Alcor A-2705
Case Report

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Table of Contents

1. Summary

All information was derived from multiple sources and was all converted to Mountain Standard Time (MST). For de-identification, dates are not shown. T-0 represents the date of pronouncement of legal death, T-X represents occurrences before T-0, and T+X represents occurrences following T-0.

A-2705 was a 67-year-old male with neuro cryopreservation arrangements who used the death with dignity laws in his state to legally terminate his life. Per the death certificate the cause of death was cardiac arrest subsequent to liver cancer and a gastrointestinal tumor. Cardiac arrest took place at about 17:15 hrs and the member was pronounced legally deceased in August of 2020 in the state of Washington at 17:17 hrs on T-0 days.

A Field Cryoprotection (FCP) was performed before the patient was transported to Alcor. Dry ice cooldown was initiated in the field at 22:54 hrs on T-0 days. Cryogenic cooldown was initiated at Alcor at 15:05 hrs on T+1 days and terminated at 18:33 hrs on T+5 days. CT scans at LN2 temperature were obtained at 11:00 hrs on T+8 days. The patient was transferred to long-term maintenance at LN2 temperature at 15:38 hrs on T+56 days.

2. Patient Assessment

This report was finalized in 2023 but the case took place in 2020; some details are no longer available.

T-123 days

The member notified Alcor by email of a diagnosis of terminal cancer and that physicians had given the member approximately 6 months to live. The member intended to utilize Washington state's Death with Dignity Act (DWD) to choose the legal date and time of death.

3. Deployment

T-121 days

Alcor's Medical Response Director (MRD) placed the member on the Watch List for monthly follow-up to continue to track the progression of the disease process. Planning the logistics of the case and a potential timeframe for the DWD date was initiated.

T-88 days

The member reported that the most recent MRI scans were not encouraging and that the predicted DWD date would be in mid-September.

T-44 days

Again, the member reported that the most recent MRI scans were disappointing. The oncologists had taken the member off the clinical trial drug formerly taken and had started a different drug. The member planned to terminate the cancer treatments and enroll for in-home hospice care. The projected DWD date was moved forward to the first week of September.

T-32 days

After extensive discussions which included Alcor's MRD, Readiness Coordinator (RC), Scientific Advisor (SA), and both strategic partners (International Cryomedicine Experts (ICE) and Suspended Animation (SA)), it was decided that this member would have a Field Cryoprotection (FCP) following stabilization in the field. As ICE personnel had previous experience with the FCP procedures this was an ICE directed case with SA assisting and being trained in the FCP procedures. Both organizations would be deployed on this case for standby, stabilization and transport (SST).

T-10 days

The member's family secured a private nurse for pronouncement of legal death. She was available 24/7 and there were no limitations on her availability or potential problems. The member's health was deteriorating rapidly; the member and family were ready to finalize the DWD date. Alcor's entire team was put on alert.

4. Standby

T-5 days

After coordinating with the nurse who would pronounce, about her availability, the member and family chose the date when the DWD medications would be taken by the member. The SST team members deployed and over the next four days, set up equipment and made preparations. A funeral home near the member's home had already been contracted to provide the death certificate, transit permit and air transport of the patient back to Alcor**.**

T-0 days

The entire SST team had arrived at the member's home by 09:18 hrs. All equipment and stabilization medications were in place and ready for use. It was agreed in advance that all SST team members would remain outside the member's room while the family assisted the member with taking his DWD medications. It was further agreed that team members would wait to initiate stabilization procedures until the family informed the team that the member had been pronounced legally deceased by the nurse.

The member took the DWD medications at 10:02 hrs. Per the family, the member lost consciousness at 10:34 hrs, and at 11:49 hrs vital signs (respiration, pulse, oxygen) remained stable. The vital signs were still stable at 13:44 hrs. At 15:03 hrs the heart rate had dropped into

the mid-'40s and respirations were labored. At 15:56 hrs the blood pressure was 104/62. The member went into cardiac arrest at approximately 17:15 hrs and was pronounced legally deceased by the nurse at 17:17 hrs.

5. Stabilization

As there were five team members several steps in the stabilization procedure could be accomplished at the same time. At 17:20 hrs the rectal occlusion device was placed as the patient was rolled onto the Megamover and then moved into a body bag on a bed of crushed ice to start external cooling. The King airway was placed, and approximately 60 lbs. of crushed ice was placed over the patient in the body bag.

The SAVe ventilator was started to ventilate the patient and the $ETCO_2$ capnograph device were started at 17:20 hrs to monitor the effectiveness of cardiopulmonary support. The first $ETCO_2$ reading was 26. The first intraosseous (IO) device was placed in the tuberosity of the right lower leg to access the patient's vasculature for the administration of medications and a nasopharyngeal probe was placed in one of the patient's nares (which nare was not noted). At 17:21 hrs the ROSC-U chest compression device was placed on the patient to initiate mechanical chest compressions to optimize cooling and to circulate the stabilization medications when administered.

The nasopharyngeal probe was secured to the patient's face to prevent it from being dislodged and the tubing for the surface conduction cooling device (SCCD) was placed around and over the patient to circulate cooled water to optimize external cooling. Approximately 3 to 4 gallons of water were added to the body bag. At 17:23 hrs the first stabilization medication was administered (see the below Table of Medications Administered for the names of the medications, the times of administration, and the dosages). The cooling mask for the SCCD was placed on the patient's face to further increase the effectiveness of the cooling and the pump was started but there was no flow. Two more gallons of water were added to start the flow, but it was intermittent and there was no room in the body bag for more water.

The ETCO2 reading was 27 at 17:25 hrs and the nasogastric tube was tied off to prevent the backflow of the antacid. A second IO was placed in the tuberosity of the left lower leg at 17:28 hrs to increase the efficiency of the administration of medications. At 17:43 hrs a Zoll impedance threshold device was added to the airway to increase venous return to the heart and therefore increase cardiac output during cardiopulmonary support. At 17:46 hrs the $ETCO_2$ reading was 10 (see Discussion section). At 17:48 hrs all the stabilization medications had been administered.

Air was escaping from the patient's mouth at 17:48 hrs. The ventilator was turned off and approximately 30 cc of air was added to the lumen of the airway. The automated ventilator was turned on at 17:51 hrs.

6. Field Surgery and Washout

The patient was moved into a vehicle to be transported to the funeral home and arrived at the funeral home at 18:18 hrs. The patient was placed on the operating table at 18:22 hrs and cannulation surgery was started at 18:40 hrs. The left carotid artery was isolated at 18:56 hrs. Cardiopulmonary support, ventilation and the face mask were all terminated at 18:57 hrs to facilitate cannulation of the arteries. The nasopharyngeal temperature (NPT) was 22.6°C at 19:03 hrs. By 19:06 hrs bilateral burr holes had been established in the patient's skull.

The right carotid artery was isolated at 19:12 hrs and the cephalic isolation was initiated at 19:15 hrs using a mallet and osteotome. The cephalic isolation was completed at 19:21 hrs. The lines for perfusate bladder #1 were primed at 19:27 hrs. An 18 French (Fr) catheter was used at 19:32 hrs to cannulate the left carotid artery.

Concurrently, open circuit cryoprotectant perfusion using the gravity feed field system (see Discussion section) was initiated through the left carotid artery at 19:32 hrs. An 18 Fr catheter was used at 19:32 hrs to cannulate the right carotid artery.

Open circuit cryoprotectant perfusion was initiated through the right carotid artery at 19:32 hrs. Securing the right cannula had become problematic due to it not advancing far enough into the artery, so the decision was made to cannulate past the bifurcation into the internal carotid artery to improve flow. Perfusion of the right carotid artery was stopped, and a 14 Fr catheter was used to replace the 18 Fr catheter at 19:37 hrs and perfusion was reinitiated. The temperature probe was placed in the burr hole at 19:50 hrs.

The vertebral arteries were draining, which confirmed that the Circle of Willis was intact and there would be reasonable perfusion pressure at the back of the brain. The vertebral arteries were clamped off at 19:54 hrs.

At 19:57 hrs the measured arterial pressure was 70 mmHg. The gravity-induced perfusion flow was initiated at 19:54 hrs with the first bladder containing nM22 cryoprotectant with a concentration of 0.05 CNV). See the below Table of Concentrations (Brix) of nM22 Solution for the precalculated refractive index of the individual bladders, times when the bladders were started, and the refractive index of the effluent samples. Bladder #4 was not infused because it had been damaged during the flight to Washington.

Cryoprotectant perfusion was terminated when bladder #12 was 75 percent expended at 22:51 hrs (see the Discussion section). The final refractive index readings were 50.1 Brix right venous (100% of perfusate concentration needed to vitrify (CNV) and 49.7 Brix left venous (99% of CNV)

7. Patient Transport

T-0 days

The NPT was -5.1°C at 22:54 hrs. The cephalon was placed in the dry ice shipper and covered with dry ice. A power supply error caused the temperature logger to fail (see the Discussion section).

T+1 days

The NPT was -70°C at 07:10 hrs. The patient was taken to a local airport and departed for Alcor at approximately 11:10 hrs, and arrived at Alcor at 14:44 hrs.

8. Cooling to Liquid Nitrogen Temperature

A computer program was used to initiate cryogenic cooldown at 15:05 hrs on T+1 days, starting at -79°C and plunging to -110°C and descending thereafter at -1°C/hour to LN_2 temperature. At 18:33 hrs on T+5 days, an uneventful cooldown was terminated at LN_2 temperature (-196°C). At 11:00 hrs on T+8 days CT scans of the cephalon at LN_2 temperature were obtained. The patient was transferred to long-term maintenance at LN_2 temperature at 15:38 hrs on T+56 days.

9. Timeline and Time Summaries

Timeline

T-0	17:15	Estimated time of cardiac arrest
T-0	17:17	Pronouncement of legal death
T-0	17:19	Placed water ice on patient
T-0	17:19	Placement of airway
T-0	17:20	Placement of first intraosseous (IO) device
T-0	17:20	Placement of first ETCO2 device (first reading = 26)
T-0	17:21	Start of mechanical chest compressions
T-0	17:21	Start ventilator and capnograph
T-0	17:23	Administration of first medication (propofol)
T-0	17:28	Placement of second intraosseous (IO) device
T-0	17:46	Final reading from ETCO2 device (reading = 10)
T-0	17:47	Administration of final medication (decaglycerol/THAM)
T-0	17:58	Start transport of patient to funeral home
T-0	18:18	Arrival of patient at funeral home (NPT 28°C)
T-0	18:40	Start field surgery (cannulation)
T-0	18:57	Termination of cardiopulmonary support (NPT 26°C)
T-0	19:15	Start of cephalic isolation
T-0	19:21	Completed cephalic isolation (cephalon not weighed)
T-0	19:32	Start of open circuit cryoprotection (left carotid artery)
T-0	22:51	End open circuit (Brix = 50.1 rt venous, 49.7 left venous)
T-0	22:54	Start of dry ice cooling (NPT = -5.1°C)
T+1	07:10	Near dry ice temperature reached (-70°C)
T+1	11:06	Departure of patient for local airport
T+1	14:18	Departure from the airport for Arizona
T+1	14:44	Arrival of patient at Alcor (temperature not recorded)
T+1	15:05	Start of patient cryogenic cooldown
T+5	18:33	End of cooldown at LN2 temperature
T+8	11:00	CT scans of cephalon at LN2 temperature
T+56	15:38	Transfer of patient to long-term maintenance at LN2 temperature

Time Summaries

Event Duration hr:min		days	time	
Stabilization				
00:02	From:	T-0	17:15	Estimated time of cardiac arrest
	Till:	T-0	17:17	Pronouncement of legal death
00:04	From:	T-0	17:15	Estimated time of cardiac arrest
	Till:	T-0	17:19	Placed water ice on patient
00:06	From:	T-0	17:15	Estimated time of cardiac arrest
	Till:	T-0	17:21	Start of mechanical chest compressions
00:08	From:	T-0	17:15	Estimated time of cardiac arrest
	Till:	T-0	17:23	Administration of first medication (propofol)
00:24	From:	T-0	17:23	Administration of first medication (propofol)
	Till:	T-0	17:47	Administration of final medication (decaglycerol/THAM)
Field Surgery and Field Cryoprotectant Perfusion				
00:22	From:	T-0	18:18	Arrival of patient at funeral home (NPT 28°C)
	Till:	T-0	18:40	Start field surgery (cannulation)
01:25	From:	T-0	17:15	Estimated time of cardiac arrest
	Till:	T-0	18:40	Start field surgery (cannulation)
00:41	From:	T-0	18:40	Start field surgery (cannulation)
	Till:	T-0	19:21	Completed cephalic isolation (cephalon not weighed)
02:17	From:	T-0	17:15	Estimated time of cardiac arrest
	Till:	T-0	19:32	Start of open circuit cryoprotection (left carotid artery)
03:19	From:	T-0	19:32	Start of open circuit cryoprotection (left carotid artery)
	Till:	T-0	22:51	End open circuit (Brix = 50.1 rt venous, 49.7 left venous)
05:36	From:	T-0	17:15	Estimated time of cardiac arrest
	Till:	T-0	22:51	End open circuit (Brix = 50.1 rt venous, 49.7 left venous)
00:41	From:	T-0	18:40	Start field surgery (cannulation)
	Till:	T-0	19:21	Completed cephalic isolation (cephalon not weighed)
00:52	From:	T-0	18:40	Start field surgery (cannulation)
	Till:	T-0	19:32	Start of open circuit cryoprotection (left carotid artery)
04:11	From:	T-0	18:40	Start field surgery (cannulation)
	Till:	T-0	22:51	End open circuit (Brix = 50.1 rt venous, 49.7 left venous)
03:19	From:	T-0	19:32	Start of open circuit cryoprotection (left carotid artery)
	Till:	T-0	22:51	End open circuit (Brix = 50.1 rt venous, 49.7 left venous)
Dry Ice Cooling and Cryogenic Cooldown				
00:03	From:	T-0	22:51	End open circuit (Brix = 50.1 rt venous, 49.7 left venous)
	Till:	T-0	22:54	Start of dry ice cooling (NPT = -5.1°C)
05:34	From:	T-0	17:20	Placement of first ETCO2 device (first reading = 26)
	Till:	T-0	22:54	Start of dry ice cooling (NPT = -5.1°C)
04:36	From:	T-0	18:18	Arrival of patient at funeral home (NPT 28°C)
	Till:	T-0	22:54	Start of dry ice cooling (NPT = -5.1°C)
00:21	From:	T+1	14:44	Arrival of patient at Alcor (temperature not recorded)
	Till:	T+1	15:05	Start of patient cryogenic cooldown

10. Table of Medications Administered

TIME	MEDICATION	DOSE	PURPOSE
17:23 hrs	Propofol (Diprivan)	200 mg	Anesthetic; reduces cerebral metabolic demand; reduces the theoretic possibility of increased awareness during aggressive CPS.
17:23 hrs	Sodium citrate	**(1st dose 60 cc)** Note 2	Anticoagulant; prevents blood clot formation.
17:25 hrs	Sodium citrate	**(2nd dose 40 cc)** Note 2	Anticoagulant; prevents blood clot formation.
17:27	Antacid	240 cc Note 3	A buffer used to protect the stomach from acid erosion.
17:28 hrs	Heparin	50,000 IU	Anticoagulant; prevents blood clot formation.
17:29 hrs	Minocycline	200 mg	Antibiotic and neuroprotectant
17:29 hrs	Decaglycerol/THAM [tris(hydroxymethyl) aminomethane]	200 cc total **(1st dose 50 cc)** Note 4	Decaglycerol inhibits cerebral edema. THAM is a buffer to mitigate acidosis.
17:29 hrs	Vasopressin	80 IU total **(1st dose 40 IU)** Note 5	Vasopressor; increases blood pressure during CPS.
17:30 hrs	SMT (S-methyl-isothiourea)	400 mg Note 6	Neuroprotectant (iNOS inhibitor); protects the brain from ischemic injury; raises blood pressure.
17:31 hrs	Vital Oxy	200 cc total **(1st dose 60 cc)** Note 7	Antioxidants: melatonin, vitamin E (D-alpha tocopherol), PBN (alpha Phenyl t-Butyl Nitrone) and anti-inflammatory carprofen.
17:37 hrs	Vital Oxy	200 cc total **(2nd dose 60 cc)** Note 7	Antioxidants: melatonin, vitamin E (D-alpha tocopherol), PBN (alpha Phenyl t-Butyl Nitrone) and anti-inflammatory carprofen.
17:38 hrs	Vasopressin	80 IU total **(2nd dose 40 IU)** Note 5	Vasopressor; increases blood pressure during CPS.
17:39 hrs	Vital Oxy	200 cc total **(3rd dose 60 cc)** Note 7	Antioxidants: melatonin, vitamin E (D-alpha tocopherol), PBN (alpha Phenyl t-Butyl Nitrone) and anti-inflammatory carprofen.
17:41 hrs	Decaglycerol/THAM [tris(hydroxymethyl) aminomethane]	200 cc total **(2nd dose 50 cc)** Note 4	Decaglycerol inhibits cerebral edema. THAM is a buffer to mitigate acidosis.
17:41 hrs	Vital Oxy	420 cc total **(4th dose 20 cc)** Note 7	Antioxidants: melatonin, vitamin E (D-alpha tocopherol), PBN (alpha Phenyl t-Butyl Nitrone) and anti-inflammatory carprofen.

17:44 hrs	Decaglycerol/THAM [tris(hydroxymethyl) aminomethane]	200 cc total **(3rd dose 50 cc)** Note 4	Decaglycerol inhibits cerebral edema. THAM is a buffer to mitigate acidosis.
17:48 hrs	Decaglycerol/THAM [tris(hydroxymethyl) aminomethane]	200 cc total **(4th dose 50 cc)** Note 4	Decaglycerol inhibits cerebral edema. THAM is a buffer to mitigate acidosis.
18:30hrs	Streptokinase	250,000 IU Note 8	A thrombolytic used to break up existing blood clots.

Notes:

1. All the medications that were in the field kit were administered.

2. The standard formulation for sodium citrate is 50 cc vials of 20% w/v = 10 grams sodium citrate, with a maximum of two vials being administered depending on patient weight. This patient received 20 grams of sodium citrate as per protocol, administered in two doses because his weight was over 40 kg.

3. Antacid was given in a single dose and was inserted through the nasogastric tube.

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).

5. Vasopressin is a fixed dosage of 40 IU, per dose for two doses. The second 40 IU dose 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.

6. SMT (S-methyl isothiourea) is a fixed-dose and 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 useful life of approximately six hours.

7. 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.

8. The standard administration of streptokinase is 250,000 IU dissolved in 5 mL of 9% sodium chloride.

11. Table of Concentrations (Brix) of nM22 Solution

Step-ramp calculator, nM22			
sixth root of [% CNV]/5 =		1.6636	step ratio
bag #	contents	[nM22], CNV	Brix (calc)
1	washout	0.00	9.80
2	0.05	0.05	11.81
3	0.08	0.08	13.14
4			
5	0.23	0.23	19.03
6	0.38	0.50	29.85
7	0.64	0.50	29.85
8	1.06	1.06	52.31
9	1.06	1.06	52.31
10	1.06	1.06	52.31
11	1.06	1.06	52.31
12	1.06	1.06	52.31

Note: Bladder #4 was not infused because it had been damaged during the flight to Washington. This case took place in 2020 which was before the more detailed reporting on field cryoprotection cases. This case was one of the first FCP cases during the Covid-19 pandemic and recording the times that individual bladders were hung had not yet become protocol.

12. Discussion

Standby, Stabilization and Transport

Alcor's standby, stabilization and transport (SST) personnel held phone and email conversations regarding when the member would take his end-of-life medications in accordance with the death with dignity laws in the state of Washington. The member was advised by Alcor that there could be increased challenges (such as obtaining the death certificate and transit permit) if he were to take the medications late in the day or near or on the weekend. Alcor wanted to be sensitive to the member's autonomy. That being said, since field cryoprotection (FCP) was being utilized, the cephalon needed to be stored on dry ice for an extended period of time, a temperature which favors ice formation.

There might have been an issue with the RespUSense $ETCO_2$ monitor. The monitor appeared to work at Alcor and was tested both before and after the case. There are different reasons that an

$ETCO_2$ reading could be low. Alcor is continuing to seek more data before suggesting that there were technical issues the first time the monitor was used.

The first $ETCO_2$ reading taken at 17:20 hrs was 26, which would have been a good reading for a typical out-of-hospital resuscitation case. Readings above 20 persisted at least during the first 15 minutes of the case, followed by a decline. An effort was made to reposition the airway and the monitor, but a more appropriate reading could not be obtained, and the reading continued to fall until the last reading of 10 at 17:46 hrs and the use of the monitor was discontinued. The SST kit did have a colorimetric device that could have been used to confirm placement but would not have provided specific $ETCO_2$ data. For future cases, an adapter will be used that will record data and provide more meaningful readings.

During patient transport to the funeral home, there was a rise in temperature. As the cause was not observed at the time, there are a couple of possible explanations. First, the nasopharyngeal probe could have shifted and become exposed to air. Another possibility is that the patient's mouth was not totally occluded and water from the recirculation mask leaked into the nasopharynx, and this would cool the probe, and then acclimate with the surrounding tissue. And another possibility could have been that additional air was introduced into the King airway due to a potential leak. If the air was escaping up into the nasopharynx there would be a cooling effect as well.

One of the results of this probe failure is that individual temperature data during CPS are unreliable. As a consequence, the initial cooling rates and S-MIX were based on linear estimates instead of individual readings. It is important to emphasize that the Alcor protocol stipulates the use of at least two separate temperature probes. In this case a tympanic probe and rectal probe (attached to the rectal plug) might have yielded more reliable readings.

Field Surgery and Cryoprotection

The gravity feed system uses a tripod that can be adjusted for height to control the arterial pressure. The pre-mixed cryoprotectant is in a series of bladders with graduated concentrations (measured by the refractive index (RI) in Brix units). By hanging two bladders with different RI concentration on a teeter-totter atop the tripod, as the bladder with the lower RI runs out and becomes lighter, at the mid-way point the teeter-totter will allow both bladders to flow, essentially mixing the two concentrations and creating a smoother transition from one concentration to the next. When the bladder with the lower RI runs out, the full concentration of the bladder with higher RI is then flowing exclusively. This process allows for a smoother curve in the increasing concentrations of cryoprotectant.

Transport temperature logging began immediately upon placement of the nasopharyngeal probe and continued through cephalic isolation until the pressure sensor was connected. When the arterial pressure sensor was connected, a power supply error caused the temperature logger to fail. The team immediately replaced the logger with a second unit without interrupting the procedure. However, due to an unknown cause, the second logger did not begin recording the temperature data. The team continued to take visual temperature measurements from the second logger.

The 12-bladder system (and here bladder #4 was missing so in reality this case was an 11-bladder system) is probably not perfusate enough to realistically achieve 100% concentration needed to vitrify (CNV) on the single-pass step ramp. Due to the results of this case, 105% CNV 2-liter bladders (12 liters) have been added to the FCP system to prolong the endpoint and get more cryoprotectant uptake into the brain.

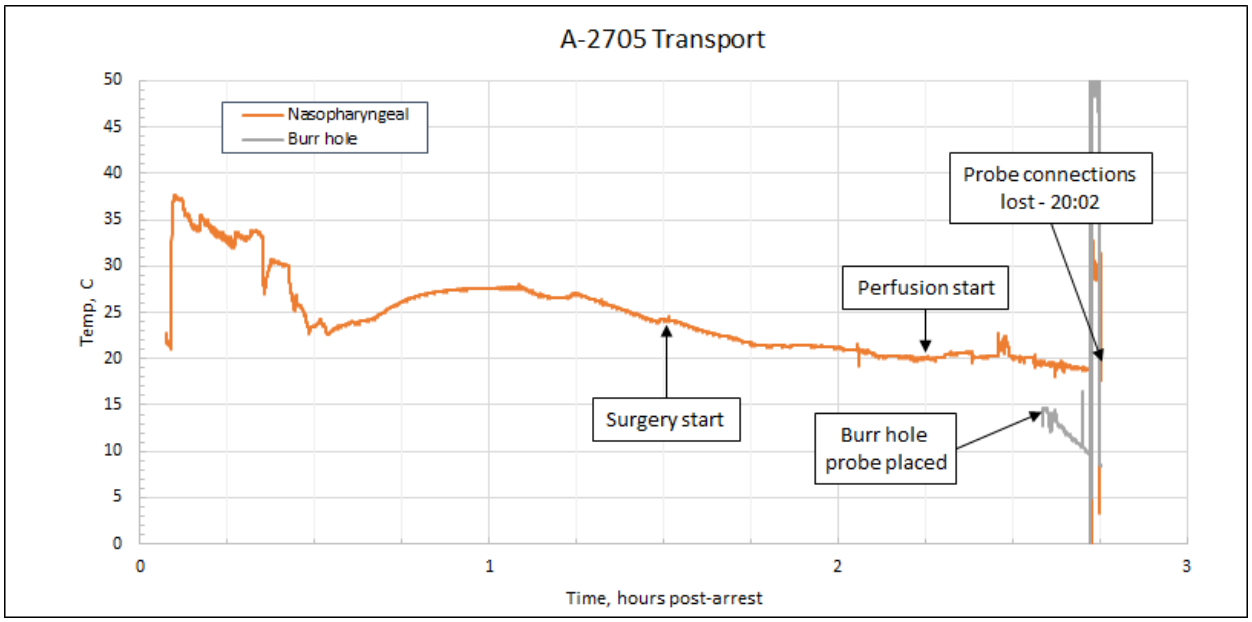
Closed circuit perfusion was terminated when there was still 25 percent of the perfusate in bladder #12. This information came from bodycam footage, but unfortunately there was no audible explanation for termination prior to the bladder being expended. As this was a 2020 case, those individuals who participated in the case do not remember with certainty, however, since the final refractive index readings were 50.1 Brix right venous (100% of perfusate concentration needed to vitrify (CNV) and 49.7 Brix left venous (99% of CNV), it is assumed that perfusion was terminated because the proper concentration for termination of perfusion had been reached before the last 25 percent of the perfusate was expended.

This is not optimal because standard protocol is to maintain perfusion after reaching 100% CNV venous concentration for at least 30 minutes (per protocol), especially in cases where not all perfusate is available (bladder 4). For this case, it is not evident whether there was enough perfusate to conform to this protocol. As can be expected in right-to-die cases with rapid CPS and cooling, flow rates were relatively high for a given pressure, requiring more perfusate.

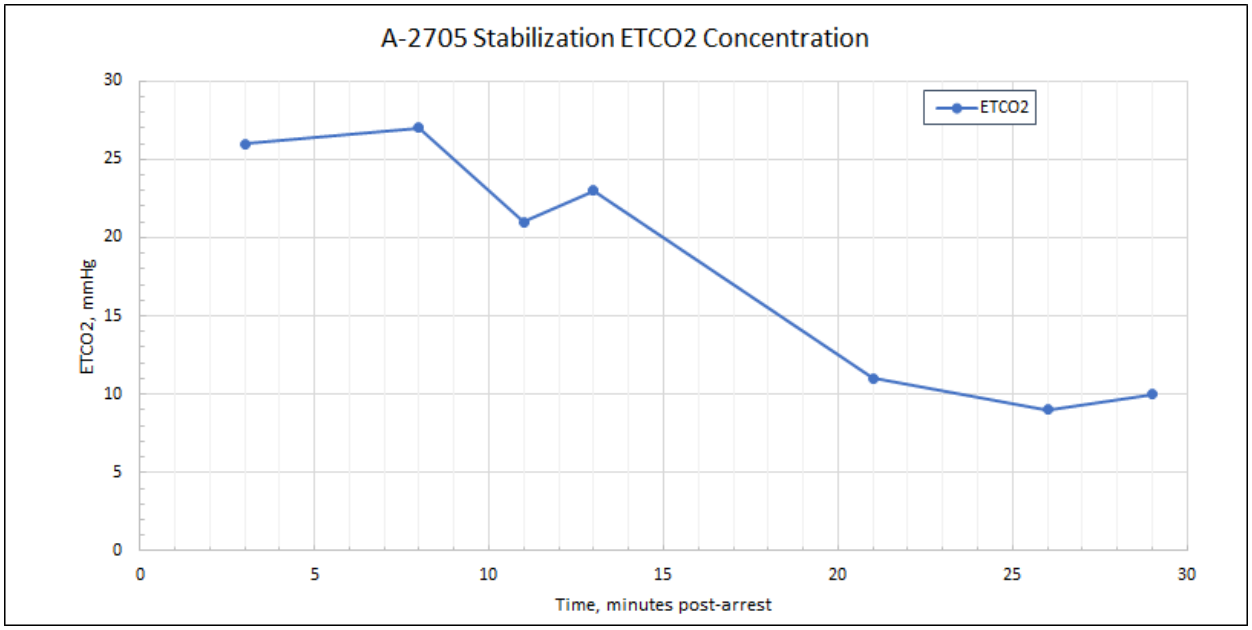
CT scans of this patient reveal reasonably good cryoprotection results, with many areas in the 80% CNV range and some areas indicating complete equilibration. The outcome of this case was greatly favored by the conditions under which the patient died, both in terms of logistics and time between circulatory arrest and start of procedures.

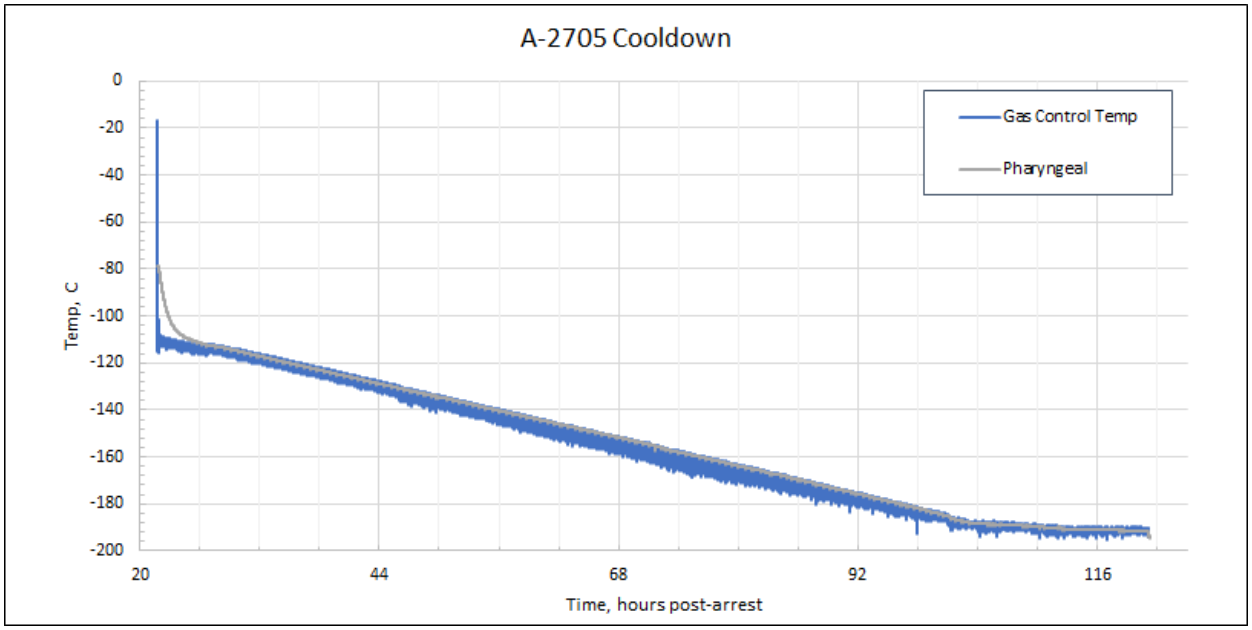
Further improvements in outcome could have included the use of a true portable ice bath to further accelerate external cooling, aggressive pressor support based on declining ETCO2 readings, complete 4-vessel cannulation, and extended perfusion times at the highest concentration to bring more areas of the brain towards 100% CNV.

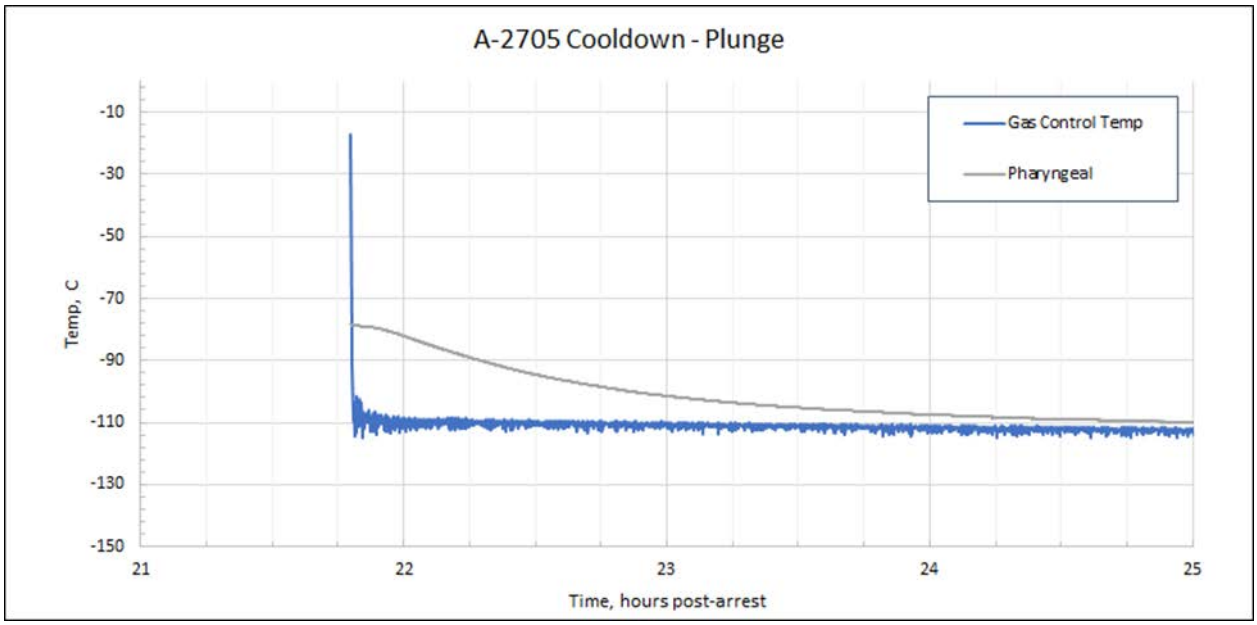
13. Cryoprotection and Temperature Graphs



Note: Two critical measurements that were taken during the period where no other temperature data exists are -5.1°C at 22:49 hrs on T-0, and -70.0°C at 7:10 hrs on T+1. No further visual measurements were made until the patient arrived at Alcor, at which point the data trail picks back up with the patient connected to the cooldown cart.




A-2705 Cooldown
Gas Control Temp
Pharyngeal
Temp, C
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
20
44
68
92
116
Time, hours post-arrest


A-2705 Cooldown - Plunge
Gas Control Temp
Pharyngeal
Temp, C
-10
-30
-50
-70
-90
-110
-130
-150
21
22
23
24
25
Time, hours post-arrest

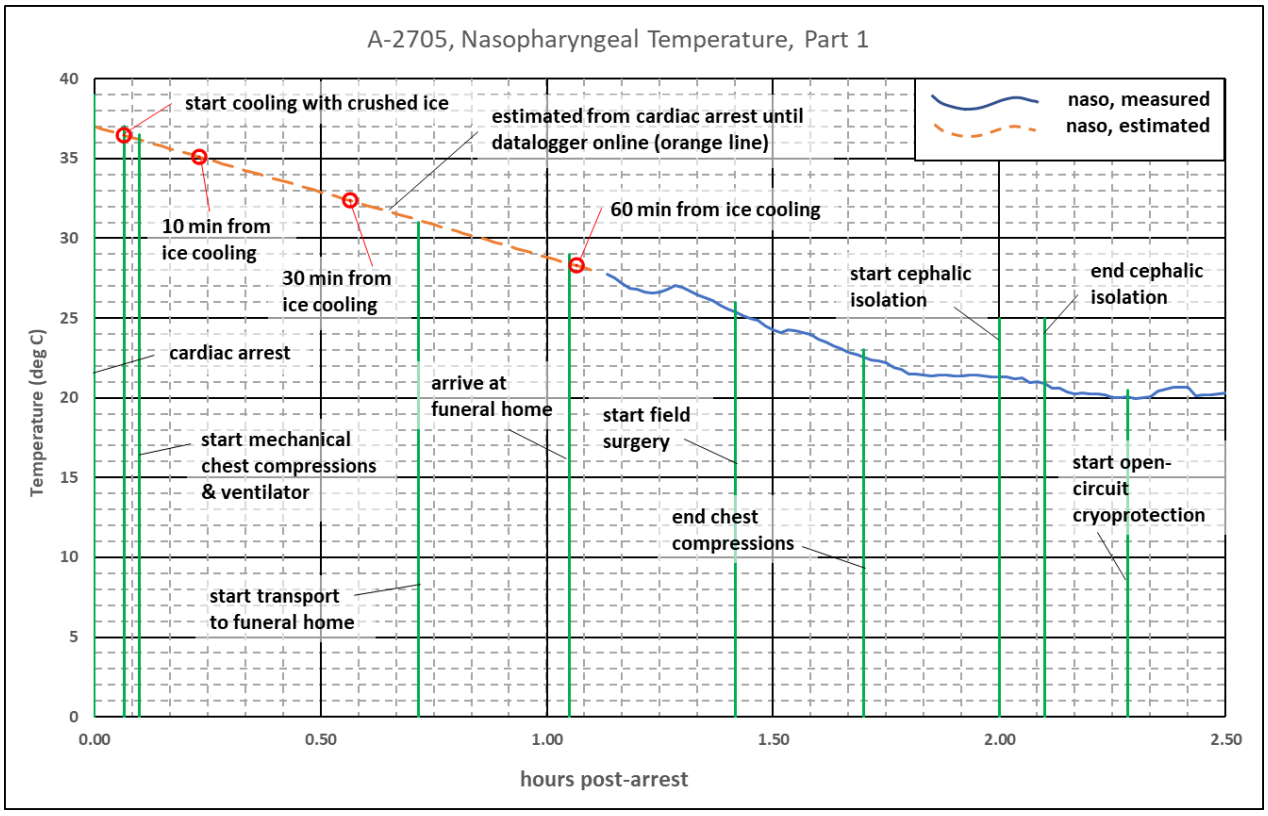
14. S-MIX

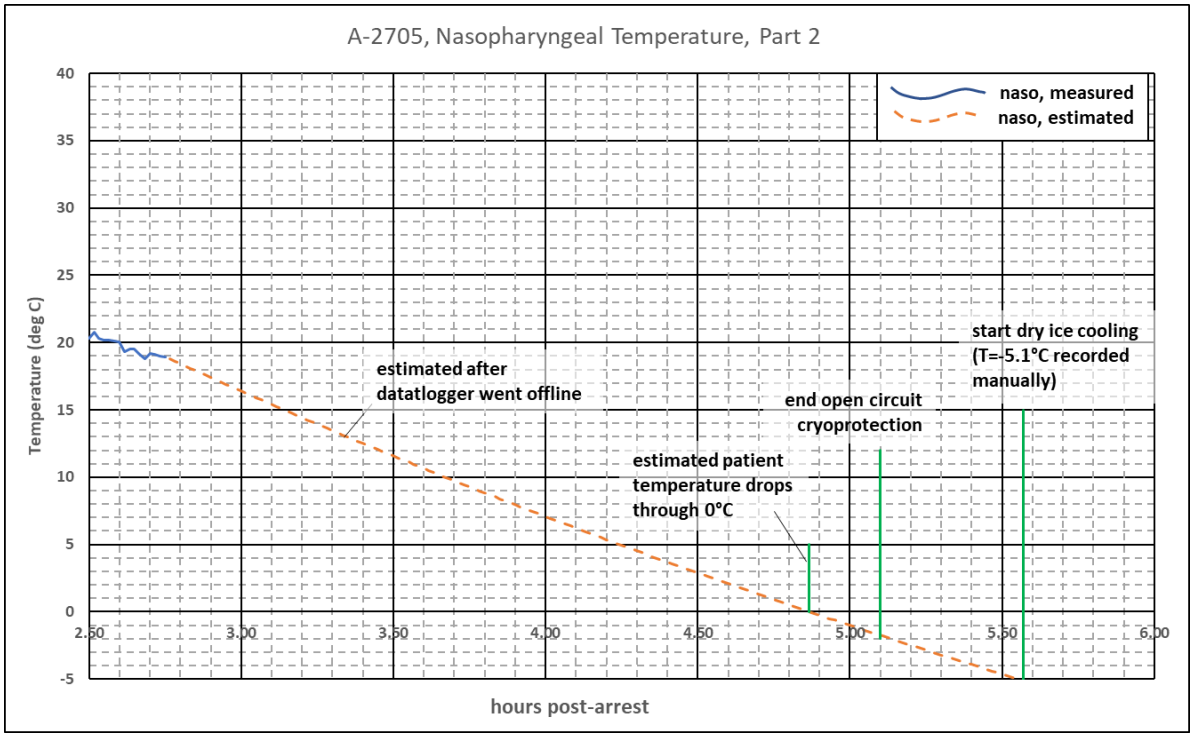
The Standardized Measure of Ischemic Exposure (S-MIX) expresses the total ischemic exposure prior to the start of cryogenic cooling as the equivalent duration of normothermic ischemia. An S-MIX of 00:00 (hh:mm) is the ideal case of no ischemic damage. The higher the S-MIX time, the more damage. Factors 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 4:52. As shown below, and due to lowering of the body temperature, S-MIX duration is shorter, at 01:15.

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	17:15	00:00	37.0			
	seg 1		00:04	00:04	-0.5	no	no	00:04
Start cooling with crushed ice & place airway		T-0	17:19	00:04	36.5			
	seg 2		00:02	00:02	-0.3	no	no	00:02
Start mechanical chest compressions & ventilator		T-0	17:21	00:06	36.2			
	seg 3		00:37	00:37	-5.0	yes	no	00:15
Start transport of patient to funeral home		T-0	17:58	00:43	31.1			
	seg 4		00:20	00:20	-2.7	yes	no	00:06
Arrival of patient at funeral home		T-0	18:18	01:03	28.4			
	seg 5		00:22	00:22	-3.0	yes	no	00:05
Start field surgery (cannulation)		T-0	18:40	01:25	25.4			
	seg 6		00:17	00:17	-2.9	yes	no	00:03
Termination of cardiopulmonary support		T-0	18:57	01:42	22.5			
	seg 7		00:18	00:18	-1.3	no	no	00:06
Start of cephalic isolation		T-0	19:15	02:00	21.3			
	seg 8		00:06	00:06	-0.4	no	no	00:02
Completed cephalic isolation		T-0	19:21	02:06	20.9			
	seg 9		00:11	00:11	-0.8	no	no	00:03
Start of open circuit cryoprotection		T-0	19:32	02:17	20.1			
	seg 10		02:35	02:35	-20.0	no	no	00:28
Estimated temperature thru 0C		T-0	22:07	04:52	0.0			
totals:			04:52	04:52	-37.0			01:15

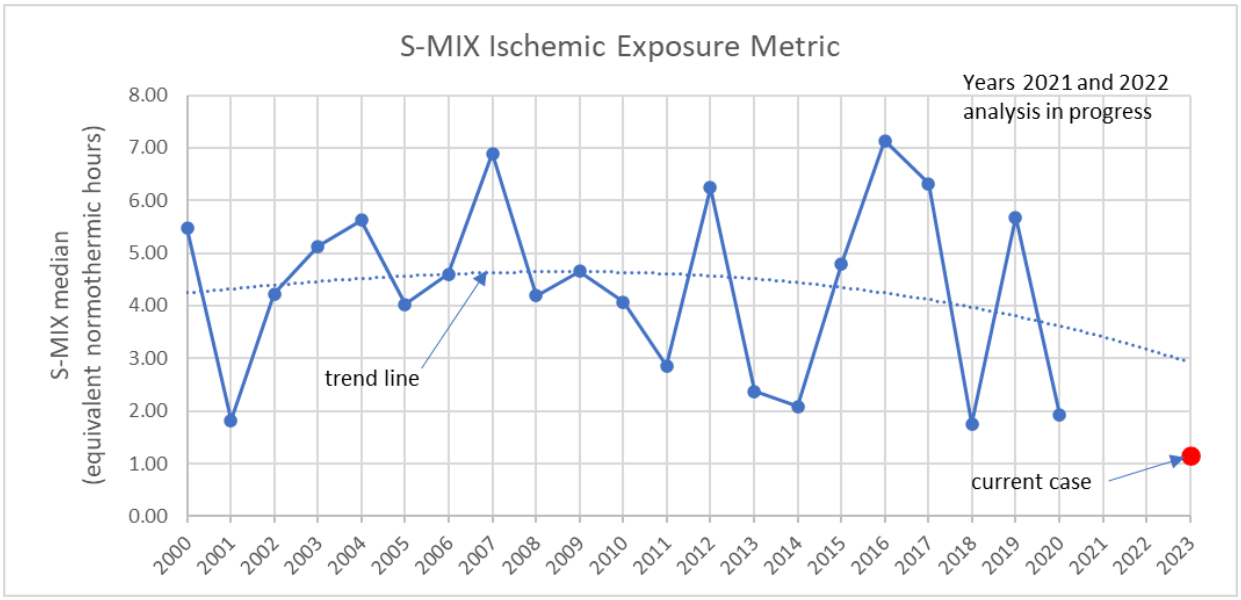
The below plots show events related to the S-MIX calculation. The red dots provide a metric for how fast the patient is cooled. This is a critical period since body temperature is highest and ischemic damage most rapid. The below table provides cooling data for 0, 10, 30, and 60 minutes after the team first applies water ice.

Patient Cooling Rate				
Note: time = 0 at start of ice cooling	0 min elapsed	10 min elapsed	30 min elapsed	60 min elapsed
Naso temperature (°C)	36.5	35.1	32.4	28.3
Temperature drop (°C) from t = 0	0.0	-1.4	-4.1	-8.2
Cooling rate (°C/min) from t = 0	N/A	-0.14	-0.14	-0.14



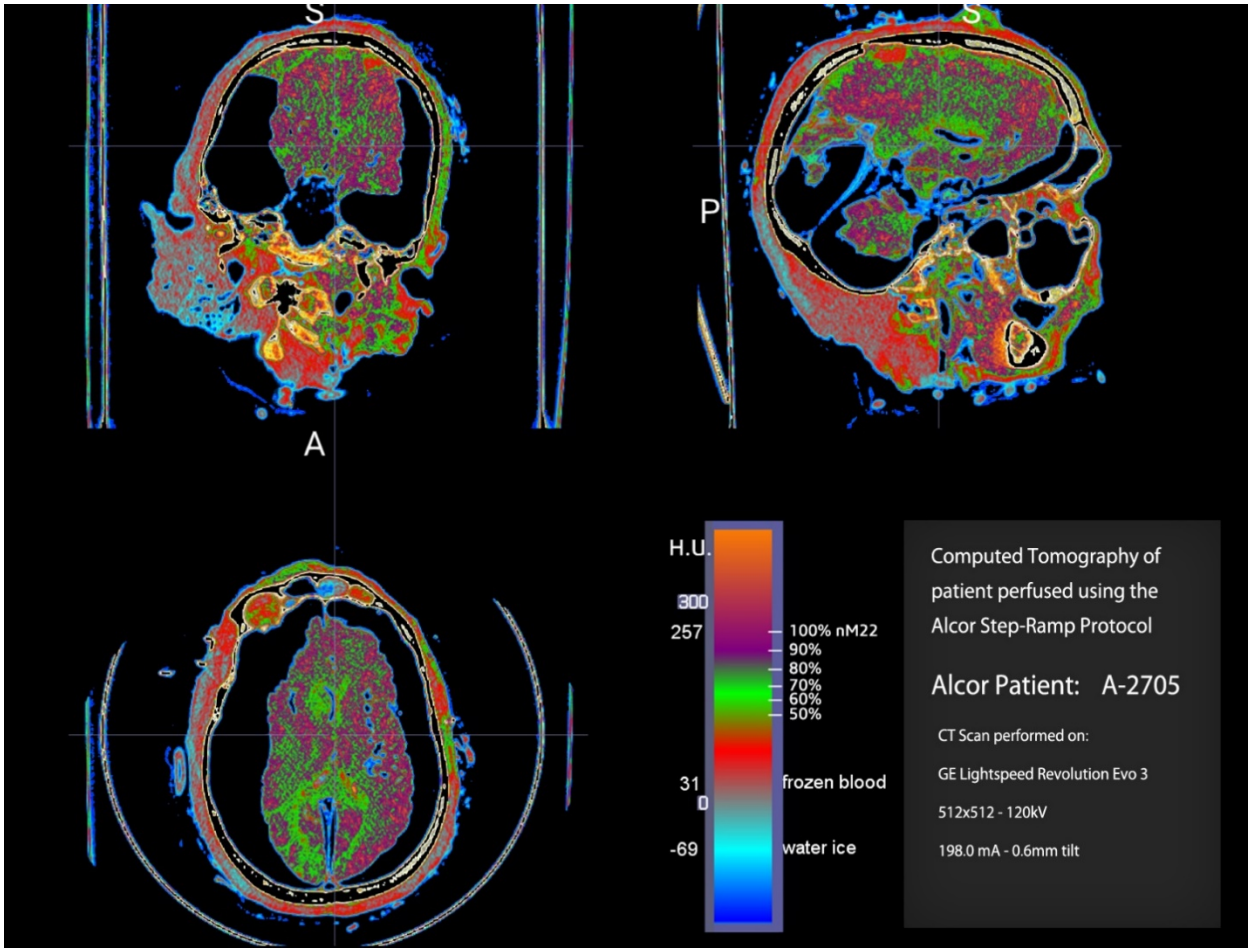


The following plot shows how the current case compares to prior years.



15. CT Scans

Cryoprotectant Distribution (Post-cryopreservation CT scan)



The post-cryogenic cooldown CT scans were obtained at 11:00 hrs on T+8 days; the patient was at liquid nitrogen temperature (-196°C).

CT visual analysis indicates that this patient's brain achieved between approximately 80% to 100% concentration needed to vitrify (CNV) and this can be seen on the single-slice 3-view CT image provided. The CT scans also indicate significant CPA-induced brain shrinking, an observation that is typically only seen in local or rapid field cryoprotection cases with rapid cardiopulmonary support (CPS).