryogenic cooldown until the following day.

5. Cooling to Liquid Nitrogen Temperature

A computer program was used to initiate cryogenic cooldown at 13:05 hrs T+6 days, plunging to -80°C , to match the temperature of the patient, and descending thereafter at $-1^{\circ}\text{C}/\text{hour}$ to liquid nitrogen temperature. The first few measured temperature points are elevated because it takes a few minutes for the thermal mass of the lid to cool from room temperature. The nasopharyngeal thermocouple was damaged upon removal of the patient from the Ziegler case. The temperature of the patient when she was disconnected from the thermocouple was -73.3°C .

On T+11 at 19:45 hrs, an uneventful cooldown was terminated, and the patient was then transferred to long-term maintenance at liquid nitrogen temperature.

6. Timeline and Time Summaries

Timeline

T-0 days

23:30 Estimated time of cardiac arrest

T+1 days

11:30 Notification of legal death

18:30 Water ice applied to patient by funeral director before transport to funeral home

23:15 NPT: 5.6°C (prior to dry ice application)

T+3 days

08:47 Patient temperature: -70.3°C; additional dry ice added

T+5 days

----- Patient shipped from remote location (time not recorded)

19:45 Arrival of the patient at Alcor

20:15 Additional dry ice (75 lbs.) added to shipper

T+6 days

13:05 Start of patient cryogenic cooldown to LN₂ temperature

13:09 Dry ice temperature reached

T-11 days

19:45 End of cooldown to LN₂ temperature

19:55 (est) Transfer of patient to long-term maintenance at LN₂ temperature

Time Summaries

Event Duration

hrs: mins

- 116:15** From the estimated time of cardiac arrest to patient arrival at Alcor:
23:30 hrs on T-0 days to 19:45 hrs on T+5 days
- 23:45** From estimated time of cardiac arrest to start of field dry ice cooling:
23:30 hrs on T-0 days to 23:15 hrs on T+1 days
- 133:39** From estimated time of cardiac arrest until dry ice temperature achieved:
23:30 hrs on T-0 days to 13:09 hrs on T+6 days
- 17:20** From arrival at Alcor to start of cooldown: 19:45 hrs on T+5 days to
13:05 hrs on T+6 days
- 133:35** From estimated time of cardiac arrest to start of cryogenic cooldown:
23:30 hrs on T-0 days to 13:05 hrs on T+6 days

7. Discussion

The member did not answer the Alcor Check-In call on T-0 days before she was found by the hospice nurse to be deceased. With the Alcor Check-In service, it is common for a member to miss this call and therefore, Alcor is not immediately notified, instead, the service calls emergency contacts provided by the member to do an initial follow-up. If the emergency contact is unable to locate and communicate with the member, then Alcor will follow-up.

Because of poor funeral director cooperation, a second funeral director was found, and the first funeral director was added to Alcor's list of "Do Not Contact" funeral homes. This list is a shared list between Alcor, Cryonics Institute, Suspended Animation, and International Cryomedicine Experts. The primary purpose of this list is to detail cooperative funeral homes that have been used historically. But there is also a section for funeral homes (such as the one described above) to be avoided in the future. Criteria for avoidance are basically declination of cooperation, rudeness, unacceptable outcomes due to negligence, etc.

At the debriefing for this case there was a discussion about whether the straight freeze procedure could have been avoided by attempting to do a neuro field cryoprotection (FCP). This was also discussed at an SST (Standby, Stabilization and Transport) committee meeting. Alcor's Scientific Advisor (in a follow-up email) pointed out that FCP was originally deployed as a better alternative than straight freezing in dry ice, or multi-day hypothermic transport on water ice, for overseas cryonics cases. When needed, it was and is intended to be used for both neuro and whole-body cases.

This also means that whenever there is a domestic case without a standby (postmortem notification), and circumstances are such that an FCP-equipped team might be able to reach the patient faster than the patient can be brought to Alcor's O.R., FCP should be considered. This is true even if the patient is a whole-body patient because a whole-body patient with some cryoprotection of the brain is a better outcome than a complete straight frozen whole-body patient.

A neuro FCP procedure on a whole-body patient, as currently practiced, requires surgically accessing and cannulating the carotid arteries without cephalic isolation and accessing and opening the jugular veins to freely drain to the table. Cephalic isolation is not performed. Therefore, it will not be possible to cannulate or ligate the vertebral arteries, so they will unavoidably flow retrograde into the rest of the body. This will cause some perfusate loss into the body, decreased perfusion pressure in the Circle of Willis, and poorer perfusion of the cerebellum. After perfusion, the whole-body patient who received FCP would be packed in dry ice for cooling and then transported to Alcor as though they had been straight frozen.

This procedure was discussed on Alcor technical email lists during development of FCP, and more recently as a procedure to use on COVID-positive whole-body patients at Alcor HQ due to surgeon unwillingness to perform median sternotomy on COVID-positive patients before there was a vaccine. FCP should be considered any time if it is deemed it will improve the cryoprotection of the patient, whether neuro or whole body.

Regarding the extended time required to reach dry ice temperature, the rule of thumb is that it takes 24 hrs after the patient is covered with dry ice before dry ice temperature (-80°C) is reached within the patient. Dry ice had been placed on the patient starting on T+1 days but dry ice temperature was not reached until the patient was at Alcor and in the cryogenic cooldown process on T+6 days.

A Ziegler case completely packed with a patient and dry ice inside Alcor's insulated dry ice shipper design should have produced temperatures close to -80°C in approximately 24 hrs, instead of five days. There are two possible reasons for this disparity. First, the shipper was stored in the funeral home garage as their cooler was too small for the Ziegler and shipping case. That garage was warmer than is typically experienced and may have produced too high of a temperature gradient to be overcome to reach full dry ice temperature within the Ziegler. The other possible explanation is the position of the temperature probe within the patient or the position of the patient within the shipper.

It should be noted that the patient was within approximately 10 degrees of dry ice temperature only 24 hours after being placed in the shipper with the dry ice, but the temperature never got quite as low as expected. There is no concrete answer for why this happened. The thermocouples that Alcor orders are pre-calibrated by the manufacturer. Alcor technical staff will do some tests to see how accurate they are. This problem will not exist with the new Universal Data Logger goes into use.

The cargo office at the airline did not initially accept the shipper because the funeral director did not have the actual weight, only an estimated weight, and no dry ice label. The weight was ascertained, and a dry ice label was printed at a local business. A second attempt was made to deliver the shipper to the cargo office but was rejected because the dry ice label did not comply with what the cargo office considered the proper form size. Another trip to the local printing company was made to print the form on a full page. The third attempt at the cargo office was successful at 12:55 hrs and completed just minutes before their cutoff time for loading the shipper on the aircraft.

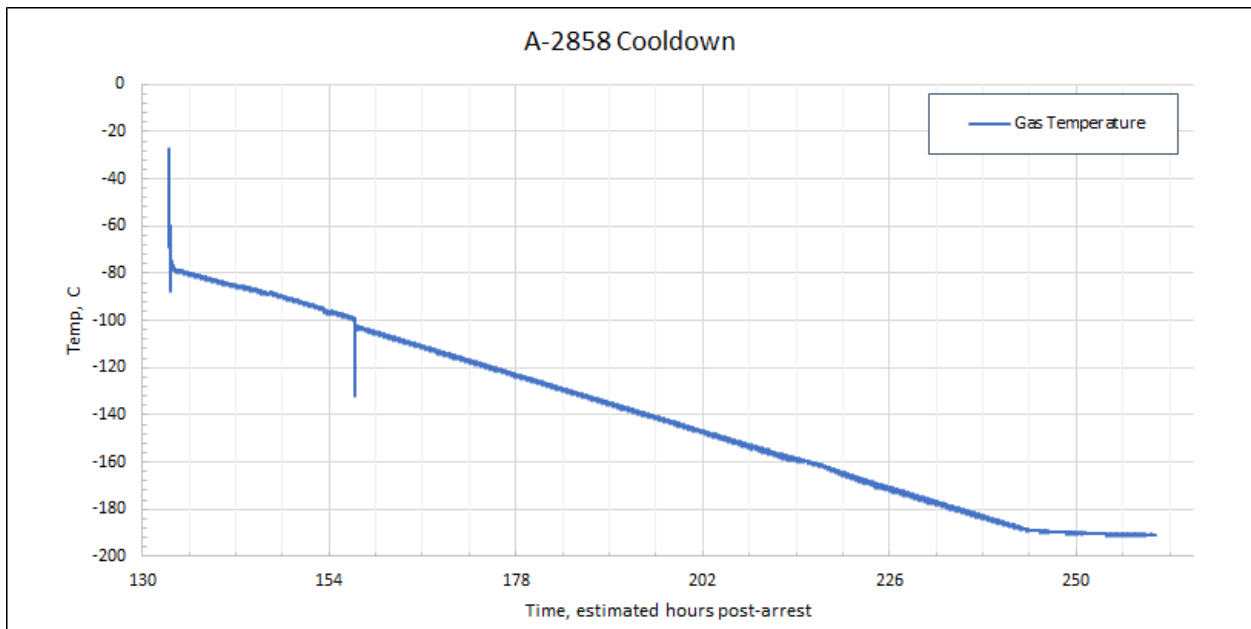
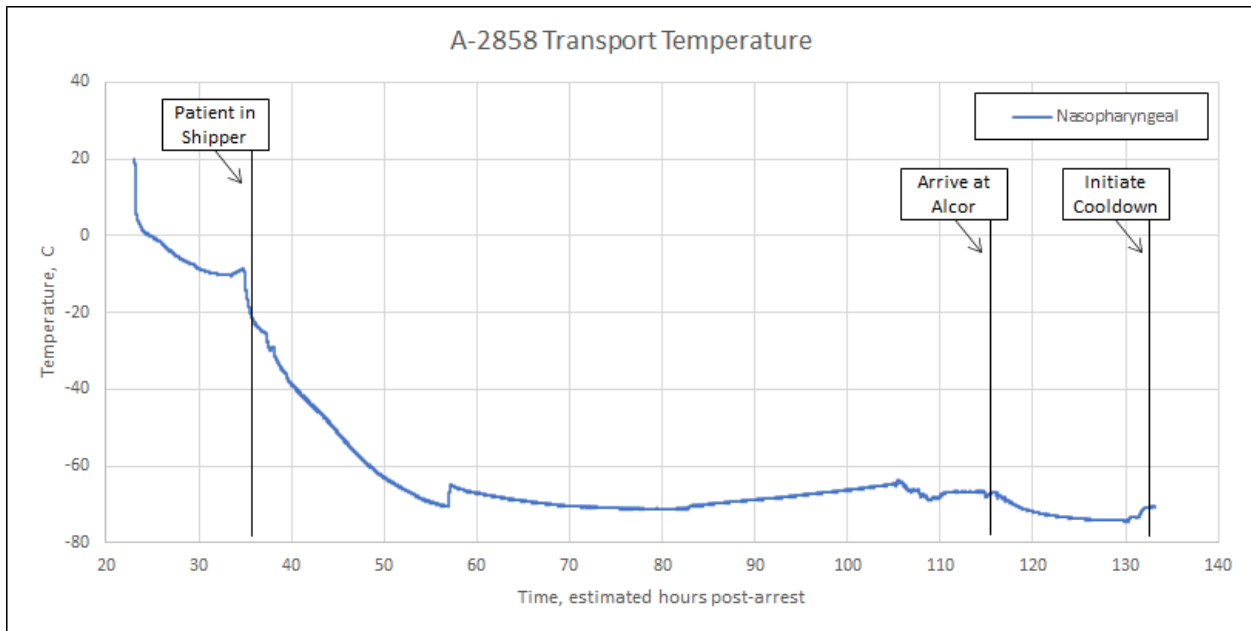
It was assumed that the above requirements were a regional choice rather than a universal standard. Alcor does have labels in the kit that are usually acceptable as following the standard that has been acceptable in the past. This was the first time there had been issues of 1) needing a “sticker” rather than a printed label that would be taped to the shipper and 2) needing the sticker to be a full page.

The patient arrived at Alcor in the evening as a straight freeze. When the shipper was opened, the temperature logger was working, and temperature data was available for that time period. Due to the late hour, the patient was packed with additional dry ice to await transfer into cooldown the following day. When the patient was lifted out of the shipper to transfer into cooldown, the thermocouple snagged on the shipper (exact location unknown) and was irreparably damaged. This has happened to other patients as they were removed from whole body shippers. We have seen this problem more often than in the past because almost every recent whole-body patient has been shipped to us on dry ice.

The patient’s temperature was not recorded during cooldown because the temperature probe was irreparably damaged when the patient was removed from the shipper. In addition to the problem of sharp edges on the shippers, there is another challenge when receiving patients already on dry ice, the thermocouple is often routed through some unknown path in the dry ice. If the thermocouple is not completely excavated from the packed dry ice, it will be caught and yanked out. This is the most likely explanation of what happened in this case.

For future cases, the thermocouple should be excavated and isolated to ensure its integrity as the first step of receiving the patient. The thermocouple should be coiled and tucked into a Ziploc bag during the lift and transferred so that it isn’t hanging free to be snagged. Those who are packing the patient should be asked to make sure the thermocouple runs straight up and out so that it is not pinned down by dry ice.

8. Graphs and CT Scans



Note: There was a temperature excursion at 24 hours cooldown runtime. The temperature PCA (pump control algorithm) controls were not set appropriately, and adjustment of the tuning values caused the system to briefly over-cool.

Cryoprotectant Distribution (Post-cryopreservation CT scan)

As this was a straight freeze procedure, no post-cryopreservation CT scans were obtained.