Alcor A-1302

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

A-1302 was a 92-year-old member with whole-body cryopreservation arrangements. The death certificate gave the cause of death as pneumonia, as a consequence of congestive heart failure, subsequent to cardiomegaly, subsequent to pulmonary interstitial fibrosis. Cardiac arrest took place at 03:59 hrs on T-0 days and the member was pronounced legally deceased in Nevada at 04:31 hrs on T-0 days in October of 2023.

After stabilization, the patient was driven to Alcor for cryoprotectant perfusion and cryogenic cooldown. The patient arrived at Alcor on T-0 days at 08:06 hrs. The cryogenic cooldown was initiated on T-0 days at14:28 hrs and terminated on T+6 days at 11:35 hrs. The patient was transferred to long-term care at liquid nitrogen temperature on T+11 days at 13:38 hrs.

2. Member Assessment

T-6 days

This case was a long-term whole-body member and a long-term member on the Alcor Watchlist. Alcor was notified of a hospital emergency room visit due to the member coughing up blood, or hemoptysis. Alcor was notified that the member was in a hospital in Arizona. Alcor's MRD spoke to the member's attending nurse at 16:40 hrs and received the following assessment:

Diagnosis: Inflammatory pneumonia (PNA), assumed aspiration

Pulmonary: Hemoglobin (HGB) dropped from 13 to 7.9. The member was started on inhaled Tranexamic acid (TXA) an antifibrinolytic, to stop the bleeding. A bronchoscopy was performed that morning and showed extremely friable lung tissue, which would bleed if even slightly touched, so the doctor ended the procedure and informed the family that further aggressive care would cause more harm than good.

Neurologic status (neuro): Altered mentation since the bronchoscopy – the member was given conscious sedation. Follows commands but cannot hold appropriate conversation or ask appropriate questions.

Cardiac: The member had a history of a transcatheter aortic valve replacement (TAVR). The medical team had concerns of severe aortic stenosis (a serious heart condition that occurs when the aortic valve narrows, thickens, and stiffens, preventing blood from flowing normally). The member had a history of a chronic thrombus in the left atrium. The blood pressure was stable; however, the member required a blood transfusion of platelets due to thrombocytopenia (platelet below 50). The lab values were as follows: Potassium 3.5 (hypokalemic/low - treated with 40mEq of potassium), Sodium 144 (normal), Chloride 111 (normal), Bicarbonate 23 (normal), Creatinine 1.2 (normal), Blood urea nitrogen (BUN) 24 (normal), Calcium 9 (normal), Phosphorus 3.6 (normal), Magnesium 1.8 (hypomagnesemia – low, treated with magnesium replacement infusion).

Gastrointestinal/Genitourinary (GI/GU): A bedside swallow evaluation was completed to determine the member's ability to eat and drink normally. Per the evaluation, the member was recommended to only have medications crushed in pureed foods due to inability to swallow. Further, any liquids were required to be thickened for ease of swallowing, as the member had risk of aspiration when swallowing thin liquids. A further study was ordered (Barium swallow evaluation, where the mechanics of swallowing are imaged using x-ray technology for further study) for the following day. Due to the member's inability to eat and drink normally, and urine output being 30mL/hour, the doctor ordered Lactated Ringers (LR) for IV fluid hydration at 75mL/hour.

The nurse provided vital signs at 21:27 hrs: Blood pressure (BP) 127/67, mean arterial pressure (MAP) 86, SPO2 100% on 2 L/min via nasal cannula. Sinus heart rate (HR) 40-60's (some episodes of A-fib with bradycardia in the 30's, no effect on BP or SPO2). The member was still having episodes of coughing, scant blood in the sputum so taken off inhaled TXA. Coarse crackles throughout. No redraw on hgb. No other changes, no other events.

The member's status was "limited code," meaning that in case of cardiac arrest, there would be no defibrillation, but there would be intubation, compressions, and Advanced Cardiovascular Life Support (ACLS) medications.

At 21:47 hrs, the hospital supervisor gave permission for Alcor personnel to enter the intensive care unit (ICU) that night. As long as Alcor did not impede any hospital care, visitation and observation of the patient would not be restricted. A meeting with hospital risk management was to be set up for the next day. The supervisor was given a name and phone number in case of any emergency.

3. Deployment

Alcor's Deployment Committee immediately called a Level-1 deployment. Both Alcor's Deployment and Recovery Team (DART) and the contractor, Suspended Animation (SA) were deployed to standby on location for th10000000000000000000000000000000is member. SA deployed to Nevada immediately, arriving on location at 02:01 hrs.

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

Upon arrival, SA obtained update vital signs: BP 125/85, MAP 98, HR 55-65, SpO2 93% on 2L of oxygen by nasal cannula, The member was alert and oriented (A&O) 1-2. Lung auscultation produced the same sounds as the day prior. On lactated ringers and antibiotics, the attending nurse and supervisor felt the member was stable enough to potentially get on a basic life support (BLS) transport if there were no changes by the next morning.

The stabilization equipment was set up in the mobile operating vehicle (MOV) outside of the hospital until permission could be obtained to bring the equipment inside the hospital.

T-5 days

At 09:00 hrs the vital signs were: BP 142/80, HR 64, RR 26, SpO2 100% on 2L nasal cannula. SA personnel introduced themselves to the member and had an alert and oriented x4 conversation.

A private meeting with the ICU doctor and hospital risk assessor was scheduled for after morning rounds. According to the day nurse, the member was doing far better than the day before. The meeting with the risk assessor concluded that they would help in any way they could. They stated that if the member remained alert and oriented, the member could leave the hospital or sign a transfer to another facility.

The ICU doctor recommended that the member be discharged to in-home hospice care. One of the member's family, who was the Medical Power of Attorney (MPOA), was travelling to be at the member's location that evening to make the decision regarding discharge.

At 11:22 hrs, the vitals were: BP 123/72, HR 60, RR 28, SpO2 100 on 3L nasal cannula. The member was still having dysphasia requiring a modified diet. Urine output for the last 24-hour period yesterday was 675 cc. Today, since 07:00 hrs 300 cc. The member's breathing while sleeping was not labored.

The decision was made at 18:25 hrs to put the member into in-home hospice care, and to be taken home via ambulance. DART and SA were both on site at the hospital that evening.

T-4 days

Alcor's Deployment Committee discussed the need to keep both SA and DART on standby. Due to the member's status, the coordination needs of this specific case, and the plan moving forward, SA was dismissed from the standby temporarily, leaving DART in charge of standby. SA would then be called back out when the member was close to cardiac arrest.

At 13:51 hrs, the MRD received an update from the family: the member was stable and enroute to home where hospice personnel were awaiting their arrival. DART members followed the Alcor member and would remain in place. At 14:42 hrs, DART reported that the member had been moved into the home. The hospice nurses were still nearby.

At 18:11 hrs, Alcor's MRD spoke with the hospice nurse, who gave the following report:

Neuro: The member is alert and oriented to self and familiar family and friends, but unable to hold appropriate conversations, making statements like, "I won't be here much longer" and "I'm on my way out." Due to agitation, the member was given morphine twice during the one-hour visit.

Cardio: HR 64, and irregular. No skin mottling was seen, however, the member was very thin/frail and bruising was seen throughout. BP 146/67.

Pulmonary: Hemoptysis present. The patient was coughing frequently. SPO2 97% on 2 L/min via nasal cannula. RR 26, and slightly labored.

GI/GU: The member remained "nothing by mouth (NPO) to comfort" so they will not be feeding unless the member requests it; they may feed according to the modified dysphagia diet recommended by the hospital. The member had a suprapubic catheter that remained in place. Minimal output, 10-15cc/hr., with blood present in the urine.

Medications: 0.5 mL morphine every 30 minutes, as needed. Also has lorazepam, atropine, and Zofran as needed, though doses not relayed to the MRD.

General: The hospice nurse stated, based solely on this one assessment, from which an appropriate judgement is extremely hard to make, that she thinks the member will not live more than a week. The Medical Power of Attorney (MPOA) is bringing the rest of the family in to be with the member during this time. The hospice nurse will visit the member 7 days/week and a home aide will be there 5 days/ week. The member's 24/7 caregiver service will also continue. The member will be monitored around the clock.

The DART members remained in place. They would be meeting with the member's security team the following day to review stabilization procedures and do a dry run of procedures to ensure that all personnel were prepared.

The primary care physician (PCP) was called this day to confirm that he would be the physician to pronounce legal death. The hospice nurse stated that when the member goes into cardiac arrest, a full code would be called.

T-3 days

At 10:46 hrs the hospice nurse provided the following update (if not noted, there was no change from the previous assessment):

BP 124/72, SPO2 98% on 2.5 L/min via nasal cannula, RR 26 non labored – winded when talking – HR 72. The member had tried to eat but was aspirating each time. Thickening the liquids and food helped diminish the aspirations. The member had a "wet cough" and was alert and oriented more this morning. The lungs were clear, with diminished sounds in the bases.

The abdomen was active in all 4 quadrants. There was shadowing to each elbow. The posterior heels were red. Suprapubic – clear yellow urine. There was delayed capillary refill with cyanotic nail beds. Almost transitioning (an RN terminology for the transition to actively dying) but able

to communicate and make needs known. Morphine for pain management and lorazepam for anxiety (the medication schedule is 0.5 mL every hour) were given during the visit.

T-2 days

At 08:47 hrs the vitals were: BP 111/72, Pulse 85, Temperature (T) 37°C, SP02 95% on 3 liters of oxygen, RR 40. At 143:5 hrs the vitals were: BP 118/67, Pulse 75, T 37°C, SPO2 92%, RR 32 and very shallow.

The family reported at 15:11 hrs that the member was arousable, but not attentive and not conversant. The member recognized familiar voices but did not look around or recognize faces. The member answered only “yes” when asked if comfortable and answered only “no” when asked if in pain. The pulse and blood pressure remain stable.

The member’s head of security was concerned with the member’s rapid rate of breathing, which was very shallow and rapid, but did not seem labored or to cause discomfort. SPO2 had continually dropped throughout the day. Oxygen demand started at 2 L per minute in the morning and was now at 3 L per minute. There were no other changes to note.

At 16:17 hrs, the hospice nurse visited and gave an update, which aligned with what the head of security stated previously:

Neuro: The member was lethargic, unable to track, gazing off into the distance. Answers only yes or no to questions.

Cardiac: The heart rate remained at 82, the blood pressure was stable at 123/76.

Pulmonary: SPO2 was 97% on 3 L per minute with rapid, shallow, labored breathing. The lung sounds were clear in the upper quadrant, diminished in the lower quadrant, and absent in the posterior.

GI/GU: Bowel sounds absent. Urine output was 500 cc total for the day. The nurse advised that no more food be offered, as she found the member had pocketed all previously offered food. Permission given to swab mouth for comfort. The member was requesting a lot of fluid intake and drinking significantly yesterday but aspirating every drink.

The MRD reviewed with the DART team the plan for patient recovery, stabilization, and blood substitution. The DART team would assume custody of the patient and perform stabilization procedures in Alcor’s mobile surgical vehicle (MSV). The patient would then be moved to the location where SA would perform the whole-body blood substitution procedure in their mobile operating vehicle (MOV). An efficient hand-off from DART to SA was studied.

T-1 days

At 01:15 hrs, the vital signs were: BP 108/64, HR 94, T 37°C, SPO2 84% on 4 L/min nasal cannula, RR 36 and labored.

The Alcor Deployment Committee made the decision to return SA to Nevada to prepare for an imminent death. SA booked flights and their team would arrive the following morning at 09:30 hrs.

At 13:15 hours, the hospice nurse gave the following updated report, if not noted, there was no change:

Neuro: The member was less responsive, only saying ouch when moved. The member was not tracking persons in the room or responding to questions.

Cardiac: No changes. There was clear mottling on the heels/feet and elbows.

Pulmonary: The lung sounds were diminished. BP 99/59, SPO2 98% on 4L/min, HR 78, RR 10-12.

GI/GU: The urine was clear yellow, urinary output was 300 cc.

The hospice nurse stated her opinion that the member would likely only last 24-48 hours.

At 14:34 hrs, SA reported that the flights of their surgeon and perfusionists had been delayed by the airline, causing the team's new arrival time to be 21:30 hrs the following day. A different perfusionist was called out and their expected arrival time was 11:00 hrs the following day.

At 16:43 hrs the vitals were: BP 94/56, HR 77, SPO2 100%, and RR 28.

At 21:22 hrs the vitals were: BP 88/52, HR 76, SPO2 97%, and RR 22.

T-0 days

At 03:54 hrs the hospice nurse called Alcor's MRD. The member was having excess secretions from the mouth and was given atropine to reduce the saliva. The member was now completely unresponsive, with SPO2 saturation in the 80s. The BP remained the same and oxygen was still needed, but the member was just unable to clear the airway due to unresponsiveness.

At 04:11 hrs the MRD received a report from the family that the member had gone into cardiac arrest at 03:59 hrs as witnessed by the hospice nurse, and manual chest compression was started. The member's private security team started manual chest compressions immediately and continued until stabilization procedures could be initiated. The member was transported to the location where initial stabilization procedures were planned to take place. Upon arrival, the team waited an additional 10 minutes for the pronouncing physician to arrive. The patient was pronounced legally deceased at 04:31 hrs by the primary care physician.

The plan was for the DART team to perform stabilization procedures and then transport the patient immediately to Alcor, without waiting for the SA team to arrive.

5. Patient Recovery and Stabilization

The DART team placed the patient into the portable ice bath (PIB) at 04:33 hrs. Approximately 200 lbs. of water ice was added to the PIB to initiate external cooling. An Easy Io intraosseous device was placed in the patient's left tibia at 04:33 hrs for vascular access to be used to administer the stabilization medications. The first stabilization medication was administered at 04:34 hrs (see the below Table of Medications Administered for the names of the medications, the times of administration, and the dosages).

The ROS-Q mechanical chest compression device was placed on the patient at 04:35 hrs to improve circulation of the medications and to improve external cooling. A King airway was placed at 04:37 hrs to allow antacid to be administered to protect the stomach. A SAVe ventilator was attached to the airway at 04:38 hrs to restore ventilation to the patient. The surface conduction cooling device (SCCD) with face mask, which circulates ice water around the patient, was placed into the PIB and started at 04:45 hrs.

Thermocouples were placed in the patient's nares at 04:41 hrs to measure the patient's nasopharyngeal temperatures (NPT). Swimmers wax was then placed in the nares, around the thermocouples, to prevent water from entering the nares and compromising the temperature readings.

The first stabilization medication was administered at 04:34 hrs (see the below Table of Medications Administered for the names of the medications, the times of administration and the dosages). The last medication was administered at 04:43 hrs, completing the stabilization procedures.

6. Patient Transport to Alcor

Because SA could not be available to do a field washout, the earlier plan needed to be changed. After stabilization, the Medical Response Vehicle (MRV) departed Nevada at 04:50 hrs to drive the patient directly to Alcor, with an estimated trip duration of 3 hours and 25 minutes. Cardiopulmonary support continued until arrival at Alcor. No problems were experienced during transport of the patient to Alcor.

7. Cryoprotectant Surgery at Alcor

The MRV arrived at the back door to Alcor at 08:04 hrs. The patient was brought into the operating room (OR) at 08:06 hrs. Insulation and packaging around the patient was removed. The initial patient temperatures from the data logger at 08:07 hrs were right NPT = 53°C, left NPT = 65°C (see the Discussion section).

At 08:09 hrs excess crushed ice was removed from around the patient, still in the Zeigler case, to prepare for moving the patient to OR table. Mechanical chest compressions were terminated at approximately 08:15 hrs. The patient was moved to the OR table and draped for cannulation at 08:21 hrs. Ice remained packed around the patient's head and thorax while the surgeon prepared the surgical back table.

The first incision for the median sternotomy was made at 08:34 hrs. The sternum was separated, and the chest opened at 08:37 hrs. At 08:39 hrs 250,000 IU Streptokinase was added to the first bladder of B1 carrier solution. When the chest was spread open, there was a tear in an artery. The artery was sutured, and the blood suctioned at 08:40 hrs.

A pursestring suture was placed in the aortic arch at 08:46 hrs. A pursestring suture was placed in the right atrium at 08:57 hrs. The right atrium was cannulated with a 32 Fr rigid venous cannula and secured at 09:06 hrs. The aortic arch was cannulated with a 22 Fr rigid arterial cannula and secured at 09:14 hrs.

At 09:18 hrs, when the perfusion pressure was increased to 50 mmHg, about half the pressure needed to open the vessels and perfuse the patient, a tear appeared in the heart tissue and began to leak. The pressure was returned to 10 mmHg and the tear was sutured. When the pressure was raised again slightly, another leak appeared at 09:25 hrs. The friable heart tissue was repaired again, and blood was suctioned again from the chest cavity. Another leak appeared at 09:31 hrs, was repaired, and the chest suctioned. Perfusion pressure was reduced to 5 mmHg.

The cannula in the aortic arch cannula slipped from the vessel at 09:40 hrs. The cannula was repositioned and the pursestring was secured at 09:54 hrs.

At 10:01 hrs the arterial pressure was increased to 10 mmHg. The blood pool in the chest cavity was increasing again. The arterial pressure was again reduced to 5 mmHg and the chest suctioned while the surgeon looked for another tear to repair.

The cannula slipped from the aortic arch again at 10:07 hrs. It was repositioned again within seconds. If the pursestring was applied too tightly, the friable tissues of the heart would tear. When the arterial pressure was increased sufficiently to open and perfuse a vessel, the friable tissues of the heart would tear and leak. At 10:10 hrs it was apparent that a flow rate sufficient to perfuse the patient would not be possible.

The perfusate that was slowly moving through the patient was noted at 10:19 hrs to be a light pink color, indicating that a large amount of the red blood cells had been removed because the system was still open-circuit, resulting in an open-circuit washout, continuing at a flow rate of 2 L/min. At 10:31 hrs the system was switched to recirculation, but there was no return flow. The gravity-feed field cryoprotection (FCP) system was set up as a back-up option while the surgical team continued to work to use the OR recirculation system.

At 10:34 hrs, return flow was still not seen. At 10:35 hrs the chest cavity was again suctioned, and the system was switched back to open-circuit perfusion. The decision was made at 10:53 hrs that perfusion of this whole-body patient was not possible and to change the cryoprotectant perfusion procedure to neuro-on-whole-body using the FCP teeter-totter system. The height of the perfusate bladders above patient was 39 inches, providing a maximum arterial perfusion rate of 80 mmHg to the brain.

The patient's scalp was cut to drill a single burr hole at 10:59 hrs. Using a Codman perforator, the burr hole was drilled and cleaned at 11:02 hrs. A thermocouple was inserted in the burr hole to measure the temperature of the brain at 11:03 hrs and sutured to scalp.

At 11:08 hrs, two surgeons, one on each side of the patient, isolated the carotid arteries. Tanning of the chest and face was already visible at 11:22 hrs. The right carotid artery was cannulated at 11:27 hrs with a 20 Fr right angle cannula and secured. The left carotid artery was cannulated at 11:28 hrs with a 16 Fr right angle and secured.

8. Cryoprotectant Perfusion at Alcor

The gravity-induced perfusion flow was initiated at 11:30 hrs with Bladder #3 containing nM22 cryoprotectant with a molarity of 1.29 and a concentration of 0.14 CNV (concentration needed to vitrify) (see the Table of Concentrations (Brix) of nM22 Solution, for the times the bladders were started, the precalculated concentrations of each bladder, and the refractive index of effluent samples taken). Perfusion to be terminated in three hours to minimize toxicity to the cells.

The left jugular vein was raised and cut at 11:33 hrs to allow effluent to drain to the table. The right jugular vein was raised and cut at 11:34 hrs to allow effluent to drain to the table. Given that this was not an isolated cephalic cannulation, the vertebral arteries could not be accessed to determine if the Circle of Willis was intact.

By hanging two bladders with different cryoprotectant concentrations on a teeter-totter atop an elevated tripod, a smoother transition of increasing concentrations of cryoprotectant can be achieved. The gravity feed system for FCP uses a tripod that can be adjusted for height to control the arterial pressure. The pre-mixed cryoprotectant was in a series of bladders with graduated concentrations [measured by the refractive index (RI) in Brix units]. The height of the bladders on the teeter totter was 39 inches which is (39” x 2.054 mmHg per inch of height = a maximum arterial pressure of 80 mmHg at the infusion site. The goal is to have the pressure between 70 and 80 mmHg and the bladders can be raised or lowered as needed to optimize flow and protection of the vasculature.

Sidebar:
Per the cryoprotection protocol, the ramp is to be paused at 30 Brix (50% of the desired terminal concentration) to allow the patient to come to osmotic equilibrium. When the bladder system is used, bladders 5 & 6 represent the pause. 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 (52.5 Brix) and held between 102% and 105% concentration until the terminal concentration is obtained.

Bladder #6 was started at 11:30 hrs and ethylene glycol antifreeze was added to the water in the heat exchanger at 11:50 hrs to bring the perfusate below 0°C.

At 13:48 hrs the refractive index (RI) reading from the left jugular effluent was 50.7 Brix. At 13:56 hrs the RI reading from the left jugular effluent was 49.9 Brix. At 14:02 hrs both pupils had collapsed, and the skin was uniformly tanned. These are both common indications of uptake of the cryoprotectant within the cells of the patient.

Cryoprotectant perfusion was terminated at 14:03 hrs because, per protocol, the refractive index of the effluent samples from both jugular veins was over 50.0 Brix, for over 30 minutes. The

molarity of the perfusate was 9.91. Lines and equipment were removed from the patient, and the cannulation sites were closed. The patient was moved into the Patient Care Bay at 14:22 hrs. Computer controlled cryogenic cooldown was initiated 14:28 hrs.

9. Cooling to Liquid Nitrogen Temperature

The patient arrived at Alcor at 08:06 hrs. The initial patient temperatures from the data logger were right NPT 53°C, left NPT 65°C.

Computer-controlled cryogenic cooldown was initiated at 14:28 hrs on T-0 days, plunging to -110°C and descending thereafter at -1°C/hour to liquid nitrogen temperature. On T+6 days at 11:35 hrs, the cooldown was terminated.

The cooldown was mostly uneventful. The primary LN2 valve of the TallBoy dewar lid developed a leak which was not discovered until several hours after the transfer. The valve set was replaced once the fault was discovered. Due to the use of a backup LN2 valve, the cooldown was not significantly impacted by this issue.

On T+11 days at 13:38 hrs, the patient was transferred to long-term care at liquid nitrogen temperature.

10. Timeline and Time Summaries

Timeline

T-0	03:59	Time of cardiac arrest
T-0	03:59	Start of manual chest compressions
T-0	04:31	Time of pronouncement of legal death
T-0	04:33	Start of ice bath cooling
T-0	04:34	Administration of first medication (propofol)
T-0	04:35	Start of mechanical chest compressions
T-0	04:37	Placed airway and started ventilation
T-0	04:43	Administration of last medication
T-0	04:50	Start transport of patient to Alcor
T-0	08:06	Arrival of patient in the Alcor OR
T-0	08:15	Termination of cardiopulmonary support
T-0	08:34	Start of median sternotomy surgery
T-0	11:03	Drilled burr holes and placed thermocouple
T-0	11:08	Start of cannulation of carotid arteries
T-0	11:28	End of surgery
T-0	11:30	Start of cryoprotectant perfusion (FCP)
T-0	14:03	Termination of FCP cryoprotectant perfusion (50.0 Brix)
T-0	14:28	Start of cryogenic cooldown
T+6	11:35	End of cryogenic cooldown
T+11	13:38	Transfer patient into long-term care at LN2

Time Summaries

Event Duration hr:min		days	time	
00:32	From: Till:	T-0 T-0	03:59 04:31	Time of cardiac arrest Time of pronouncement of legal death
00:34	From: Till:	T-0 T-0	03:59 04:33	Time of cardiac arrest Start of ice bath cooling
00:00	From: Till:	T-0 T-0	03:59 03:59	Time of cardiac arrest Start of manual chest compressions
00:35	From: Till:	T-0 T-0	03:59 04:34	Time of cardiac arrest Administration of first medication (propofol)
00:09	From: Till:	T-0 T-0	04:34 04:43	Administration of first medication (propofol) Administration of last medication
04:07	From: Till:	T-0 T-0	03:59 08:06	Time of cardiac arrest Arrival of patient in the Alcor OR
00:28	From: Till:	T-0 T-0	08:06 08:34	Arrival of patient in the Alcor OR Start of median sternotomy surgery
02:54	From: Till:	T-0 T-0	08:34 11:28	Start of median sternotomy surgery End of surgery
07:31	From: Till:	T-0 T-0	03:59 11:30	Time of cardiac arrest Start of cryoprotectant perfusion (FCP)
03:24	From: Till:	T-0 T-0	08:06 11:30	Arrival of patient in the Alcor OR Start of cryoprotectant perfusion (FCP)
02:56	From: Till:	T-0 T-0	08:34 11:30	Start of median sternotomy surgery Start of cryoprotectant perfusion (FCP)
02:56	From: Till:	T-0 T-0	08:34 11:30	Start of median sternotomy surgery Start of cryoprotectant perfusion (FCP)
02:33	From: Till:	T-0 T-0	11:30 14:03	Start of cryoprotectant perfusion (FCP) Termination of FCP perfusion (50.0 Brix)
00:25	From: Till:	T-0 T-0	14:03 14:28	Termination of FCP perfusion (50.0 Brix) Start of cryogenic cooldown
10:29	From: Till:	T-0 T-0	03:59 14:28	Time of cardiac arrest Start of cryogenic cooldown
06:22	From: Till:	T-0 T-0	08:06 14:28	Arrival of patient in the Alcor OR Start of cryogenic cooldown

11. Table of Medications Administered

T-0 days

TIME	MEDICATION	DOSE	PURPOSE
04:34 hrs	Propofol	200 mg	Anesthetic; reduces cerebral metabolic demand; reduces the theoretic possibility of increased awareness during aggressive CPS.
04:35 hrs	Sodium citrate	20 g Note 1	Anticoagulant; prevents blood clot formation.
04:36 hrs	Heparin	50,000 IU	Anticoagulant; prevents blood clot formation.
04:37 hrs	Vasopressin (1st dose)	40 IU Note 2	Vasopressor; increases blood pressure during CPS.
04:38 hrs	Minocycline	200 mg	Antibiotic and neuroprotectant
04:84 hrs	SMT (S-methyl-isothiourea)	400 mg Note 3	Neuroprotectant (iNOS inhibitor); protects the brain from ischemic injury; raises blood pressure.
04:40 hrs	Decaglycerol/THAM	200 ml Note 4	Decaglycerol inhibits cerebral edema.
04:40 hrs	Antacid	250 ml Note 5	A buffer used to neutralize stomach acid.
04:41 hrs	Vasopressin (2nd dose)	40 IU Note 2	Vasopressor; increases blood pressure during CPS.
04:41 hrs	Vital Oxy (w/ saline)	45 ml Note 6	Antioxidants: melatonin, vitamin E (D-alpha tocopherol), PBN (alpha Phenyl t-Butyl Nitrone) and anti-inflammatory carprofen.
04:43 hrs	Decaglycerol/THAM	200 ml Note 4	Decaglycerol inhibits cerebral edema.
08:39 hrs	Streptokinase	250,000 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.

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. 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.

4. 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 200 ml.

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

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.

12. Table of Concentrations (Brix) of nM22 Solution

A-1302 step-ramp, nM22

Preferred endpoint is over 49.9 Brix from both jugulars for 1/2hr

2L Bag label number	[nM22], CNV	Molarity of penetrating CPAs*	Brix (calc)	Bag start hh:mm, MST	hrs post pronounc-ement	Bag avg. flow rate, mL/min		Sample time hh:mm, MST	Effluent Conc., Brix
3	0.14	1.29	15.35	11:30	7.32	133.3		11:37	17
4	0.23	2.15	19.03	11:45	7.57	222.2		11:55	30
5	0.50	4.67	29.85	11:54	7.72	66.7		12:10	32.3
6	0.50	4.67	29.85	12:24	8.22	87.0		12:48	32.8
7	1.06	9.91	52.31	12:47	8.60	80.0		13:00	38.1
8	1.06	9.91	52.31	13:12	9.02	57.1		13:14	48.4
9	1.06	9.91	52.31	13:47	9.60	125.0		13:23	49.2
END				14:03	9.87	-3.4		13:29	49.2
								13:35	50.1
								13:48	50.7
								13:56	49.9
								14:01	50

* does not account for concentration of non-penetrating CPAs

13. Discussion

Standy and Stabilization

When the patient arrived at Alcor, the initial patient temperatures from the data logger were right NPT = 53°C, left NPT = 65°C. A difference in temperatures like this on the data logger is usually due to water leaking into the nares, or a probe being placed too far into the nare. The cause in this specific case is not known.

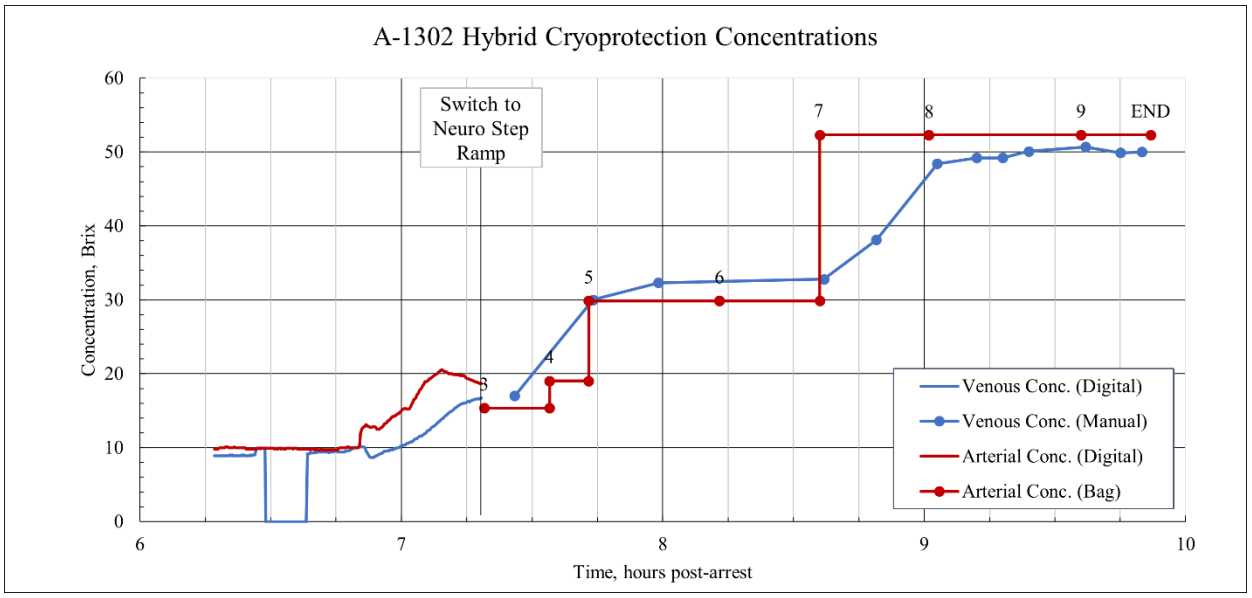
At 14:34 hrs, SA reported that the flights of their surgeon and perfusionists had been delayed by the airline, causing the team's new arrival time to be 21:30 hrs the following day. A different perfusionist was called out and their expected arrival time was 11:00 hrs the following day. This made it necessary to abandon the plan to do a field blood substitution in favor of stabilizing the patient and then immediately driving to Alcor for cryoprotectant perfusion.

Surgery at Alcor

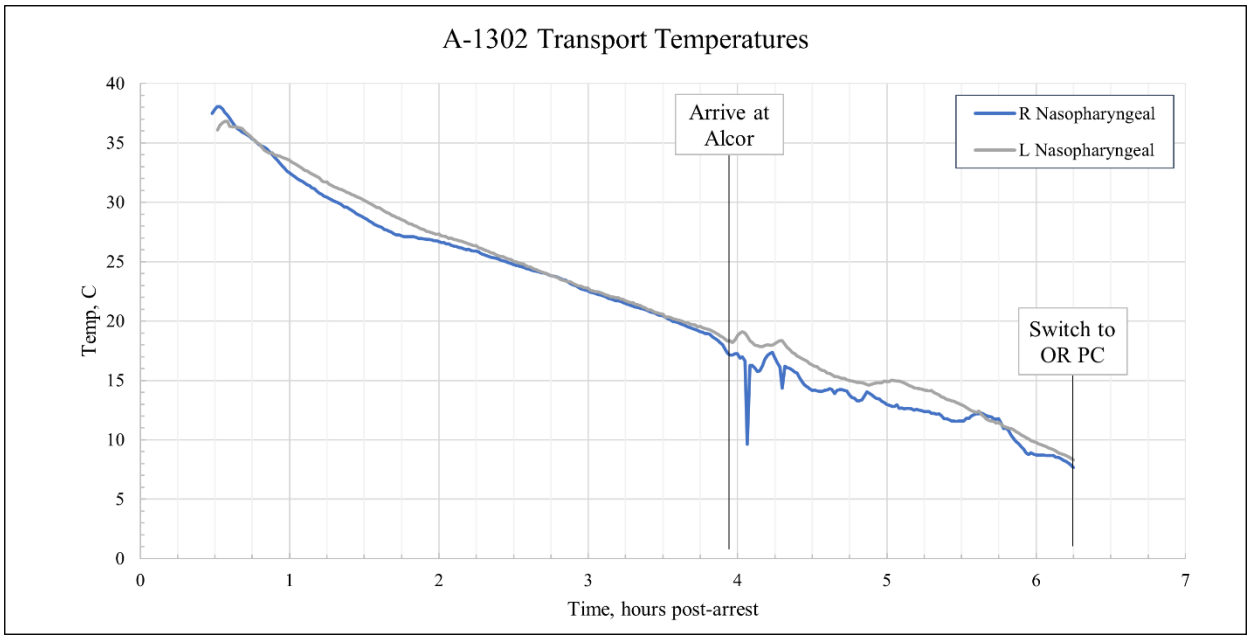
The central cannulation of the patient was met with multiple complications. One of the major issues being poor cardiac tissue (very friable), which caused many tears when higher pressures were attempted. The patient previously had a minimally invasive aortic valve replacement (TAVR). Scar tissue, adhesions, and sutures in the heart were visible from that previous procedure, which added the technical challenges to the current procedure. Three hours of surgery and multiple attempts to resolve the issues resulted in the decision to convert to neuro-on-whole-body procedure using the field neuro step ramp.

This demonstrates the potential challenges to perfusion of an elderly whole-body patient. If this had been attempted in the field, they would not have had the resources to mitigate the problems that were available in the Alcor OR. They also would not have had the neuro-on-whole-body procedure to fall back on.

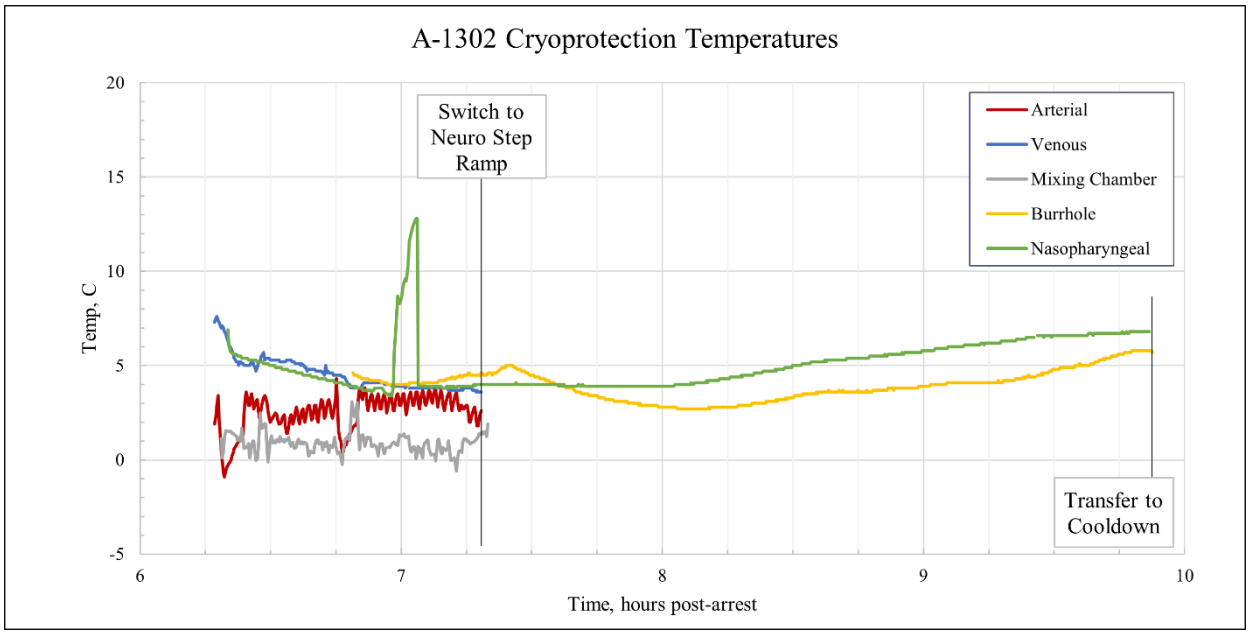
14. Cryoprotection and Temperature Graphs

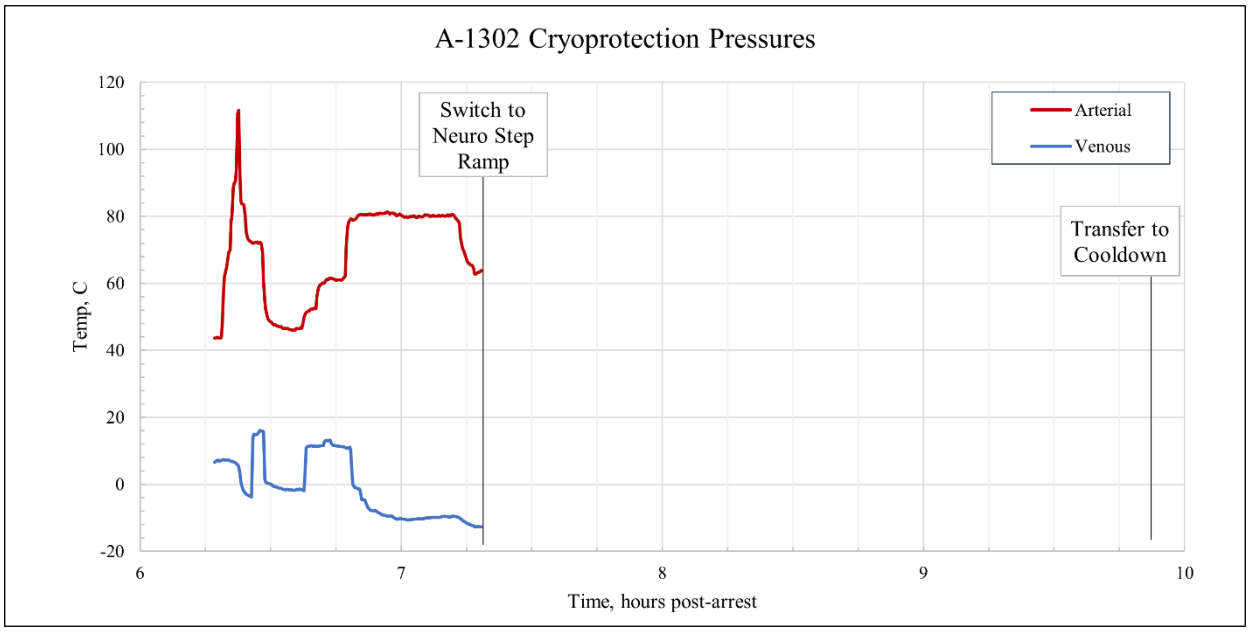


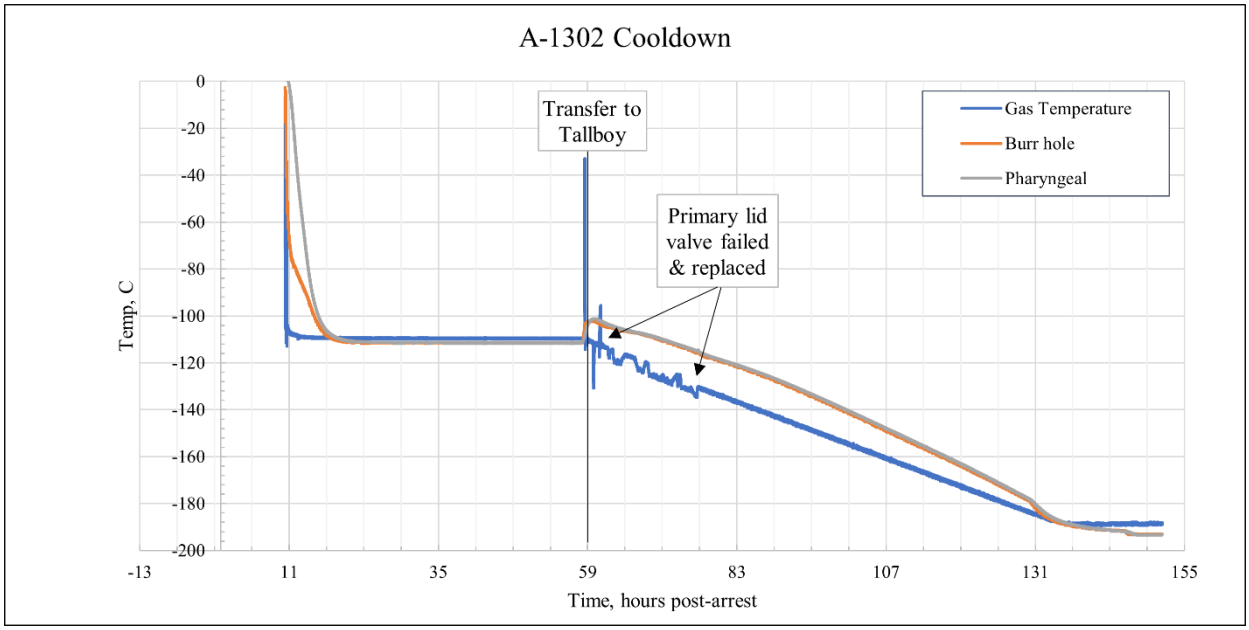
The Hybrid Cryoprotection Concentrations graph represents a combination of the computer-controlled and step-ramp portions of the procedure.

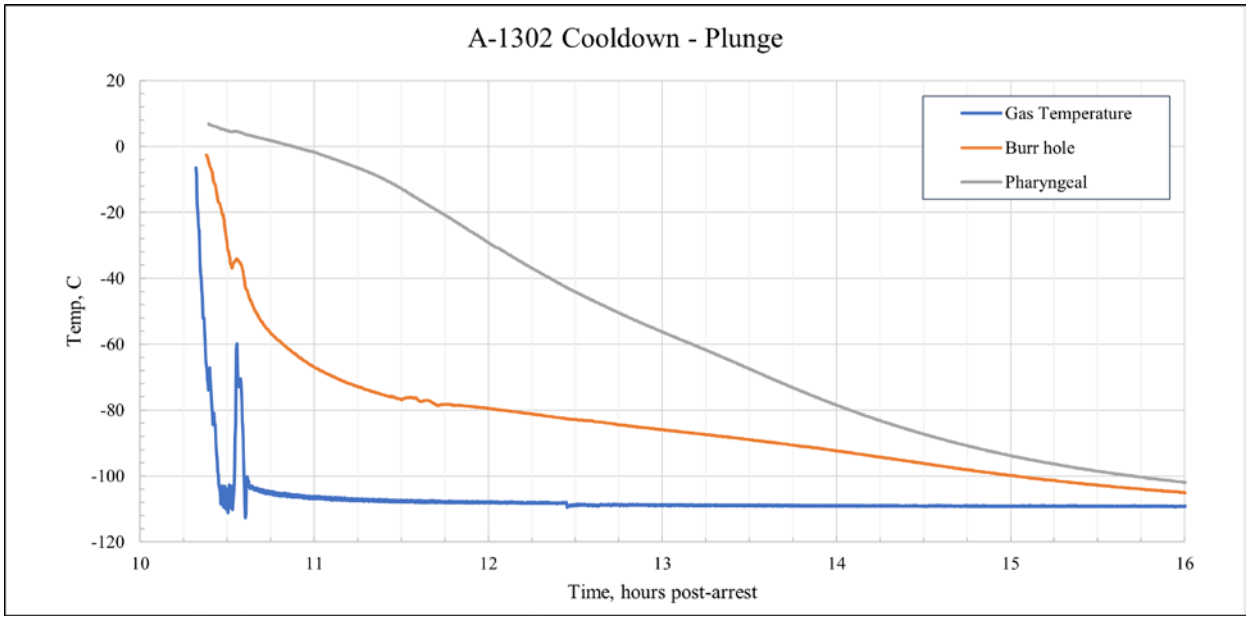


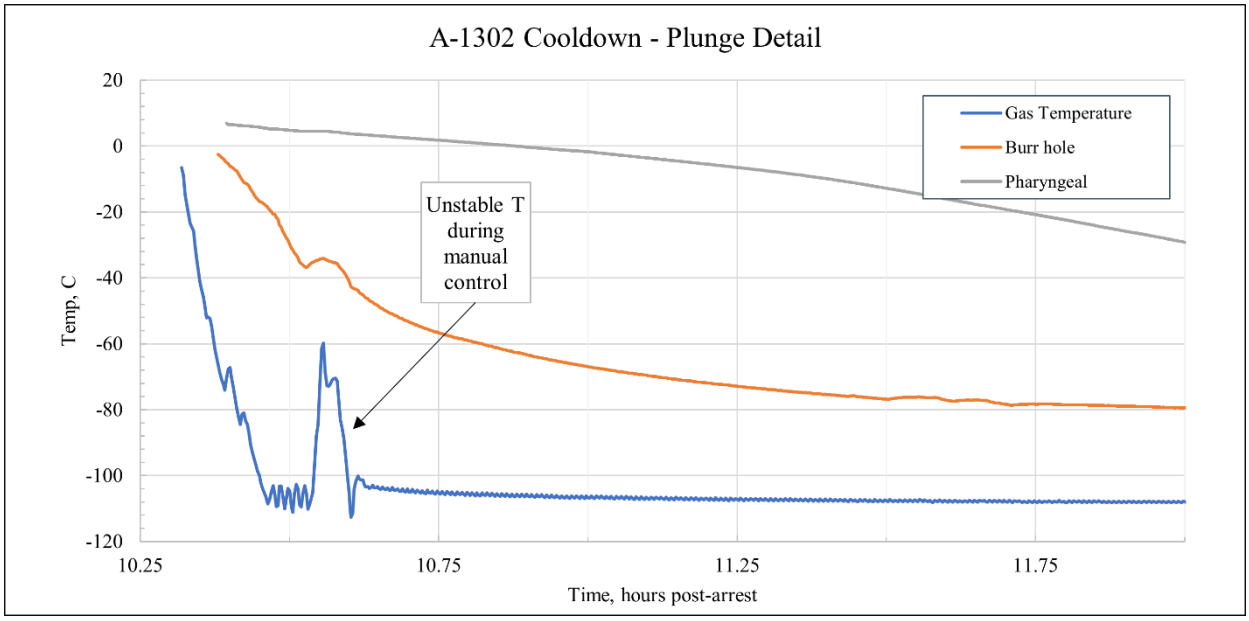
The below Cryoprotection Temperatures and Pressures graphs both have multiple signals which cut off at the point the system was switched from whole body to neuro step-ramp. These channels recorded irrelevant information after the switch.






A-1302 Cooldown
Transfer to Tallboy
Primary lid valve failed & replaced
Gas Temperature
Burr hole
Pharyngeal
Temp, C
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-13
11
35
59
83
107
131
155
Time, hours post-arrest


A-1302 Cooldown - Plunge
Gas Temperature
Burr hole
Pharyngeal
Temp, C
20
0
-20
-40
-60
-80
-100
-120
10
11
12
13
14
15
16
Time, hours post-arrest

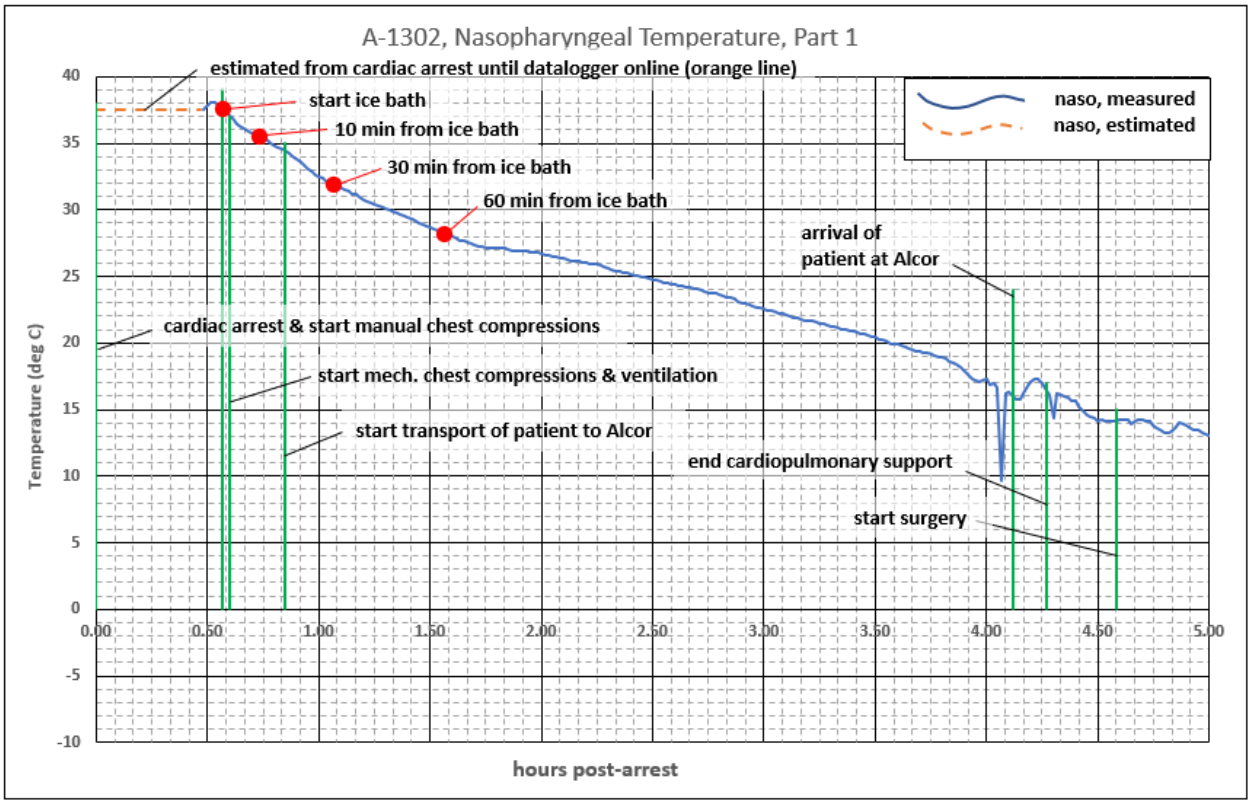

A-1302 Cooldown - Plunge Detail
20
0
-20
-40
-60
-80
-100
-120
Temp, C
10.25
10.75
11.25
11.75
Time, hours post-arrest
Gas Temperature
Burr hole
Pharyngeal
Unstable T during manual control

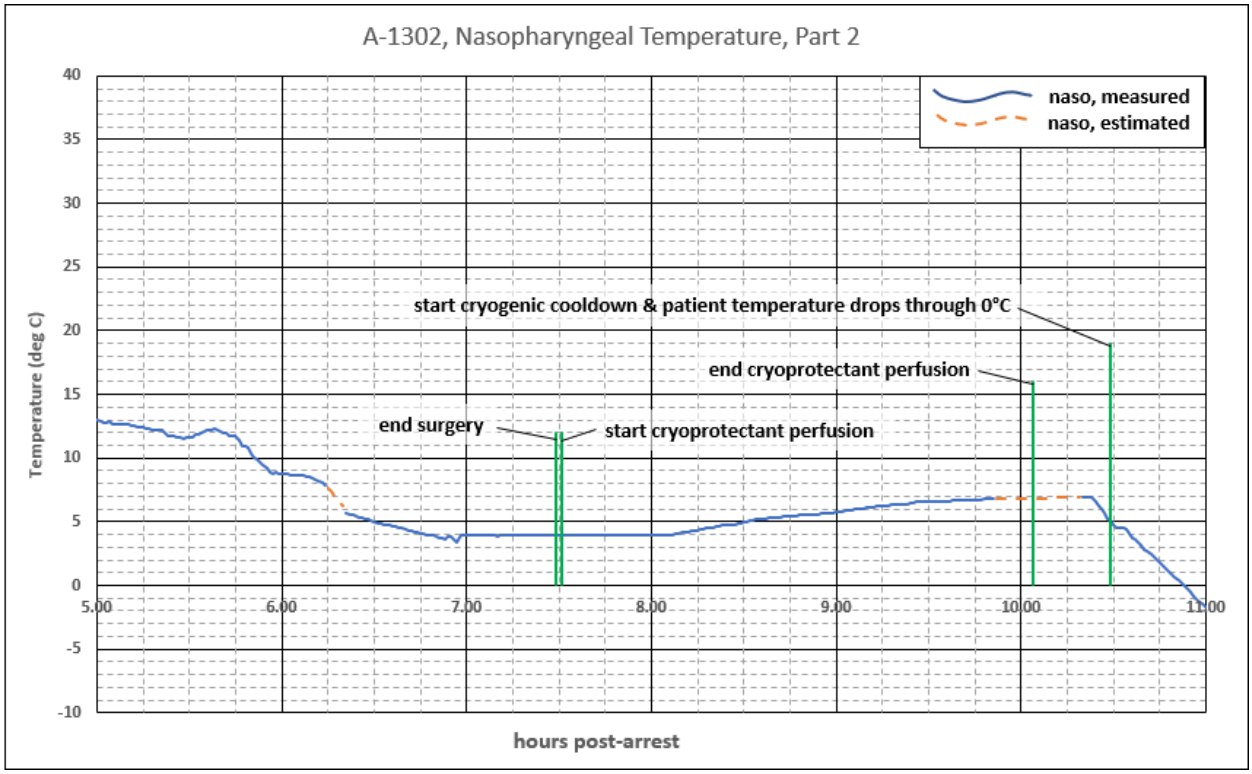
S-MIX

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 below table 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 10:29. As shown below, and due to lowering of the body temperature, S-MIX duration is shorter, at 02:24.

event	segment #	days (T+X)	time (MST) duration	post-arrest	Tnaso (deg C)	CPS w/ ventil.	washout oxygen.	S-MIX (hh:mm)
compressions		T-0	03:59	00:00	37.5			
	seg 1		00:34	00:34	0.1	no	no	00:35
Start of ice bath cooling		T-0	04:33	00:34	37.6			
	seg 2		00:02	00:02	-0.5	no	no	00:02
Start mech. chest compressions & place airway		T-0	04:35	00:36	37.1			
	seg 3		00:15	00:15	-2.6	no	no	00:14
Start transport of patient to Alcor		T-0	04:50	00:51	34.5			
	seg 4		03:16	03:16	-18.4	yes	no	00:44
Arrival of patient in the Alcor OR		T-0	08:06	04:07	16.0			
	seg 5		00:09	00:09	0.4	yes	no	00:01
Termination of cardiopulmonary support		T-0	08:15	04:16	16.5			
	seg 6		00:19	00:19	-2.3	yes	no	00:02
Start of median sternotomy surgery		T-0	08:34	04:35	14.2			
	seg 7		02:54	02:54	-10.2	no	no	00:25
End of surgery		T-0	11:28	07:29	4.0			
	seg 8		00:02	00:02	0.0	no	no	00:00
Start of cryoprotectant perfusion (FCP)		T-0	11:30	07:31	4.0			
	seg 9		02:33	02:33	2.9	no	no	00:17
Termination of FCP cryoprotectant perfusion		T-0	14:03	10:04	6.9			
	seg 10		00:25	00:25	-1.8	no	no	00:03
Start of cryogenic cooldown		T-0	14:28	10:29	5.1			
totals:			10:29	10:29	-32.4			02:24

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.

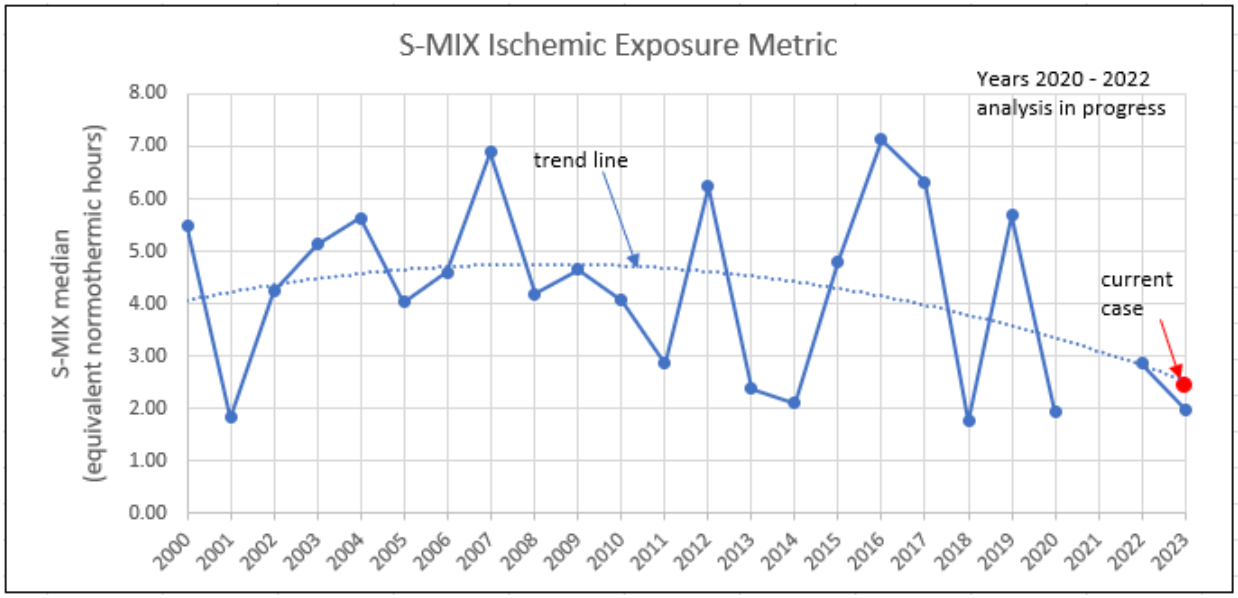




The below table provides cooling data for 10, 30, and 60 minutes after the team first applies water ice.

Patient Cooling Rate			(patient weight 64 kg; 141 lb)	
Note: time = 0 at start of ice bath	0 min elapsed	10 min elapsed	30 min elapsed	60 min elapsed
Naso temperature (°C)	37.6	35.5	31.9	28.2
Temperature drop (°C) from t = 0	0.0	-2.1	-5.7	-9.4
Cooling rate (°C/min) from t = 0	N/A	-0.21	-0.19	-0.16

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



15. CT Scans

Cryoprotectant Distribution (Post-cryopreservation CT scan)

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