Alcor A-1159

Case Report

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Table of 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 cardiac arrest, T-X represents occurrences before T-0, and T+X represents occurrences following T-0.

A-1159 was an 85-year-old member with neuro cryopreservation arrangements. Cardiac arrest was observed at 09:38 hrs on T-0 days and the member was pronounced legally deceased in Arizona at 09:46 on T-0 days in March of 2024.

After pronouncement of legal death, stabilization procedures were performed while driving the patient to Alcor for cryoprotectant perfusion and cryogenic cooldown. The patient arrived at Alcor at 10:13 hrs on T-0 days. The cryogenic cooldown was initiated on T+0 days at 15:07 hrs and terminated on T+4 days at 16:17 hrs. The patient was transferred to long-term care at liquid nitrogen temperature on T+145 days at 12:05 hrs.

2. Member Assessment

T-56 days

The member expressed thoughts of despair to their Medical Power of Attorney (MPOA). Alcor's Medical Response Director (MRD) called and spoke to the member, confirming the member's frustration. At the time, the member was inpatient at a skilled nursing facility (SNF) receiving treatment for a urinary tract infection (UTI) and had acquired pneumonia since residing there. The MRD spoke to the member about contacting his/her physician to go over options for long term care. The member set up a hospice evaluation with the physician.

T-54 days

The MRD received a call from the member's MPOA stating that the member had a "pulmonary event last night." The member was stable but wanted to go home. The MRD reminded the MPOA of the hospice conversation with the physician planned for that day and the MPOA agreed to wait for that.

T-53 days

The member reached out to the MRD and stated they wished to be home at any cost. The physician relayed during their visit the day prior that the plan was to keep them inpatient at the SNF for a month.

T-47 days

The physician saw the member for their weekly visit. The member stated their wishes to be home and leave the SNF. The physician ordered a hospice care consultation, and an evaluation was scheduled. The MRD was unable to get ahold of the nursing station to find out the date of the evaluation. The member's MPOA stated they also had trouble reaching the nurses.

T-53 days

The MRD received an update from the MPOA. The hospice had evaluated the member and deemed them appropriate for in-home hospice. The member expressed their wishes for cryopreservation and was allowed to remain a full code. The member was discharged from the skilled nursing facility and placed on in-home hospice care.

T-18 days

The member remained stable; however, expressed wishes to the MPOA to stop eating and drinking. The date for that had not been set, and the MPOA stated that he did not mention this wish to the hospice nurse earlier that day when she was there. The member signed a Do Not Resuscitate (DNR) that day.

T-15 days

The member called the MRD to inform Alcor of the decision to stop all medications except for comfort medications (oral Vicodin) and would begin refusal of food and fluids. The member sounded weak. Alcor's MRD reached out to the hospice organization to ensure their understanding of Alcor's involvement and procedures, that they still had the member on their services, and could provide prompt pronouncement, to which they agreed on all counts.

T-11 days

The MRD called the MPOA for an update. The member was still eating and drinking. According to the MPOA, the member was physically the same, though mentally declining. When asked for clarification, the MPOA stated the member was not always making sense, he was unable to use the phone properly, and would sometimes fall asleep in the middle of conversations.

T-8 days

The member had eaten dinner the night prior and had been drinking about a cup of water a day. The member was interacting with the MPOA and the nurse during the visit at 08:00 hrs. The member's blood pressure during that visit was 226/101, but the member refused the blood pressure medication. Capillary oxygen saturation (SPO2) was 80% on room air. The MPOA told the nurse that the member had refused supplemental oxygen for the past 3 days, so the nurse placed the member on 5 L/min nasal cannula.

The MPOA informed the MRD at13:20 hrs that the member was no longer responding to him. He attempted to give the member his oral pain medication, and the member was unable to follow the commands to open his mouth and swallow. The MRD requested that he call hospice for an as-needed visit. The hospice nurse returned at 14:13 hrs and gave the following assessment:

Neurological status: the member was just lying in bed, eyes were open, mostly staring off into space, but tracking. The member did not follow commands and was not moving arms and legs. Following a drift test, the extremities gave no resistance to gravity.

Cardiopulmonary: Pulses were weak, heart tones were loud, and skipped beats were heard 5-10/min. No mottling, cool to the touch on the feet, hands warm. Lung sounds clear in the lobes.

Gastrointestinal and Genitourinary (GI/GU): Last intake was dinner the night prior. The member would not open mouth for water or pain medications. Urine output (UOP) this morning was 750mL (emptied at 08:00 hrs) and 20mL since then, cloudy with particles, arms and hands were 3+ (severely) edematous.

Skin: thin/frail, tenting present, scattered bruising.

Vital signs: SPO2 80% on 5L/min oxygen by nasal cannula, BP 151/84, HR 84.

General impression: The member could have had a stroke from high blood pressure or was hypoxic from not being on the oxygen. The hospice nurse placed an order for end-of-life medications (sublingual morphine for pain management and lorazepam for anxiety) and stated she would be visiting daily. She left orders for Morphine 5 mg every 4hr or as needed for pain, 5 mg every 1hr for shortness of breath, Lorazepam 2 mg/ml every 4hr or as needed for agitation and restlessness, and Atropine 2 drops every 1hr or as needed for secretions. A hospice nurse was scheduled to visit the member daily and to be on-call all weekend.

3. Deployment

T-8 days

The MRD arrived at the member's home at 16:59 hrs to visually assess the member. The member's vital signs were: SPO2 73% on 5L/min nasal cannula, HR 104, BP 128/74. The member was nonresponsive to verbal stimuli, and the MRD observed labored, shallow breathing. The skin was diaphoretic, frail, and there was scattered bruising as mentioned.

The MRD discussed the findings and assessments with the Alcor Deployment Committee, and there was a unanimous agreement at 17:43 hrs to call a Level-1 deployment and standby for the member. The Alcor DART team activated immediately. The DART Operations Manager (DOM) was already on-site at Alcor preparing for deployment and readied the Alcor operating room (OR) for field cryoprotectant perfusion (FCP) as back up to the standard OR neuro-cryopreservation and data acquisition system. The Mobile Response Vehicle (MRV) was also made ready and medications for stabilization were prepared. DART remained on standby at Alcor (4 min away from the member's home) until notified otherwise.

Sidebar:

The medical personnel on the Alcor Deployment Committee have established a list of medical indicators to assist in determining whether to call either a Level-1 standby, a high probability of death within seven days, or a Level-2 standby, a medium probability of death within seven days. The Deployment Committee voting members use these criteria when considering if a deployment is necessary.

4. Standby

The MPOA notified the MRD at 18:26 hrs that the member had been given a dose of morphine (5mg sublingual) at 17:15 hours. The MPOA stated he would like to discontinue the oxygen according to the member's wishes, as soon as Alcor could confirm that the OR was ready.

Alcor personnel arrived at Alcor at 19:44 hrs to prepare the OR neuro-cryopreservation and data acquisition systems. Alcor notified the MPOA that the OR was ready at 20:10 hrs. The oxygen was removed by the MPOA at 20:14 hrs and the MRD was notified. SPO2 was at 85% when oxygen was removed.

The MRD contacted the hospice on-call nurse at 21:02 hrs. The MRD was assured that they were aware of this situation and that they would respond to the call when the member was close to expected cardiac arrest so that prompt pronouncement could be made, and stabilization procedures could proceed immediately.

DART arrived at the member's home at 21:45 hrs to assess the member. They found the member nonverbal but looking around. The vital signs were: BP 115/84, HR 96 with pulse strong & regular, SPO2 82% room air, temperature (T) 37°C, 150 ml urine output since 09:00 hrs, last water approximately10:00 hrs. DART returned to Alcor for standby.

T-7 days

DART personnel continued their standby at either the Alcor facility (4 minutes from the member) or a hotel (1 minute from the member). They placed themselves on rotating visits with the member to update vital signs every 8 hours at a minimum, and often more frequently, to ensure proper assessment was taking place.

The member's vitals at 01:00 hrs were: BP 151/88, HR 88, pulse strong regular, SPO2 88% room air, RR 18 and shallow, T 37°C, pupils equal and reactive to light (PERL), 50 ml urine output, morphine 5ml given.

The member's vitals at 05:14 hrs were: BP 192/121, HR 89, SPO2 84% room air, RR 17, T 38°C, no urine output since 01:00 hrs. Notable improvements: showing increased alertness, utilizing hands to take items in and out of a box, and increased response to stimuli and commands. Morphine 5ml given post assessment.

The member's vitals at 12:18 hrs were: BP 134/89, HR 88, pulse strong regular, RR16, respirations shallow, SPO2 88% on room air, T 38°C, 100 ml urine output since 05:00 hrs. Display of purposeful movement and attempts to use words.

The member's vitals at 20:57 hrs were: BP 200/132, T 37°C, SPO2 87%, HR 87, regular, 80 ml urine output since 16:30 hrs, 400 ml urine output total since 01:00 hrs today, Lorazepam administered at 18:57 hrs.

T-6 days

The member's vitals at 05:00 hrs were: SPO2 90% on room air, RR 14 and unlabored, HR 63, BP 224/114, T 36°C, decreased responsiveness, grunting while assessed, appears comfortable / medicated, 150 ml urine in catheter bag, MPOA not available for medication update.

The member's vitals at 14:58 hrs were: BP 169/101, HR 73, T 36°C, SPO2 93%, eyes open, slight tracking, grunts when being assessed but no words. 50 ml urine output. The nurse reported a stage 2 pressure ulcer on the right flank, and a stage 2 pressure ulcer on the sacrum. Both morphine and lorazepam were given at 14:45 hrs. The member was starting to use accessory muscles with breathing, RR 14 and shallow.

The member's vitals at 21:26 hrs were: SPO2 92%, HR 83, RR 16, shallow, unlabored breathing, BP 180/98, 100 ml urine output since 15:00 hrs, both meds given at 18:30 hrs, eyes open and tracking, pupils were equal, round and reactive to light and accommodation (PERRLA), nonverbal, facial grimacing, moving left upper extremity (LUE) independently, bilateral lower extremities (BLE) restless, positive bowel sounds, no skin changes.

T-5 days

The member's vitals at 09:09 hrs were: T 36°C, SPO2 88%, HR 87, BP 198/112, RR 22 shallow, 3-4 seconds of apnea, abdominal breathing, total 580 ml urine output, estimated 150 ml since last assessment, unresponsive to touch/voice. Both medications given 06:30 hrs, patient appears more imminent today.

A hospice nurse visited at 11:49 hrs and changed the morphine to every 1 hour as needed (PRN). The member's vitals were: BP 188/98, SPO2 93%, HR 90, T 36°C, RR 20, no urine output in the catheter bag, unresponsive.

The member's vitals at 19:14 hrs were: T 36°C, SPO2 91%, HR 70, BP 196/98, 16 RR, shallow, continues abdominal breathing with no apnea, 180 mL urine output. The member was awake and answering some yes/no questions, drank sips of water. Repeatedly requesting to "go home," both medications given at 18:30 hrs, morphine given every 2 hours prior, member appeared to be rallying. Another assessment would be done in the morning.

T-4 days

The member was set up on a video and vital monitoring device known as the Owlet Dream Sock, a device in testing phase for DART monitoring of remote patients. This device can measure HR, SPO2 and video monitors the member when the DART team member is away from the bedside.

The member's vitals at 09:40 hrs were: SPO2 93%, 64 HR, T 36°C, 22 RR, shallow, BP 230/110, 200 ml urine output, active bowels, medications given throughout the night on 2 hour schedule. Member attempted to respond, minimal eye opening, grunting, Right lower extremity (RLE) pulse weaker than left lower extremity (LLE). Butterfly rash on sacrum (Kennedy terminal ulcer and seen only in patients as part of the dying process). A bath was given by aides.

The member's vitals at 14:31 hrs were: T 37°C, SPO2 90%, HR 74, BP 222/98, RR 16. The member drank water from a sponge, then from a straw, had a slight cough, gave inappropriate responses to Y/N questions, and repeatedly said "it's broken." Lorazepam and morphine were both given at 14:30 hrs.

At 19:36 hrs the members vital signs were: BP 145/77, 150 ml urine output, SPO2 82%, HR 106, T 37°C, RR 14, 3-5 seconds of apnea, no breath sounds in bases, decreased pulse strength.

The member responded “what” when addressed. There was mottling in the fingertips. At 18:30 hrs both medications were given. The caregiver/MPOA is administering morphine every 2 hours and Ativan every 4 hours.

The member’s vitals at 22:55 hrs were: T 37°C, SPO2 86%, HR 99, BP 224/110. Both Ativan and morphine were administered at 22:36 hrs. The member drank a little water through straw in drops to wet the mouth. Urine output was 50 ml. The member was talking, mumbled but responsive at times, and moving the extremities.

T-3 days

The member’s vitals at 06:27 hrs were: T 37°C, SPO2 89%, HR 84, BP 168/82, urine output 100 ml, RR 24 with Cheyne-Stokes breathing. The member gave mumbled responses.

The member’s vitals at 11:22 hrs were: T 37°C, SPO2 87%, HR 68, BP 180/92, 5-6 seconds of apnea when breathing, Cheyne-Stokes breathing, cyanotic lips, mottling of a toe. There had been no urine output this morning. The member was unresponsive to assessment. Medications continued to be given every 2 hours with the last dose at 10:30 hrs. The caregiver wanted to speak to the nurse about increasing the medication dosage, as it did not seem to be effective. Notation will be made when the nurse changes the medications order.

The member’s vitals at 17:19 hrs were: T 37°C, SPO2 77-83%, HR 101, BP 156/80, 80 ml urine output. The member was diaphoretic and cool to the touch, lethargic and showing minimal responsiveness.

T-2 days

The member’s vitals at 13:24 hrs were: T 37°C, SPO2 72%, BP 152/86, HR 100, RR 10, Cheyne-Stokes breathing.

The member’s vitals at 21:54 hrs were: T 37°C, HR 108, BP 122/78, SPO2 50% on fingers and 77% on toes, RR 8, 5-7 seconds of apnea. The member was unresponsive and drowsy. There had been no urine output. The medications were being given as scheduled; the last doses given at 20:40 hrs. There was mottling on both fingers and toes.

At 22:30 hrs the MRD called the on-call nurse and obtained the nurse’s personal cell number to use in case the main line number did not respond immediately. The nurse also stated he was willing to be called about an hour prior to when it would be believed the member would go into cardiac arrest so he would be on site. The human remains release form had been pre-filled so DART could recover the patient and leave immediately after pronouncement of legal death. The nurse was 13 miles from the member’s house which was calculated to be about a 25-minute drive, so the nurse requested a 40-60 minute warning, and would be okay with waiting if the member had not yet arrested upon his arrival. The nurse fully supported the member’s final wishes and was very cooperative.

T-1 days

The member's vitals at 05:17 hrs were: T 37°C, SPO2 78%, HR 102 to140, BP 130/92 (barely audible, unable to obtain on electric cuff), RR 8, 5-7 seconds of apnea, terminal secretions. No urine output.

The member's vitals at 09:45 hrs were: T 37°C, SPO2 67%, HR 108, no urine output, unable to obtain BP, RR 9, apnea, continued unresponsiveness. The aide gave a bath without concerns.

DART drew up the stabilization medications at 11:03 hrs in anticipation of cardiac arrest. The pump system in the Alcor OR was being reconfigured at 11:04 hrs to replace a faulty main pump. This meant this case would be performed as a standard OR recirculating cryoprotectant perfusion, not as a step ramp perfusion with the field bladder system.

At 13:32 hrs the hospice nurse reported that the member was experiencing increasing episodes of apnea and had educated the caregiver on the use of atropine every hour to limit secretions from the mouth. There were no other changes in the medications. The nurse estimated that the member would live less than 36 hours at this point.

The member's vitals at 20:51 hrs were: BP 90/40, SPO2 78%, RR 10, HR 120. Occasional rattled breathing, gasping and Cheyne-Stokes breathing, very irregular. The member was not responsive to any stimulation.

The member's vitals at 23:43 hrs were: T 38°C, SPO2 was too weak to obtain, BP 68/palpation (unable to obtain audible diastolic pressure reading). Respiration was irregular, RR 8 with non-labored irregular breathes, gasping with a light rattle.

T-0 days

The member's vitals at 08:33 hrs were: T 38°C, SPO2 58%, BP 64/Palp, HR 111, RR 12. There had been no urine output.

From 08:45 hrs when the DART team left the member, Alcor's MRD was watching the member on the remote monitoring video device. The SPO2 % was not reading. The MRD watched the member take two deep breaths, and then at 09:38 hrs the member stopped breathing. This is considered to be the time of cardiac arrest. Both DART (4 min away) and the hospice nurse (10 min away) were immediately called.

Out of pure coincidence, another hospice nurse was already enroute to the member's home for the daily assessment. DART and hospice nurse arrived simultaneously at 09:43 hrs and the member was pronounced legally deceased at 09:46 hrs. The member weighed 90.7 kg (200 lbs.).

5. Patient Recovery, Stabilization, and Transport to Alcor

Because of a tight hallway configuration that prevented the portable ice bath (PIB) from being inside the patient's room, the patient was carried out of the room and placed into the PIB at 09:51 hrs. The patient was then moved into the Mobile Recovery Vehicle (MRV) and the stabilization procedures continued enroute to Alcor.

An EZIO was placed in the patient's right tibia at 09:56 hrs to access the vasculature for administration of the stabilization medications. A King airway was placed at 10:03 hrs for ventilation, and an antacid was administered to protect the stomach.

The SAVe ventilator was connected to the King airway, and ventilations were started at 10:08 hrs. At 10:23 hrs, the SAVe ventilator stopped working and a battery error occurred, even when plugged in. A DART team member administered ventilations via an AMBU bag for the remainder of the stabilization procedure.

The first stabilization medication was administered at 09:57 hrs (see the below Table of Medications Administered for the names of the medications, the dosages, and the times of administration). The final medication was administered enroute to Alcor at 10:03 hrs.

6. Cryoprotectant Surgery at Alcor

10 liters of B1 carrier solution had been put into the mixing reservoir. Because the patient would have less than an hour since pronouncement, the nM22 cryoprotectant perfusion would start with a concentration needed to vitrify (CNV) of 9.45 Brix.

The MRV with the patient arrived at the back door to Alcor at 10:10 hrs. The patient, in the PIB with mechanical chest compression and bag-valve ventilation was moved into the operating room (OR) at 10:13 hrs. At 10:14 hrs the initial nasopharyngeal temperatures (NPT) from the data logger were 29°C on the right and 25°C on the left.

25,000 IU of streptokinase, to break up blood clots, was added to the mixing reservoir at 10:44 hrs. Chest compression and ventilation were discontinued at 10:46 hrs to prepare for surgery. The patient was moved from ice bath to operating table at 10:50 hrs. Ice bags were placed around the patient's head and thorax at 10:51 hrs while the surgeon prepared the surgical back table. At 10:51 hrs the right NPT was 24°C and the left NPT was 17°C.

The first surgical cut for the carotid cannulation was made on the left side of the patient's neck at 10:58 hrs. The left carotid artery was isolated at 11:02 hrs. The right carotid artery was isolated at 11:08 hrs.

The single burr hole was started in the right frontal quadrant of the patient's head at 11:11 hrs. The brain dura was punctured at 11:12 hrs for placement of the thermocouple (port 3 on the data logger). The initial burr hole temperature reading was 29°C. The burr hole thermocouple was sutured to patient's forehead at 11:14 hrs.

The cephalic isolation was started at 11:16 hrs by surgically removing the tissues around the trachea and spinal cord. The cephalon separation device was used to separate the trachea and spinal cord at 11:21 hrs. The procedure was completed at 11:22 hrs. The cephalon weighed 5.81 kg before being cryoprotected. The cephalon was placed in the cephalic ring inside the cephalic perfusion enclosure at 11:23 hrs.

At 11:25 hrs the data acquisition system was connected to the patient. An NPT thermocouple was placed in the patient's left nare. The initial readings were: NPT 26 °C, burr hole (BH) 19°C, cephalic enclosure 14°C.

The perfusion lines and cannulas primed at 11:27 hrs with B1 carrier solution. The right carotid artery was cannulated with a red Robinson cannula at 11:28 hrs. The left carotid artery was cannulated with a red Robinson cannula at 11:31 hrs. The right vertebral artery was cannulated with a red Robinson cannula at 11:33 hrs and was flowing. The left vertebral artery was cannulated with a red Robinson cannula at 11:36 hrs and was flowing. When the vertebral arteries are flowing, it is an indication of a complete Circle of Willis, which means that the whole brain will be perfused.

A custom-made thermocouple cannula was inserted into right internal jugular vein at 11:38 hrs and connected to data acquisition system 11:39 hrs. A custom thermocouple cannula was inserted into left internal jugular vein and connected to the data acquisition system at 11:39 hrs.

The perfusion circuit was placed on computer control in recirculation mode. The RI reading from the left jugular vein was 9.66% Brix at 11:42 hrs. The computer-controlled target arterial perfusion pressure was set to 80mmHg. The flow rate was 106 ml/minute.

7. Cryoprotectant Perfusion at Alcor

The cryoprotectant perfusion ramp was started at 11:46 hrs. The cephalon was rotated within the enclosure for better perfusion control and the enclosure lid was put in place at 11:47 hrs. Nitrogen gas was turned on to flow into the enclosure to improve patient cooling at 11:48 hrs.

Tanning of the patient's skin was observed to have started on the cheeks, but the eyes remained convex at 12:03 hrs. These are normal signs that the nM22 vitrification solution is being taken up by the cells. At 12:08 hrs the perfusion flow rate was proceeding without incidence. At 12:33 hrs tanning of the skin was uniform. At 12:51 hrs both eyes were now concave.

The perfusate addition pump was slowed at 13:19 hrs in preparation for the 30-minute pause for equalization. The 30-minute pause was initiated at 13:20 hrs and the computer-controlled target temperature was switched from 3°C to -3°C.

Sidebar
Per the cryoprotection protocol, the ramp is to be paused at 30 Brix (approximately 50% of the desired terminal concentration of 52.5 Brix) to allow the patient to come to osmotic equilibrium. The cephalic/patient enclosure and the chiller are switched from +3°C to -3°C operation. At the end of the 30-minute pause, the ramp is resumed at the maximum addition rate (maximum without losing total volume in the circuit) to go to 105% of the desired end concentration (49.9 Brix x 105% = 52.5 Brix) and held between 102% and 105% concentration until the terminal concentration is obtained.

At 13:20 hrs the data acquisition monitor began to show different RI values than the direct RI venous reading (see the Discussion section). A second blood filter was opened in the circuit as an extra precaution at 13:39 hrs.

The 30-minute pause for equilibration was complete at 13:50 hrs. The addition pump was set to full speed for duration of cryoprotectant ramp. Perfusion was uneventful. The 30-minute countdown to termination of cryoprotectant perfusion was initiated at 14:26 hrs. The venous

refractive index was 50.1 Brix. The cryoprotectant perfusion ramp was terminated at 14:56 hrs. The venous RI was 49.9 Brix, and the arterial RI was 51.3 Brix.

A hole was drilled into the vertebrae to add I-bolt for better handling of the cephalon at 14:58 hrs and the I-bolt was put in place. The cephalon was weighed post-perfusion at 15:01 hrs. The cephalon weighed 4.88 kg. (5.51kg - 4.88 kg = 0.93 kg weight loss, or 16% weight loss). Dehydration of the brain is an indicator of water removal and perfusate uptake within the brain.

The cephalon was moved into the Patient Care Bay at 15:01 hrs and placed into the cool down dewar at 15:02 hrs. The cryogenic cooldown was initiated at 15:04 hrs.

8. Cooling to Liquid Nitrogen Temperature

Computer-controlled cryogenic cooldown was initiated at 15:07 hrs on T-0 days, plunging to -110°C and descending thereafter at -1°C/hour to liquid nitrogen temperature. On T+4 days at 16:17 hrs, an uneventful cooldown was terminated. On T+145 days at 12:05 hrs (see the Discussion section), the patient was transferred to long-term care at liquid nitrogen temperature.

9. Timeline and Time Summaries

Timeline

T-0	09:38	Estimated time of cardiac arrest
T-0	09:46	Pronouncement of legal death
T-0	09:51	Start of ice bath cooling
T-0	09:56	Placement of IV and/or intraosseous device
T-0	09:57	Administration of first medication (propofol)
T-0	09:58	Start of mechanical chest compressions
T-0	10:03	Placement of King airway
T-0	10:03	Administration of final medication (antacid)
T-0	10:13	Arrival of patient in OR at Alcor (RNPT 29°C)
T-0	10:46	Termination of CPS (24°C)
T-0	10:58	Start of surgery
T-0	10:58	Start carotid, vertebral, and jugular artery cannulation
T-0	11:12	Drilled single burr hole
T-0	11:16	Start cephalic isolation
T-0	11:22	Finish cephalic isolation
T-0	11:23	Weigh patient cephalon (5.81 kg)
T-0	11:39	Finish cannulation of vessels (finish surgery)
T-0	11:41	Start of neuro washout
T-0	11:46	Completion of neuro washout
T-0	11:46	Start of cryoprotectant perfusion ramp
T-0	13:20	Start pause at 50% of CNV for equilibration
T-0	13:50	Start of sub-zero terminal concentration ramp (off pause)
T-0	14:26	Start 30-minute countdown to termination of ramp
T-0	14:56	Termination of cryoprotection (49.9 Brix)
T-0	15:01	Weight patient cephalon after perfusion (4.88 kg)
T-0	15:04	Start of patient cryogenic cooldown
T+4	16:17	End of cooldown
T+145	12:05	Transferred to long-term maintenance

Time Summaries

Event Duration				

hr:min		days	time	
00:08	From:	T-0	09:38	Estimated time of cardiac arrest
	Till:	T-0	09:46	Pronouncement of legal death
00:13	From:	T-0	09:38	Estimated time of cardiac arrest
	Till:	T-0	09:51	Start of ice bath cooling
00:20	From:	T-0	09:38	Estimated time of cardiac arrest
	Till:	T-0	09:58	Start of mechanical chest compressions
00:19	From:	T-0	09:38	Estimated time of cardiac arrest
	Till:	T-0	09:57	Administration of first medication (propofol)
00:06	From:	T-0	09:57	Administration of first medication (propofol)
	Till:	T-0	10:03	Administration of final medication (antacid)
00:35	From:	T-0	09:38	Estimated time of cardiac arrest
	Till:	T-0	10:13	Arrival of patient in OR at Alcor (RNPT 29°C)
00:45	From:	T-0	10:13	Arrival of patient in OR at Alcor (RNPT 29°C)
	Till:	T-0	10:58	Start of surgery
00:41	From:	T-0	10:58	Start of surgery
	Till:	T-0	11:39	Finish cannulation of vessels (finish surgery)
02:08	From:	T-0	09:38	Estimated time of cardiac arrest
	Till:	T-0	11:46	Start of cryoprotectant perfusion ramp
01:33	From:	T-0	10:13	Arrival of patient in OR at Alcor (RNPT 29°C)
	Till:	T-0	11:46	Start of cryoprotectant perfusion ramp
00:48	From:	T-0	10:58	Start of surgery
	Till:	T-0	11:46	Start of cryoprotectant perfusion ramp
03:58	From:	T-0	10:58	Start of surgery
	Till:	T-0	14:56	Termination of cryoprotection (49.8 Brix)
03:10	From:	T-0	11:46	Start of cryoprotectant perfusion ramp
	Till:	T-0	14:56	Termination of cryoprotection (49.8 Brix)
00:08	From:	T-0	14:56	Termination of cryoprotection (49.8 Brix)
	Till:	T-0	15:04	Start of patient cryogenic cooldown
05:26	From:	T-0	09:38	Estimated time of cardiac arrest
	Till:	T-0	15:04	Start of patient cryogenic cooldown
04:51	From:	T-0	10:13	Arrival of patient in OR at Alcor (RNPT 29°C)
	Till:	T-0	15:04	Start of patient cryogenic cooldown

10. Table of Medications Administered

T-0 days

TIME	MEDICATION	DOSE	PURPOSE

09:57 hrs	Propofol	200 mg	Anesthetic; reduces cerebral metabolic demand; reduces the theoretic possibility of increased awareness during aggressive CPS.
09:59 hrs	Sodium citrate	20 g Note 1	Anticoagulant; prevents blood clot formation.
10:00 hrs	Heparin	50,000 IU	Anticoagulant; prevents blood clot formation.
10:01 hrs	Vasopressin (1st dose)	40 IU Note 2	Vasopressor; increases blood pressure during CPS.
10:03 hrs	Minocycline	200 mg	Antibiotic and neuroprotectant
10:03 hrs	Antacid	250 ml Note 3	A buffer used to neutralize stomach acid.
10:06 hrs	SMT (S-methyl-isothiourea)	400 mg Note 4	Neuroprotectant (iNOS inhibitor); protects the brain from ischemic injury; raises blood pressure.
10:07 hrs	Decaglycerol/THAM	200 ml Note 5	Decaglycerol inhibits cerebral edema.
10:08 hrs	Vasopressin (2nd dose)	40 IU Note 2	Vasopressor; increases blood pressure during CPS.
10:09 hrs	Vital Oxy (w/ saline)	40 mL Note 6	Antioxidants: melatonin, vitamin E (D-alpha tocopherol), PBN (alpha Phenyl t-Butyl Nitrone) and anti-inflammatory carprofen.
10:11 hrs	Decaglycerol/THAM	200 ml Note 5	Decaglycerol inhibits cerebral edema.
10:44 hrs	Streptokinase	25,000 IU Note 7	A thrombolytic used to break up existing blood clots.

Notes:

1. The standard formulation for sodium citrate is 20% w/v, in sterile packaging provided by the manufacturer. 10 grams of sodium citrate are given to patients who weigh less than 40 kg, and 20 grams are given to patients who weigh over 40 kg. This patient weighed 90.7 kg and therefore received 20 grams of sodium citrate.

2. Vasopressin is a fixed dosage of 40 IU, per dose for two doses. The second 40 IU dose is to be administered concurrently with Vital-Oxy, I.V. Vasopressin is to be administered only if the patient's temperature is above 20°C as it is ineffective at cold temperatures.

3. An antacid can be given in several doses, totaling 250 mL, and inserted through the nasogastric tube in an airway.

4. SMT (S-methyl isothiourea) is a powder, (1 vial = 400 mg) dissolved in 10 mL of saline and injected through a 0.2 µ filter. SMT is unstable in solution with a use life of approximately six hours.

5. Decaglycerol/THAM is administered as a custom formulation of 20% w/v decaglycerol and 4.5% w/v THAM (tromethamine) in water (pH = 10.4 and pKa = 8.3). It is a fixed dose of 400 ml to be given in two separate doses.

6. The medications protocol dilutes 70 mL or less, based on body weight, of Vital-Oxy into 150 mL of saline for a total of 220 cc of diluted Vital-Oxy saline. Each mL of Vital-Oxy contains 194 mg Sigma Cremophor EL (or Sigma Kolliphor EL), 155 mg ethanol, 19.4 mg PBN, 3.24 mg carprofen, 1.55 mg melatonin, and 198 IU vitamin E.

7. The standard administration of streptokinase is 250,000 IU fixed dose, dissolved in 5 mL of 9% sodium chloride, to be added to the blood washout solution prior to remote blood washout, or to the first cryoprotection flush in the OR. The dosage is reduced to 25,000 IU in field neuro (FCP) cases and added to the first bladder). This medication previously needed to be infused through a 0.2 µ filter. The medication now in use is already sterile-filtered and can be reconstituted in the vial.

11. Discussion

Standby and Stabilization

The patient ventilator batteries were old and would not hold a charge. For this case, an AMBU bag was used. The ventilator was left in the PIB, and after the ice melted, the ventilator was water damaged. A new set of 10 ventilators have been ordered to replace the damage ventilators to avoid this issue in the future.

The caretaker was not able to adequately care for the patient without assistance. DART is not allowed to assist in any member care, such as the administration of medications. The Owlet monitor was extremely useful in monitoring the patient.

The stabilization medications were drawn up too early and had to be re-drawn during the case. This is expensive and wasteful. Although difficult to estimate when cardiac arrest will take place, every effort needs to be made so that medications are not drawn up until the 24-48 hours until cardiac arrest.

This member was in home hospice care, but vital signs were not taken by the hospice nurses often enough. DART was frequently used for obtaining the vital signs. The wrist blood pressure cuffs in the kits are not sufficiently accurate. Manual blood pressure cuffs and stethoscopes are more accurate and will be used on future deployments.

The King airway balloon was pierced, requiring the DART team to continuously apply air to maintain the airway. The airway should have been replaced with redundant equipment in the kit.

Two nasopharyngeal temperature (NPT) thermocouples were showing readings as much as 10°C apart causing uncertainty about which was more accurate. Temperature probes can differ if not inserted at the same depth, or if different styles are used. The team will be given additional training regarding the SOP for inserting the temperature probes, and the use of barriers or other tools necessary to prevent ice from entering the airway.

Cryoprotectant Surgery and Perfusion at Alcor

The refractometry system failed just after the start of the 30-minute countdown to termination of the cryoprotectant ramp. Because of this, the levels recorded by the data acquisition system did

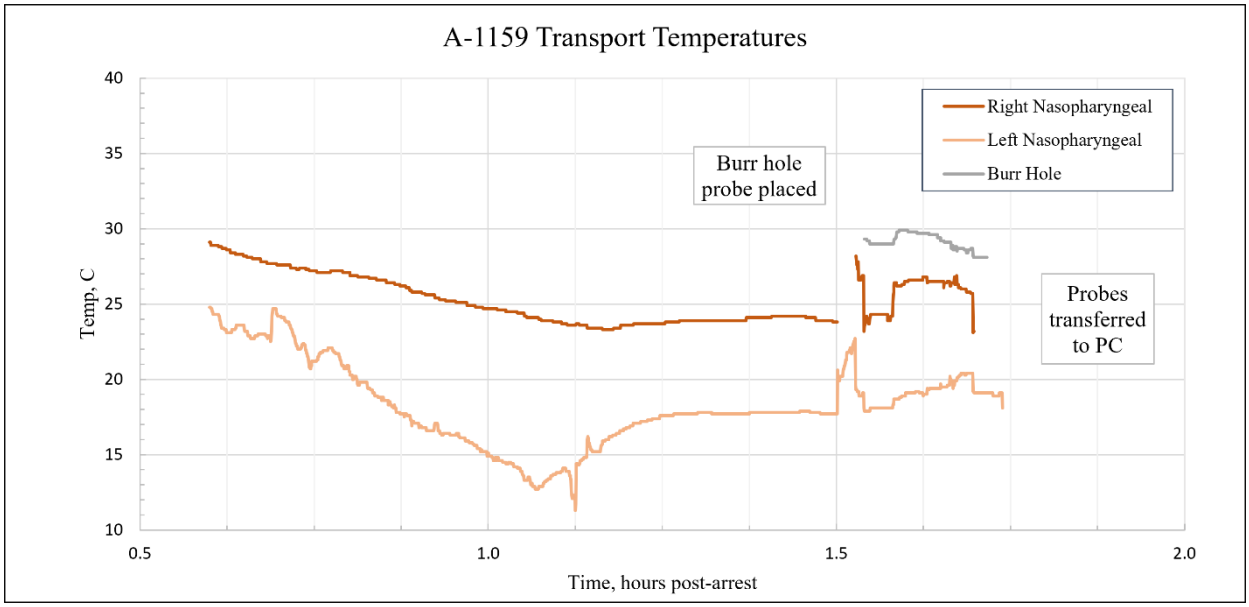
not match those displayed on the refractometer output displays. Manual recordings of the refractometer displays were taken at 15-minute intervals. As all three refractometers are connected to a common data acquisition module, the team believes that an electrical disturbance from the faulty unit affected the readings of all three sensors.

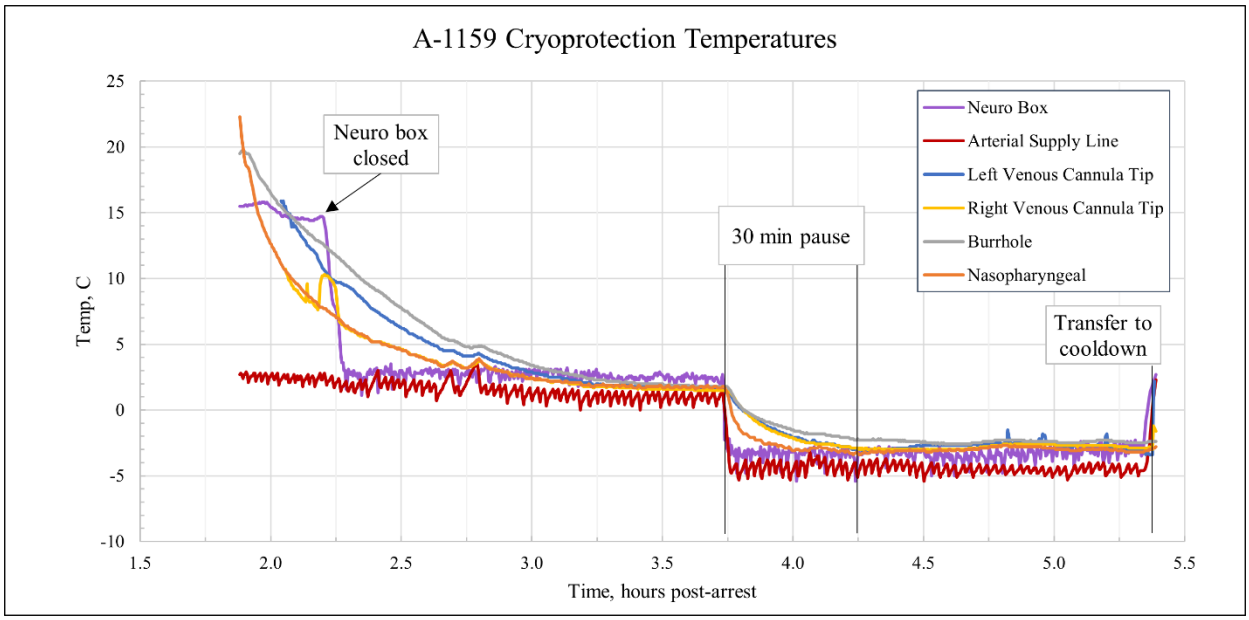
Cryogenic Cooldown

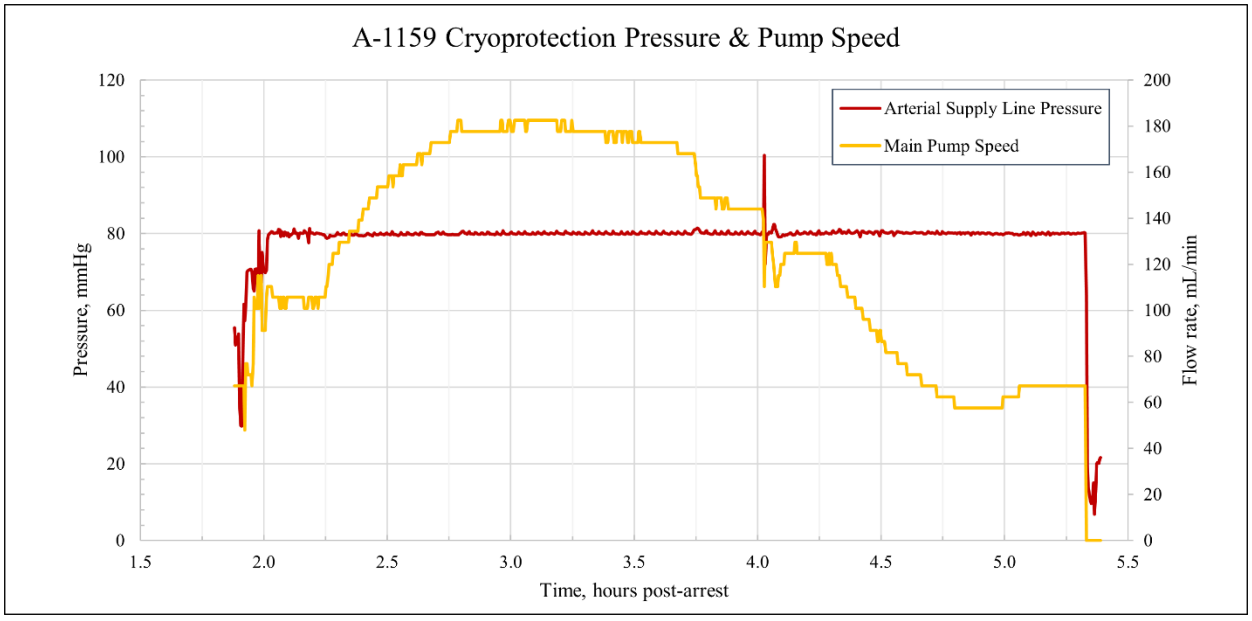
The cooldown was uneventful. During transfer, while the burr hole probe was still physically attached to the cephalon, it slid out of its place and only recorded gas temperature. This was not discovered until several hours after the start of cooldown.

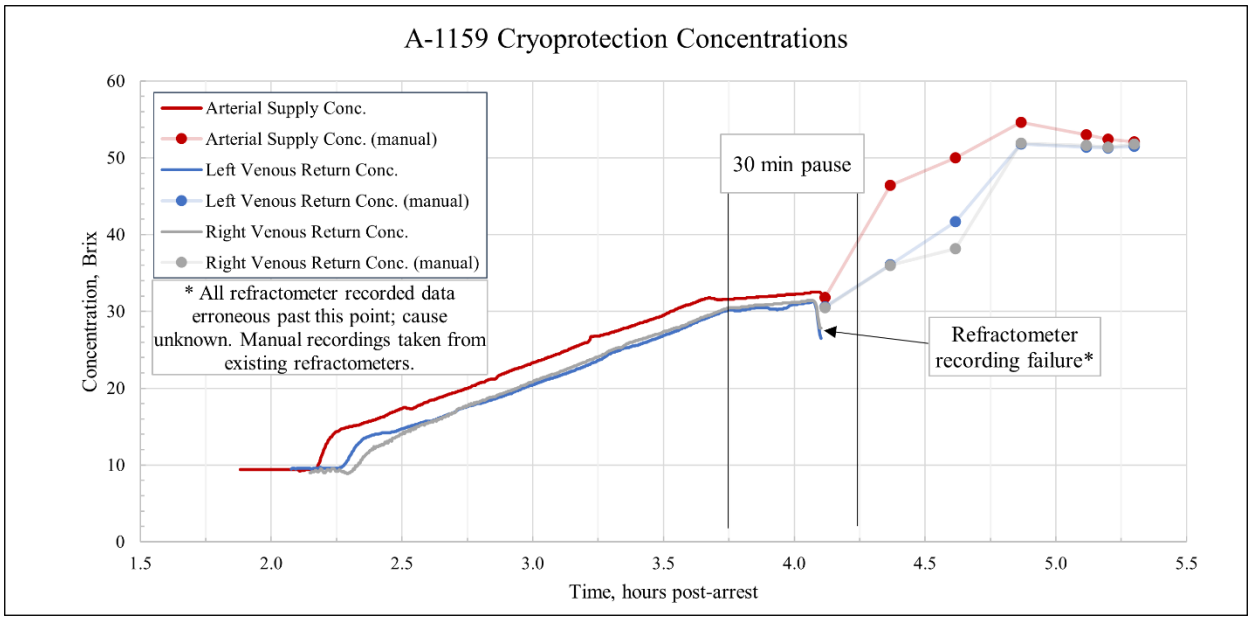
This patient was not transferred to long-term care at liquid nitrogen temperature until T+145 days. It is common for neuro patients to remain in a cooldown dewar until several neuro patients can be transferred at the same time.

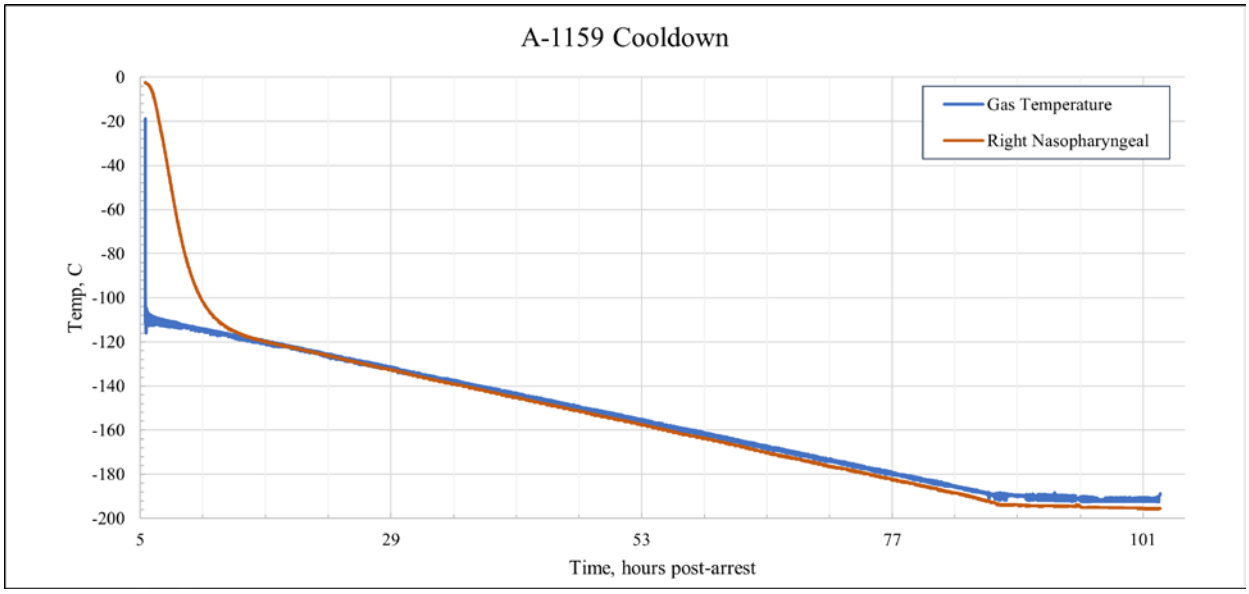
12. Cryoprotection and Temperature Graphs

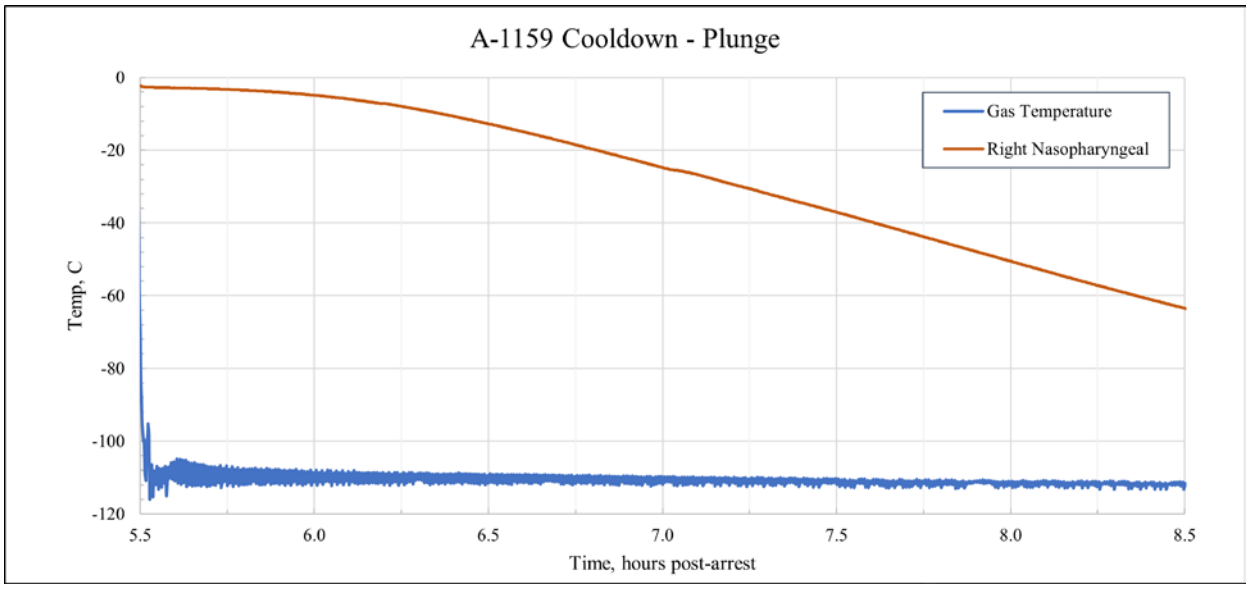

A-1159 Transport Temperatures
Temp, C
Time, hours post-arrest
Right Nasopharyngeal
Left Nasopharyngeal
Burr Hole
Burr hole probe placed
Probes transferred to PC


A-1159 Cryoprotection Temperatures
Temp, C
Time, hours post-arrest
Neuro Box
Arterial Supply Line
Left Venous Cannula Tip
Right Venous Cannula Tip
Burrhole
Nasopharyngeal
Neuro box closed
30 min pause
Transfer to cooldown


A-1159 Cryoprotection Pressure & Pump Speed
Arterial Supply Line Pressure
Main Pump Speed
Pressure, mmHg
Flow rate, mL/min
Time, hours post-arrest
120
100
80
60
40
20
0
200
180
160
140
120
100
80
60
40
20
0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5


A-1159 Cryoprotection Concentrations
Arterial Supply Conc.
Arterial Supply Conc. (manual)
Left Venous Return Conc.
Left Venous Return Conc. (manual)
Right Venous Return Conc.
Right Venous Return Conc. (manual)
* All refractometer recorded data erroneous past this point; cause unknown. Manual recordings taken from existing refractometers.
30 min pause
Refractometer recording failure*
Concentration, Brix
Time, hours post-arrest
60
50
40
30
20
10
0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5


A-1159 Cooldown
Gas Temperature
Right Nasopharyngeal
Temp, C
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
5
29
53
77
101
Time, hours post-arrest

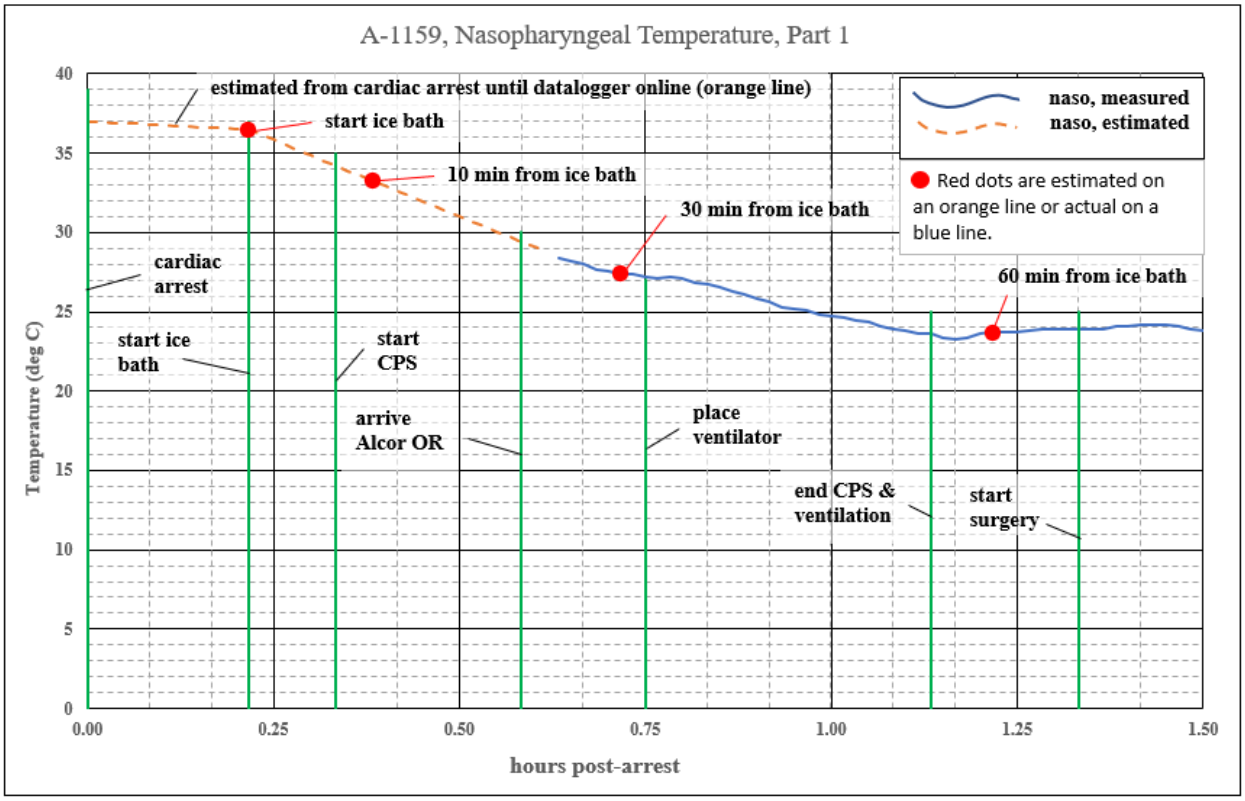

A-1159 Cooldown - Plunge
Gas Temperature
Right Nasopharyngeal
Temp, C
0
-20
-40
-60
-80
-100
-120
5.5
6.0
6.5
7.0
7.5
8.0
8.5
Time, hours post-arrest

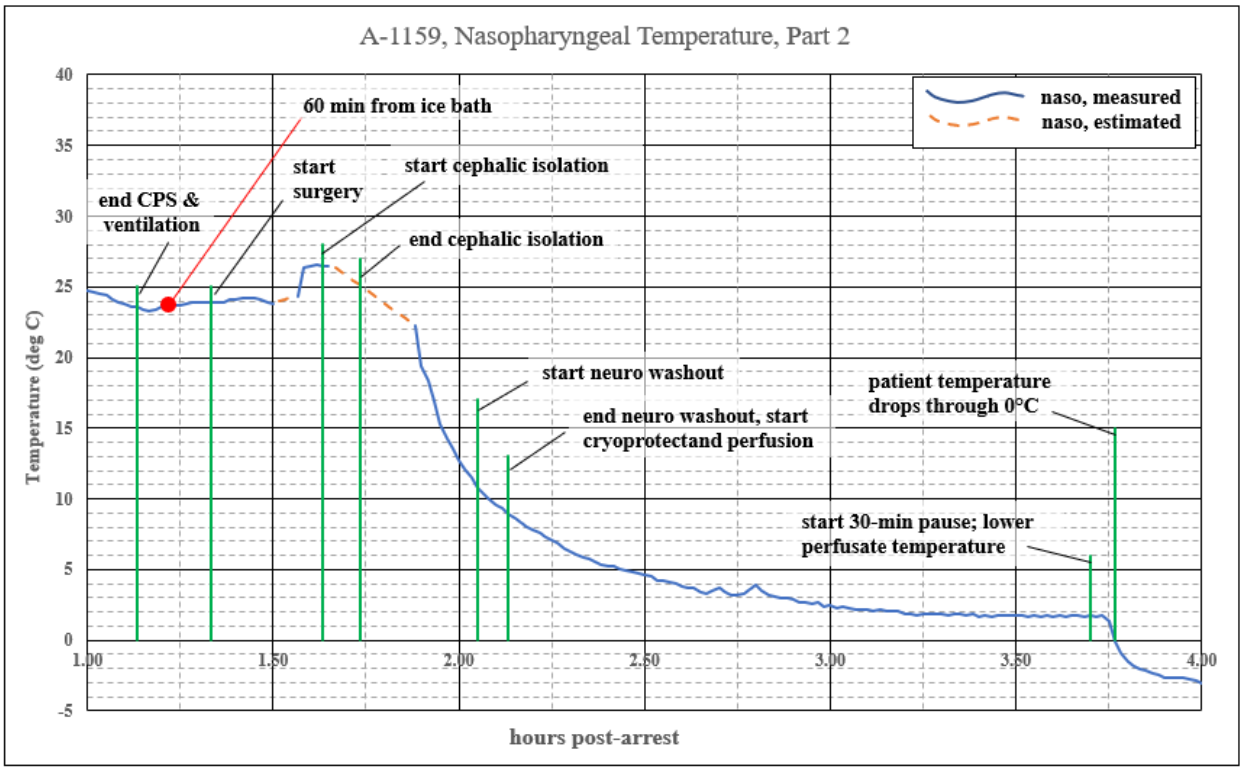
13. S-MIX

The Standardized Measure of Ischemic Exposure (S-MIX) expresses the total ischemic exposure prior to the start of cryogenic cooling as the equivalent duration of normothermic ischemia. An S-MIX of 00:00 (hh:mm) is the ideal case of no ischemic damage. The higher the S-MIX time, the more damage. Factors that improve the S-MIX, and that are quantitatively accounted for in the table below are: shorter times at higher temperatures, ventilation during cardiopulmonary support (CPS), and oxygenation during blood washout. The duration from cardiac arrest to 0°C is 03:46. As shown below, and due to lowering of the body temperature, S-MIX duration is shorter, at 01:11.

event	segment #	days (T+X)	time (MST) duration	post-arrest	Tnaso (deg C)	CPS w/ ventil.	washout oxygen.	S-MIX (hh:mm)
Estimated time of cardiac arrest		T-0	09:38	00:00	37.0			
	seg 1		00:13	00:13	-0.5	no	no	00:13
Start of ice bath cooling		T-0	09:51	00:13	36.5			
	seg 2		00:07	00:07	-2.3	no	no	00:06
Start of mechanical chest compressions		T-0	09:58	00:20	34.2			
	seg 3		00:15	00:15	-4.8	no	no	00:11
Arrival of patient in OR at Alcor (RNPT 29°C)		T-0	10:13	00:35	29.4			
	seg 4		00:10	00:10	-2.2	no	no	00:05
Placement of ventilator		T-0	10:23	00:45	27.2			
	seg 5		00:23	00:23	-3.6	yes	no	00:05
Termination of CPS and ventilation		T-0	10:46	01:08	23.6			
	seg 6		00:12	00:12	0.3	no	no	00:05
Start of surgery		T-0	10:58	01:20	23.9			
	seg 7		00:18	00:18	2.6	no	no	00:08
Start cephalic isolation		T-0	11:16	01:38	26.5			
	seg 8		00:06	00:06	-1.4	no	no	00:03
Finish cephalic isolation		T-0	11:22	01:44	25.1			
	seg 9		00:19	00:19	-14.3	no	no	00:06
Start of neuro washout		T-0	11:41	02:03	10.8			
	seg 10		00:05	00:05	-1.9	no	no	00:01
End neuro washout. Start cryoprotectant		T-0	11:46	02:08	8.9			
	seg 11		01:34	01:34	-7.1	no	no	00:09
Start 30-min pause; lower perfusate to -3°C		T-0	13:20	03:42	1.8			
	seg 12		00:04	00:04	-1.9	no	no	00:00
Patient temperature thru 0°C		T-0	13:24	03:46	-0.1			
totals:			03:46	03:46	-37.1			01:11

The below plots show events related to the S-MIX calculation. The red dots can be used to construct a metric for how fast the patient is initially cooled (see the Patient Cooling Rate table below). This is a critical period since body temperature is highest and ischemic damage most rapid.

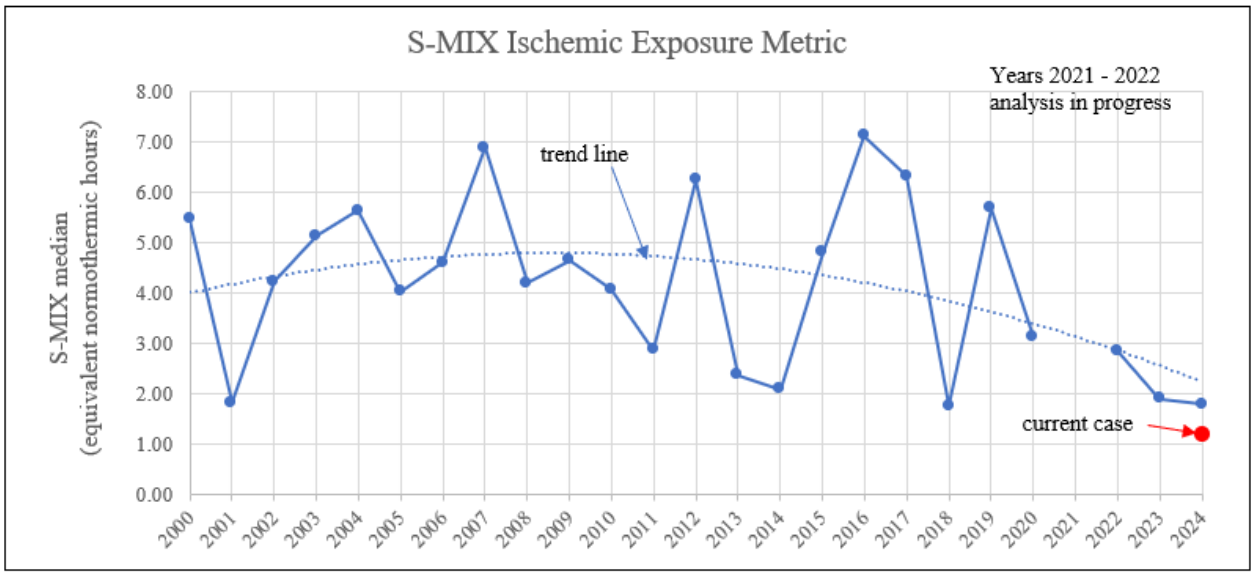




The below table provides cooling data for 10, 30, and 60 minutes after the team first applies water ice.

Patient Cooling Rate			(patient weight 200 kg; 90.7 lb)	
Note: time = 0 at start of ice bath	0 min elapsed	10 min elapsed	30 min elapsed	60 min elapsed
Naso temperature (°C)	36.5	33.2	27.4	23.7
Temperature drop (°C) from t = 0	0.0	-3.3	-9.1	-12.8
Cooling rate (°C/min) from t = 0	N/A	-0.33	-0.30	-0.21

The following plot shows the trend of S-MIX achieved since 2000.



14. CT Scans

Cryoprotectant Distribution (Post-cryopreservation CT scan)

When the in-house scanner is functional and patients are being scanned, additional information will be added to this report.