Alcor A-2357

Case Report

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Alcor A-2357 Case Report Contents:

1. Overview

A-2357, who requested confidentiality, became a member of Alcor on April 30th, 2008. He was born in England on July 10th, 1925. Upon retirement, he lived with his sons and family in a small residential community in the Phoenix Metroplex. His clinical death occurred at his home at the age of 85.

Alcor's Arizona response team provided standby services twice at the home of A-2357 in the Phoenix valley, approximately 50 miles from Alcor in Scottsdale. The first standby lasted six days before the member's condition improved enough for the team to stand down. While continuing to monitor the individual's health through a very supportive hospice organization, the attending physician determined it was time to restart the standby just two weeks later. On the second day of the standby, despite relatively strong vital signs, the member's breathing became weaker until he finally just ceased to take a breath. The patient was pronounced on June 17, 2011. He was a neurosuspension member.

2. Personnel

Aaron Drake, Medical Response Director, led response team members Steve Graber, Sandra Russell, and Joan O'Farrell during the standby, stabilization and cooldown components of the case. They were supported by Max More, CEO; and Steve Harris, M.D., Chief Medical Advisor.

Personnel at Alcor's surgery suite included José Kanshepolsky, MD, Surgeon; Aaron Drake, NREMT-P, Surgical Assistant; Hugh Hixon, Cryoprotection Perfusionist; Steve Graber, Assistant Cryoprotection Perfusionist; Max More, Ph.D., Scribe; Bonnie Magee, Refractometry; R. Michael Perry, Ph.D., Cooldown Coordinator. Surgical support staff: Bruce Cohen and Jerry Searcy. Observer: Christine Estrada, MD;

3. Pre-Deployment

A-2357, who asked to remain confidential, was an 85 year old male who suffered from dementia, atrial fibrillation, hypertension, prostate cancer and silent cerebral infarcts. Both of the member's sons were also signed up with Alcor and therefore communication was excellent.

In April, 2011, his family called Alcor to let us know their father had experienced numerous falls recently and had become increasing listless. This had prompted them to seek out a 'hospice at home' program to assist with his declining health. This was their father's second admittance into

hospice. Eight months prior he had been admitted for the same diagnosis; however he was determined to be “too fit”. This time his health was steadily declining and he had been losing weight from a loss of appetite.

Max More, Steve Graber and Aaron Drake traveled to the member’s home – approximately an hour drive from Alcor. This provided them with an opportunity to not only review his hospice chart that tracked his recent medical decline but also to see the environment that they might eventually need to use for stabilization and cooldown. Alcor staff and the sons engaged in a lengthy discussion about cryonics theory and the advancements that are currently in practice today. The family said they would keep us abreast of any changes in their father’s health.

Four weeks later on May 22nd, 2011, we received a TeleMed alert from the hospice nurse that our member had probably suffered a stroke, as he had all of the clinical indicators. He had choked on phlegm to the point the family thought he had died due to respiratory arrest. He was very cyanotic; they described him as a bright purple color. The family rolled him on his side, which cleared the plug and he started breathing again. Initially, he lost the ability to swallow and drooled all day, with left-sided facial droop, along with a flaccid left arm and leg. A hospice nurse came out and was very concerned about his long term survivability, which was what prompted the family to call Alcor's emergency number to notify us. The nurse’s concern centered on the possibility that her patient might lose the ability to eat and drink, which would hasten his clinical death. His vitals were currently stable and she did not see a need for us to initiate a standby immediately; only to alert us.

After consulting with Dr. Harris about her concerns, we decided that it was too early to start the standby yet, but that we should closely monitor any changes. The family felt uneasy about their dad passing in the middle of the night without them being aware. Therefore Alcor decided to deliver the CO2SMO the next day to help monitor their father’s pulse oximetry. We also included a mini-med kit to administer meds and a LUCAS 2 chest compression device to circulate those meds while an Alcor team was en-route, in the event he passed unexpectedly.

On Wednesday, May 25th, the case manager for the hospice visited and was quite concerned with her patient’s decline. She expected that he might only survive for another 48-72 hours. She noted that she was being very conservative in her estimate and admitted that the family was quite anxious to have us start the standby. Nevertheless, she stated she was committed to having Alcor in place prior to his clinical death. We did not see anything critical at that time, but given the nurse’s prediction, the family's anxiety and the local nature of the standby, we felt compelled to begin the standby sometime the following day.

4. Deployment

On Thursday, May 26th, Aaron and Steve drove Alcor's rescue vehicle to the home, about 45-60 minutes from Alcor, depending on traffic. Sandra Russell and Joan O'Farrell, both from Critical Care Research in Rancho Cucamonga, CA, flew out to Phoenix to alternate with Aaron and Steve during the standby. The hospice's nurse, case manager and medical director were all within a 10-15 minute drive and could easily come over to pronounce on a moment's notice, day or night. When the patient's decline entered the active dying phase, they would plan on having someone stay at the home full time.

Coolers of ice and stabilization supplies were positioned in the home and the ice was replenished every two days. Two standby member teams rotated every 12 hours over the course of the next six days. The patient alternated between good and bad days but his vital signs remained steady throughout. The deployment committee decided that the standby should end until such a time that his health declined further. The hospice offered to assist Alcor in starting the procedures in the event they were absent and something happened unexpectedly. Aaron provided training to the nurses on how to use a bone injection gun and left behind a mini-med kit for medication administration and additional coolers to hold bags of ice. This alleviated some of the concerns of the family, who did not want the standby to be cancelled.

The hospice continued to provide updates every few days that included the patient's blood pressure, pulse, oxygen saturation, respiratory rate and level of consciousness. This continued through mid-June when the member had become increasingly agitated and refused to eat or drink anything. The hospice provided subcutaneous fluid infusion therapy to prevent dehydration but this did not prevent his steady decline.

On June 16, 2011, we received another emergency text in the middle of the night that our member was "near death". Apparently, the family was trying to spoon feed their father some Ensure and he began to choke. The family become very concerned and called the nurse and told her that his legs were mottled and his hands were blue. The hospice paged us immediately.

The hospice nurse drove out to the home to check on their patient. The family had bathed and massaged their father's legs so she saw no sign of the mottling or cyanosis in his hands. His O2 saturation was in the mid-70s, but when the nurse re-positioned him, his sats returned to the high 90's. The nurse then called Aaron to report the patient's condition and she shared that she did not think his death was imminent or that he would likely pass in the next 48 hours. She also mentioned that the hospice medical director was planning to visit later in the afternoon to better prognosticate his condition. Aaron asked if he could meet with her to discuss Alcor's procedures.

Aaron drove out and met with her while she was assessing the patient. Based upon her years of experience in hospice care, she felt that his health was declining rapidly and she expected that he would likely pass in the next 24 hours. She based this on his absent bowel sounds, peripheral shunting and a precipitous drop in his blood pressure. She felt very confident in her prediction and after discussing this turn of events with Max and Dr. Harris, we restarted the standby.

Aaron stayed onsite while Steve drove the rescue vehicle across town to the family's home. The equipment was repositioned inside the home and the medications were prepared. To allow for rotation of team members, Sandra and Joan planned to fly back to Phoenix the next morning to assist. The hospice nurse had decided to stay at the home through the night; in the event something happened she could monitor the patient continuously.

After all the equipment and supplies were readied, inspection of the coolers of ice previously left at the home revealed the ice had not recently been replenished and therefore the amount of ice on hand was not optimal. Since the patient appeared to breathing well, the team departed for the local store to get ice and nourishment. While en-route back to the home, the nurse called to say that the patient was now breathing very erratically and she had called her medical director to come over quickly.

When we arrived, the nurse was standing over the patient listening to his breath sounds, which were agonal, indicating that he might possibly be in cardiac arrest but still demonstrating the gasping respirations which can continue over a period of minutes. While Steve and Aaron placed a base layer of ice in the portable ice bath, the medical director arrived and went straight into the patient's bedroom. She listened for the next few minutes as his breath sounds continued to dimished until they ceased altogether. She pronounced the patient at 5:55 AM on June 17th, 2011.

5. Field Stabilization, Cooling & Transportation

The Medical Director, who had been trained on how to use a bone injection gun, offered to help the Alcor team. She initiated an intraosseous access site in the left tibial plateau. Aaron administered the first five low volume medications through the 3-way stopcock extension set attached to the access site. Once the initial low volume medications were flushed with 60cc's of normal saline to circulate, the patient was rolled over onto his right side to place him on a portable, multi-handled, heavy fabric net called a Mega Mover. The rectal occlusion device was inserted to keep the ice bath from contamination with fecal matter and the patient was rolled onto his back and centered. The medical director, nurse, Aaron and Steve then lifted the patient off the bed and moved to the ice bath and covered him with additional ice.

The LUCAS 2 automatic chest compression device was placed over the patient's chest and started to begin circulating the medications through the vascular system. A King airway was placed and secured in the patient's esophagus and the nurse was instructed to ventilate the patient with a bag valve mask. A second medication administration site was established with a Bone Injection Gun and a Baxa infusion pump, hung on a mounted IV pole, was connected to the port to begin pushing the vasopressors automatically.

Aaron continued to push stabilization medications while Steve went to the rescue vehicle to lower the lift gate and turn on the air conditioning unit to keep the patient care area as cold as possible. Once the vehicle was ready, the patient was covered with a privacy sheet and the portable ice bath was then rolled out of the house and into the driveway where the rescue vehicle was parked. The ice bath was loaded onto the vehicle's lift gate and raised up until the ice bath could be positioned and locked down.

Once inside, a thermocouple was inserted in the nasopharynx to begin recording the cooldown progress on a DuaLogR. The thermocouple wires were secured in place using a surgical stapler. The additional ice that was purchased and stored in the back of the rescue vehicle was added to completely cover the patient to maximize the rate of cooling. The LUCAS 2 was shifted from DC power to AC power to conserve battery life. Five gallons of water was added to the ice bath to support the new "squid" (SCCD, or surface convection cooling device) water recirculation device that Steve designed at Max's request after discovering that a squid had not been used in recent cases. This device was placed over the patient to continuously bathe the body with ice-cold water to achieve faster cooler using convective cooling, in addition to the normal conductive cooling from simple ice contact.

The hospice's Medical Director said she needed to leave to attend to other patients, but she planned to drive to Alcor later in the morning to observe the surgical and perfusion procedure. Due to limited resources, the nurse offered to stay and assist while Steve and Aaron continued to administer the large volume medications. When the last of the stabilization medications were infused, they thanked the nurse for her cooperative involvement and said goodbye. The roll-up door to the vehicle was closed and the lift gate was secured in preparation to leave. Steve drove the vehicle while Aaron stayed in back with the patient to ensure everything remained secure. Hugh Hixon was notified by phone that they were departing for Alcor and to expect arrival in approximately one hour.

6. Surgical Procedure

The Alcor surgical team was ready and waiting when the rescue vehicle pulled up to the rear doors of Alcor at 7:45 am. The LUCAS 2 was switched back from AC to DC to allow chest compressions to continue while the portable ice bath was being moved to the operating theatre.

The rear of the rescue vehicle was opened; the ice bath was unlocked from its brace and loaded onto the lift gate, which then lowered to the asphalt. Once everything was rolled into the operating theatre, the patient was lifted out of the ice bath using the Mega Mover and placed onto a bed of ice bags laid on the surgery table.

The head was shaved by Aaron prior to aseptically prepping the region with alcohol. Dr. José Kanshepolsky made two vertical incisions with a scalpel to expose the skull. The scalp was parted with Weitlaners and two bilateral burr holes were drilled using a Codman craniotome perforator. The exposed dura mater of the brain was cut through using a #10 scalpel blade and the remainder was cleaned up with a Sperling-Kerrison rongeur. A thermocouple probe was inserted into the right burr hole and secured to the scalp with 2-0 Silk.

Then the patient's face and chest were draped, leaving only the neck exposed for the surgery. Aaron aseptically prepped the exposed region. Dr. Kanshepolsky then proceeded to make a skin incision with a #10 scalpel blade along the anterior border of the left sternomastoid and divided the loose areolar tissue through dissection using Metzenbaum scissors and DeBakey forceps. Aaron held the surgical field open with two Army-Navy retractors. Once the left common carotid artery was identified and raised with a right angle Kantrowitz Mixter forcep, a silk tourniquet and a DeBakey bulldog clamp were used to maintain vascular control. The same procedure was repeated for the right common carotid artery. Both arteries were then severed distal to the clamps using a #11 scalpel blade.

Using scalpels, the remaining tissue around the neck was severed, leaving only the spinal column intact. The cephalon was separated with an osteotome and mallet before being moved from the operating table to the neuro box and mounted in the head ring. Both carotid arteries were cannulated with 18 Fr. red robinson catheters and secured in place with a surgical basket stitch. After an initial flow of perfusate, the vertebral arteries were identified with mouse tooth forceps and clamped off with Diethrich micro bulldog clamps. A crackphone element was inserted into each of the burr holes and secured with 2-0 Silk.

7. Perfusion Summary

The cryoprotection perfusion circuit used in this case was a stepped-based circuit that Alcor has authorized for overseas "field cryoprotection" cases and is currently under review for US-based cases. The standard recirculating neuro cryoprotection circuit and system were modified to a single-pass system, using a prepared stepped-cryoprotective ramp in 2-liter steps. To conform to the Society for Cryobiology recommendation of steps of no more than 2x/step, an eight-bag procedure was calculated, resulting in a step size of 1.69x/step. Eight additional terminal concentration bags were made up to deal with an assumed long approach to equilibrium.

The pump, heat exchangers, filters, refractometer sampling system and environmental box were all retained in their functions, with the ramp steps being introduced at the washout connection. The pump was stopped for a few seconds when each bag was spiked, as can be seen by the perfusion pressure graph (page 14). If the terminal jugular cryoprotectant concentration had not been reached by the end of the bags, the circuit would have been filled from the effluent, the circuit switched to recirculating mode, and the cryoprotection run to the normal end point. However, the number of bags was more than adequate and this was not necessary. Done thusly, this was a partial simulation of performing a neuro step ramp cryoprotection in the field, backed up by the conventional system.

As it turned out, equilibration occurs rather rapidly without the additional volume of the usual ramp generator circuit, as can be seen from the plotted concentration data; within about a target volume (i.e., here, one tissue volume of the head). This result was not anticipated, and as a result the perfusion was run out to the end of the bags.

The important lesson from this method of cryoprotection is that equilibrium can be attained much faster than with the continuous ramp generator system, resulting in much shorter exposure of the perfused tissues to the somewhat toxic cryoprotectant.

The cryoprotection was uneventful; terminal concentration was reached about five hours post-arrest, but was continued for another 2.5 hours due to the unanticipated rapid equilibrium from the use of the step procedure. The brain was retracted in both burr holes, 3.5 cm on the left and 4 cm on the right. Cooldown began at 8:20 hours post-arrest and was completed 103 hours post-arrest, on 21 June.

On 30 July, a post-cryopreservation CT scan was performed to locate the crackphone elements. As can be seen from the scans (page 16), neither of the "crackphone" acoustic sensors were in contact with the brain, which is typically dehydrated in response to good cryoprotective perfusion, and any events recorded by the sensors were simply noise. This also demonstrates the inadequacy of estimating brain dehydration by observation through burr holes, as well as the direction of dehydration, toward the central sulcus.

On 1 August, A-2357 was placed in a neurocontainer for permanent storage.

8. Timelines - June 17, 2011, 5:55 AM, MST

Stabilization

5:55 Patient pronounced
Permission to begin procedures given

5:57 Intraosseous access site established
5:58 200 mg Propofol administered
250,000 U Streptokinase administered
100,000 U Heparin administered
80mg Gentamicin administered
15mg Ketorolac administered
6:00 60cc normal saline given to flush medications
6:02 Patient rolled on to Mega Mover
Rectal Occlusion Device inserted
6:04 Patient moved to PIB
6:05 Patient covered with additional ice
6:06 Lucas 2 placed over patient and started
6:08 King airway placed and secured
6:11 2nd intraosseous access site established
6:13 Bolus of 1 mg Epinephrine and 20 IU Vasopressin administered
Baxa infusion pump started with 29 mg Epinephrine and 180 IU Vasopressin
6:14 250cc Maalox administered through King airway
300 mg Acetylsalicyclic Acid in 10 ml THAM administered
400 mg SMT (S-methyl-isothiourea) in 50ml Citrate-Dextrose administered
6:19 Patient moved from house to rescue vehicle
6:23 Nasopharyngeal probe placed and secured
DuaLogR recording started
6:25 Additional ice and water was added to the portable ice bath
6:27 SQUID water recirculation device applied and started
6:29 2.0 g Ni-Ky in 100 cc Citrate-Dextrose administered
6:30 4-Hydroxy-TEMPO in 50 cc Citrate-Dextrose administered
6:31 Remaining THAM administered
6:34 500 cc Hetastarch administered
6:37 400 cc Vital Oxy administered
6:40 500 cc Mannitol administered
6:45 Departed for Alcor

Surgical

7:45 Arrived at Alcor.
7:56 Temp = 20.9ºC (up from 17ºC).
8:06 Shaved head.
8:09 Dr. Kanshepolsky cut scalp.
8:10 Temp = 15.2ºC.
8:11 Ready to drill.
8:12 Right burr hole established.
8:14 Left burr hole established.
8:15 Temp = 12.4ºC.

8:20 Temp = 9.3ºC.
8:21 Burr holes cleared. Temp = 8.6ºC.
8:26 Started separation surgery.
8:32 Temp = 7.0ºC. Isolated carotids.
8:41 Severed right carotid.
8:48 Neuroseparation completed.
8:50 Cephalon placed in cephalon box.
8:54 No flow.
8:55 Flow resumed. Pressure 200, then down to 60.
8:57 Right carotid cannulated and secured. Bag #2 spiked.
9:00 Left carotid artery cannulated and secured.
9:07 Found vertebrals. At least one was flowing. Pressure = 103.
9:09 Pharyngeal temp = 13.37ºC.
9:12 Left jugular thermocouple placed and secured. Temp = 9.4ºC at time of connection.
9:13 Pharyngeal temp = 12.14ºC.
9:15 Bag #3 attached.
9:16 Brain retraction -1 cm on right.
9:17 Brain surface temperature probe attached, right burr hole.
9:19 Chiller turned down to 1ºC.
9:21 2 cm retraction on right; 1 cm on left.
9:22 Thermocouple probe on right burr hole turned out to be defective.
9:27 Brain surface thermocouple replaced and working. Temp = 6.0ºC.
9:27 Bag #4. Fluid going in = 4.6ºC.
9:34 Head slipped in box due to too much pressure.
9:37 Bag #5.
9:39 Finished placing both crackphones subdurally.
9:44 Lid placed on cephalon box.
9:45 Bag #6.
9:54 Bag #7.
10:06 Bag #8.
10:12 Eyeball partially collapsed due to dehydration. Fairly even mottling on skin.
10:17 Changed temperature of box to -3ºC.
10:22 Chiller temperature down to minus 5ºC.
10:24 Bag #9.
10:50 Bag #10.
11:15 Bag #11.
11:38 Brain surface temperature = 0.1ºC.
11:40 Bag # 12.
12:04 Bag #13.
12:27 Bag #14.
12:45 Hugh measures brain retraction: 3.5 cm/right; 4.0/left.
12:52 Bag # 15.
13:17 Bag # 16.
13:45 Perfusion ends.
13:55 Eyeball size returned to normal.
14:15 Began cooldown.

9. Issues and Actions

Issue: Had to contaminate an existing facility mop when cleaning the operating room after the patient transfer.

Action: Order a mop and bucket specifically for the operating room.

Issue: We experienced problems using the existing surgical staplers and not having enough staples in a cartridge.

Action: Order more surgical stapler cartridges, and identify potential new types of staplers.

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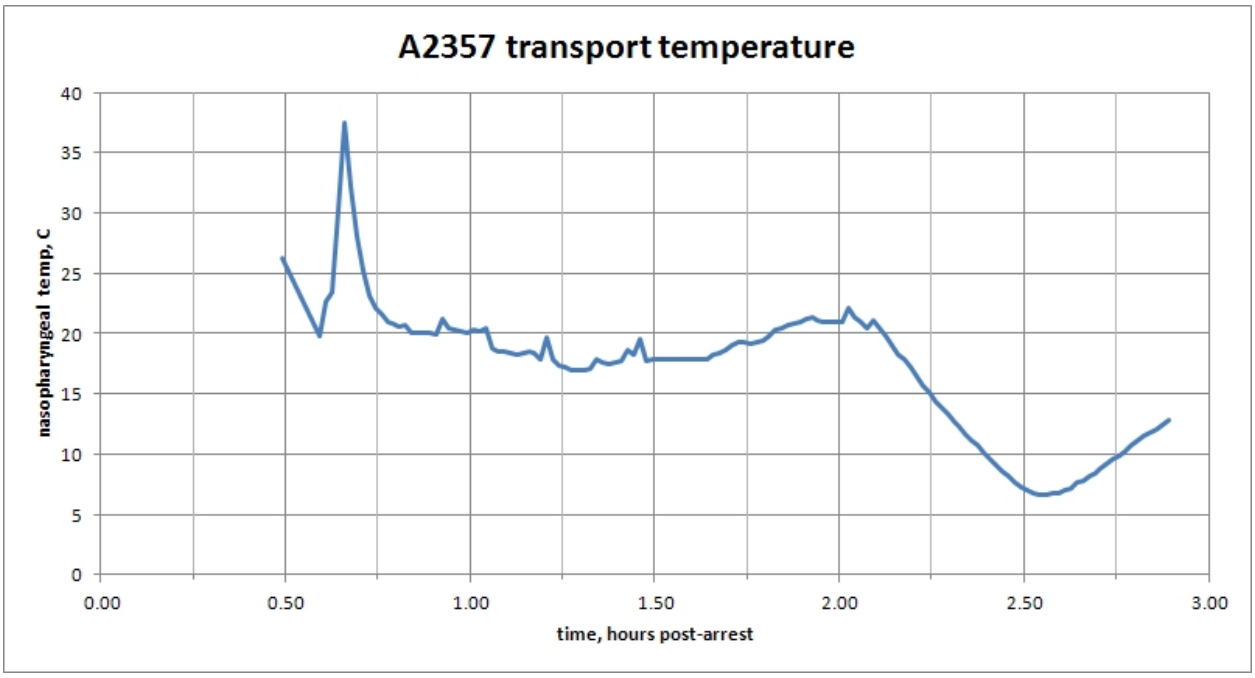
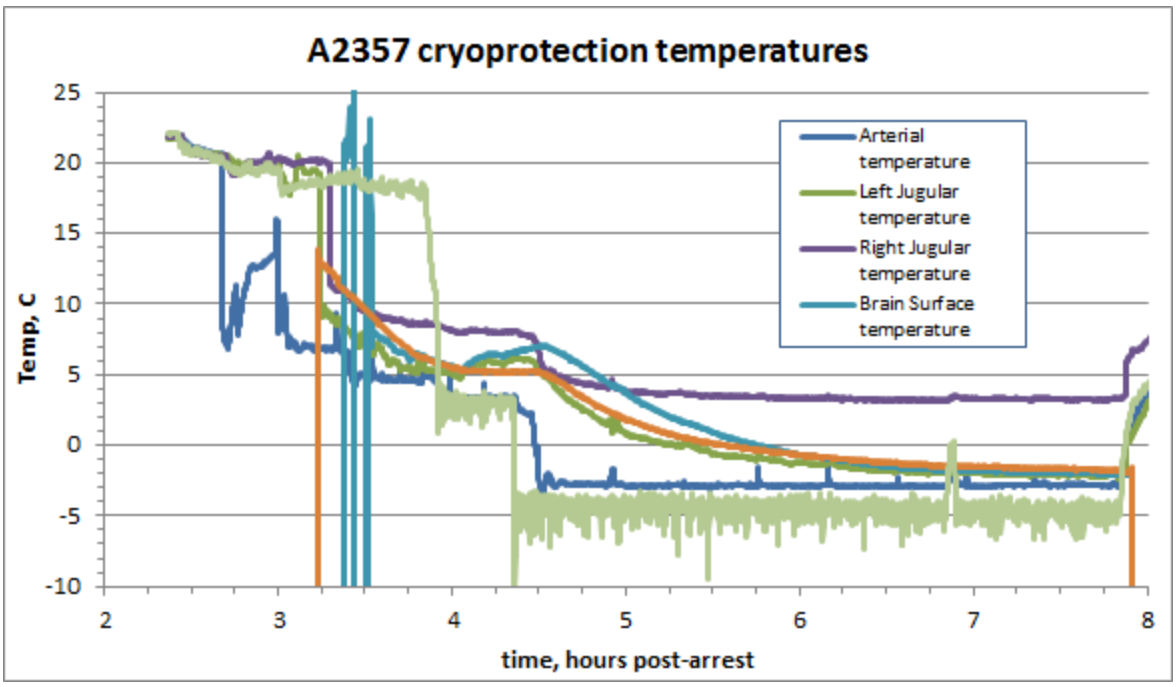
10. Graphs




A2357 cryoprotection temperatures
Temp, C
time, hours post-arrest
Arterial temperature
Left Jugular temperature
Right Jugular temperature
Brain Surface temperature
25
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-10
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7
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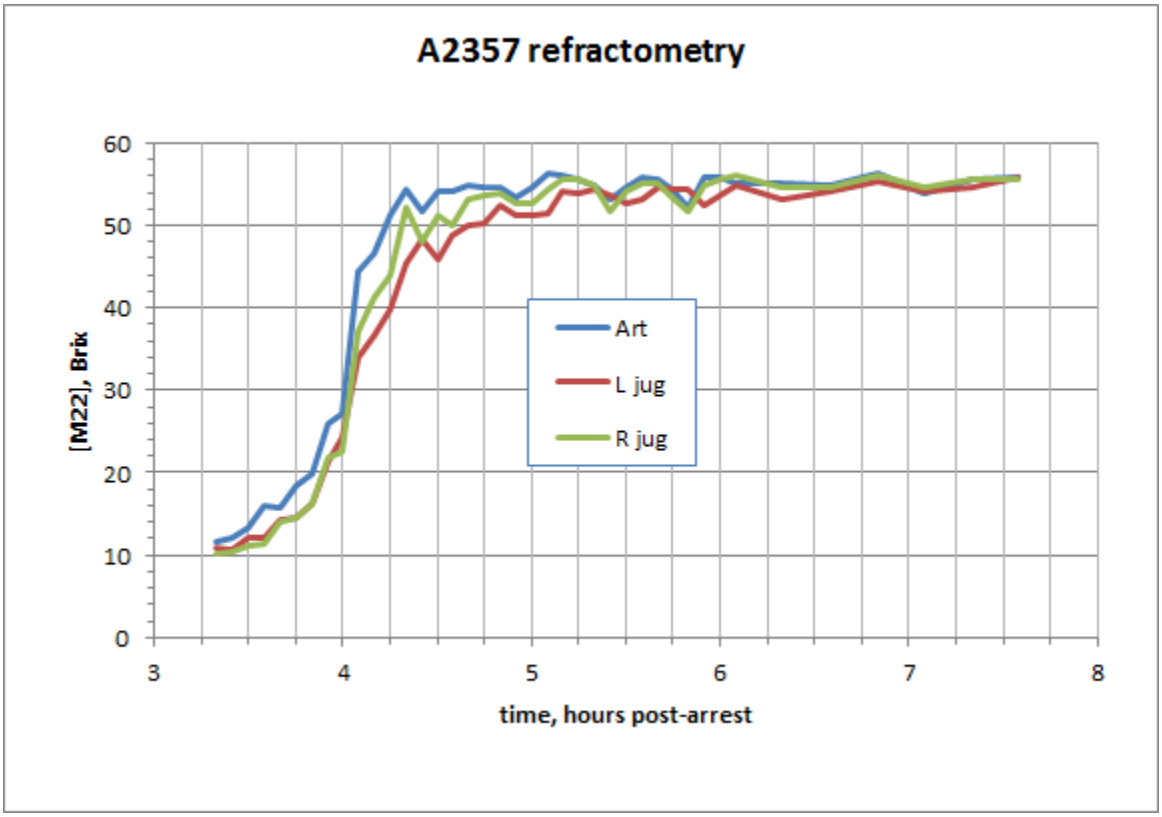
A2357 refractometry
[M22], Brix
time, hours post-arrest
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R jug
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50
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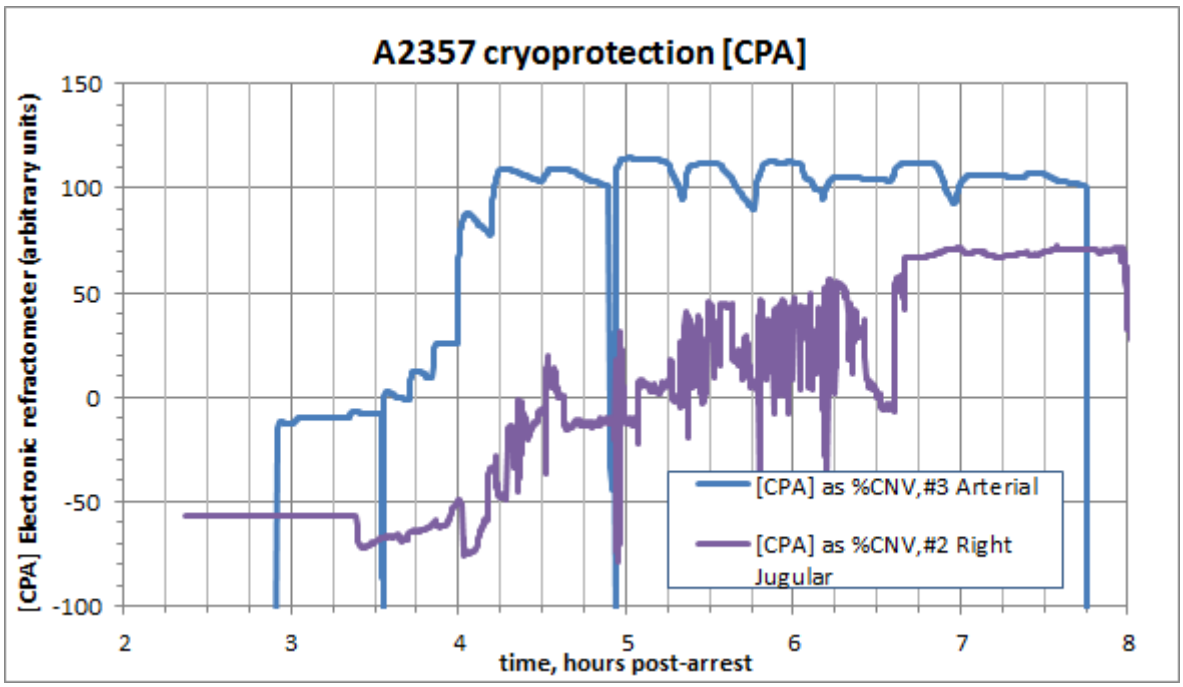
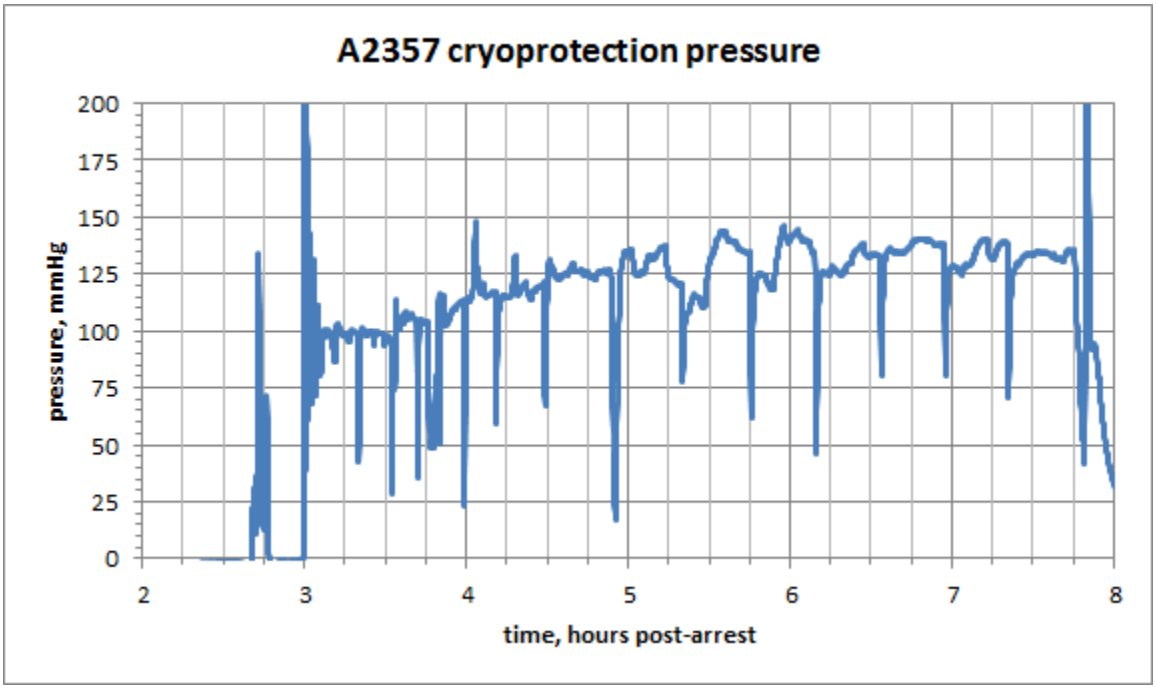
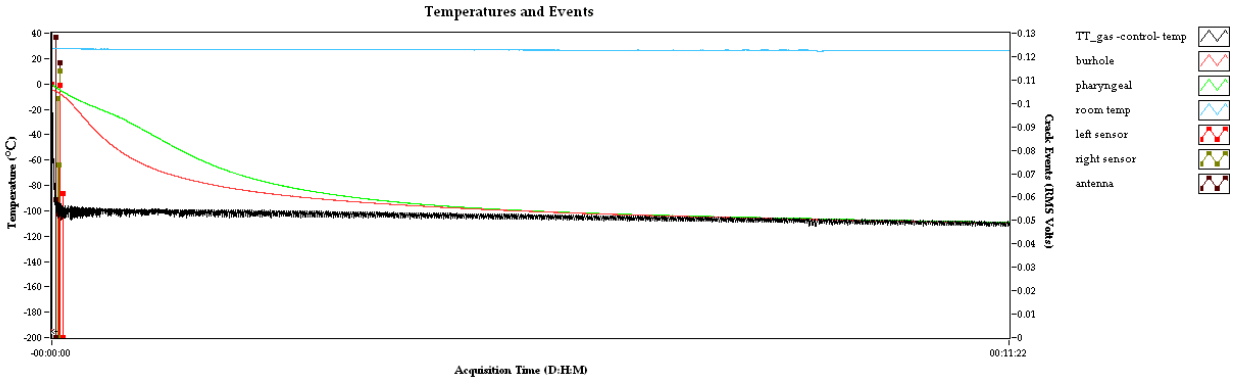
7
8





The sharp peak and valleys of this graph indicate when bags of perfusate were switched out and do not represent the actual cryoprotection pressure.


Temperatures and Events
Temperature (°C)
Crack Events (RMS Volts)
Acquisition Time (D:H:M)
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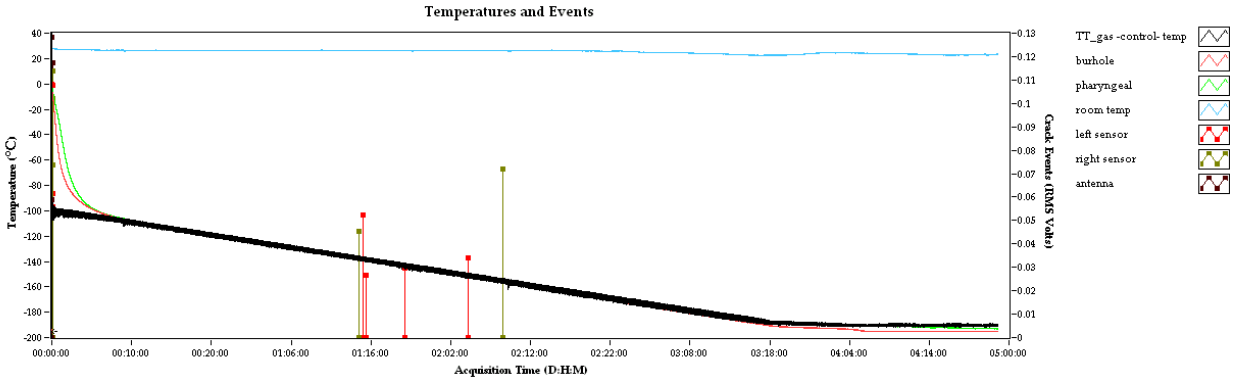
burhole
pharyngeal
room temp
left sensor
right sensor
antenna


Temperatures and Events
Temperature (°C)
Crack Events (RMS Volts)
Acquisition Time (D:H:M)
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01:16:00
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02:12:00
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03:08:00
03:18:00
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05:00:00
TT_gas -control- temp
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pharyngeal
room temp
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right sensor
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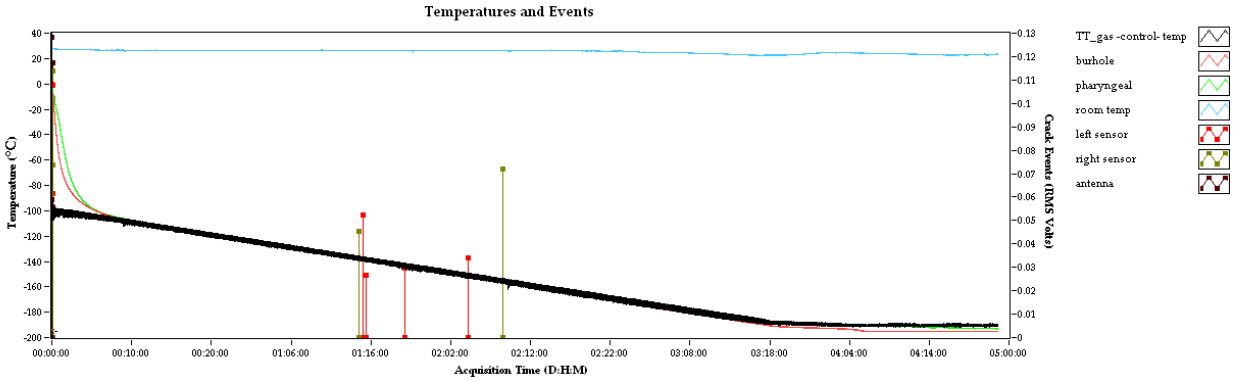
Temperatures and Events
Temperature (°C)
Crack Events (RMS Volts)
Acquisition Time (D:H:M)
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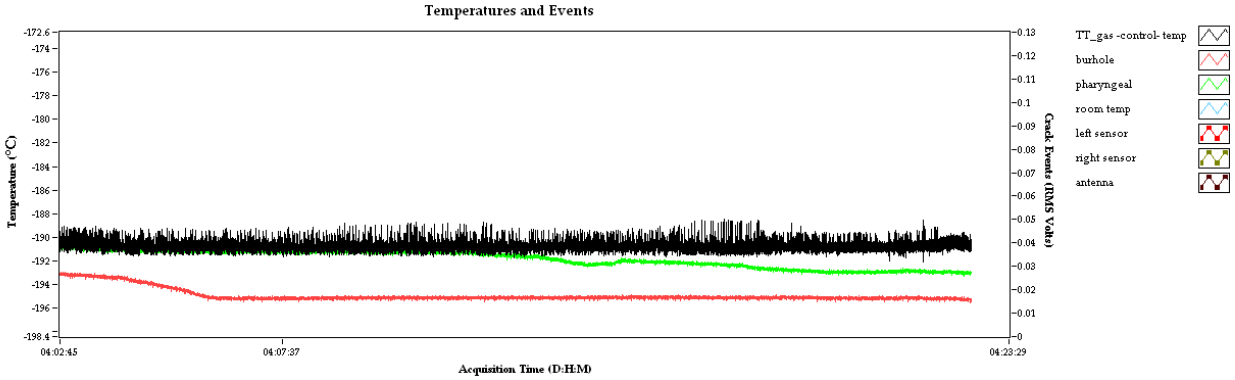
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Crack Events (RMS Volts)
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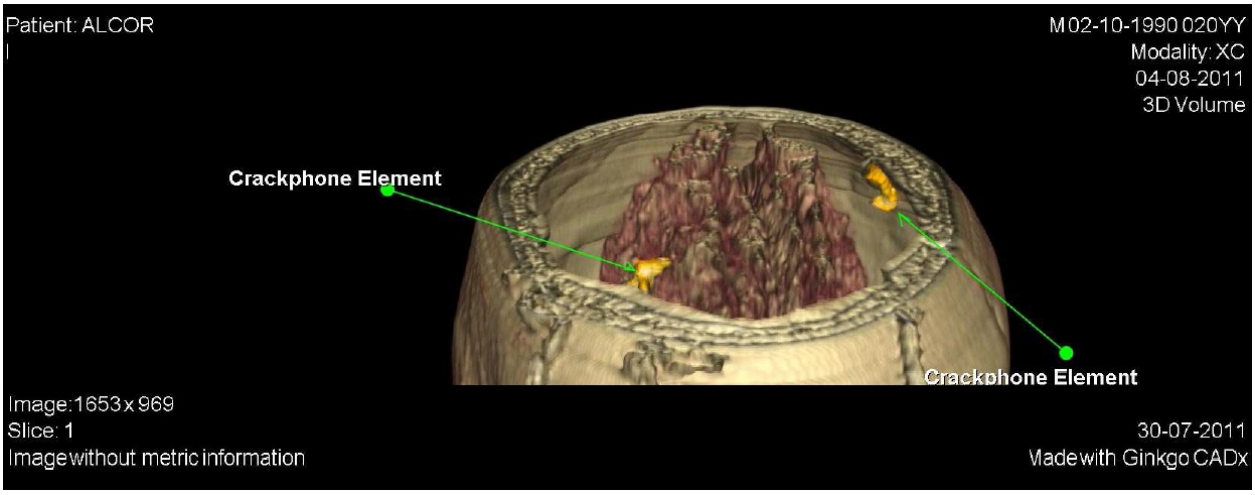
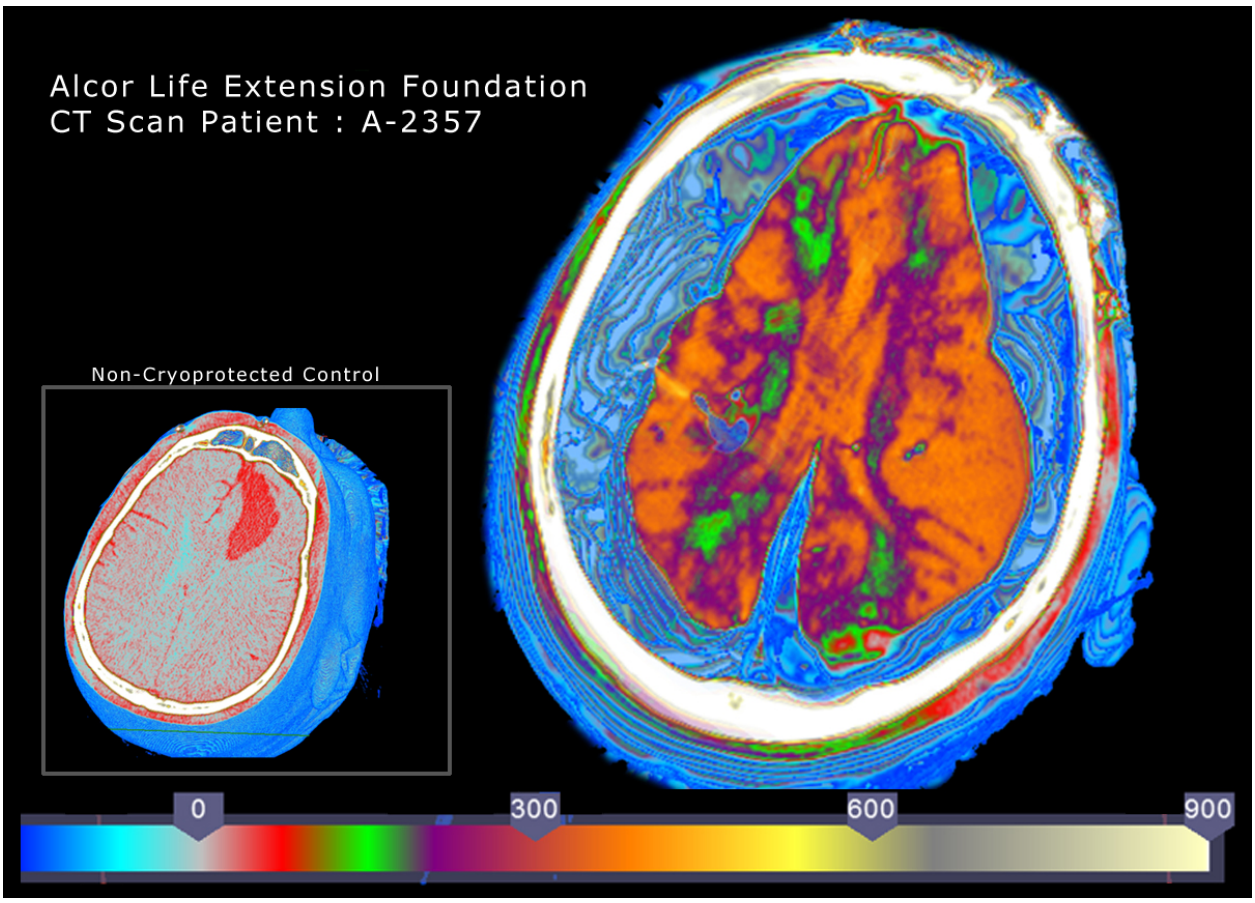
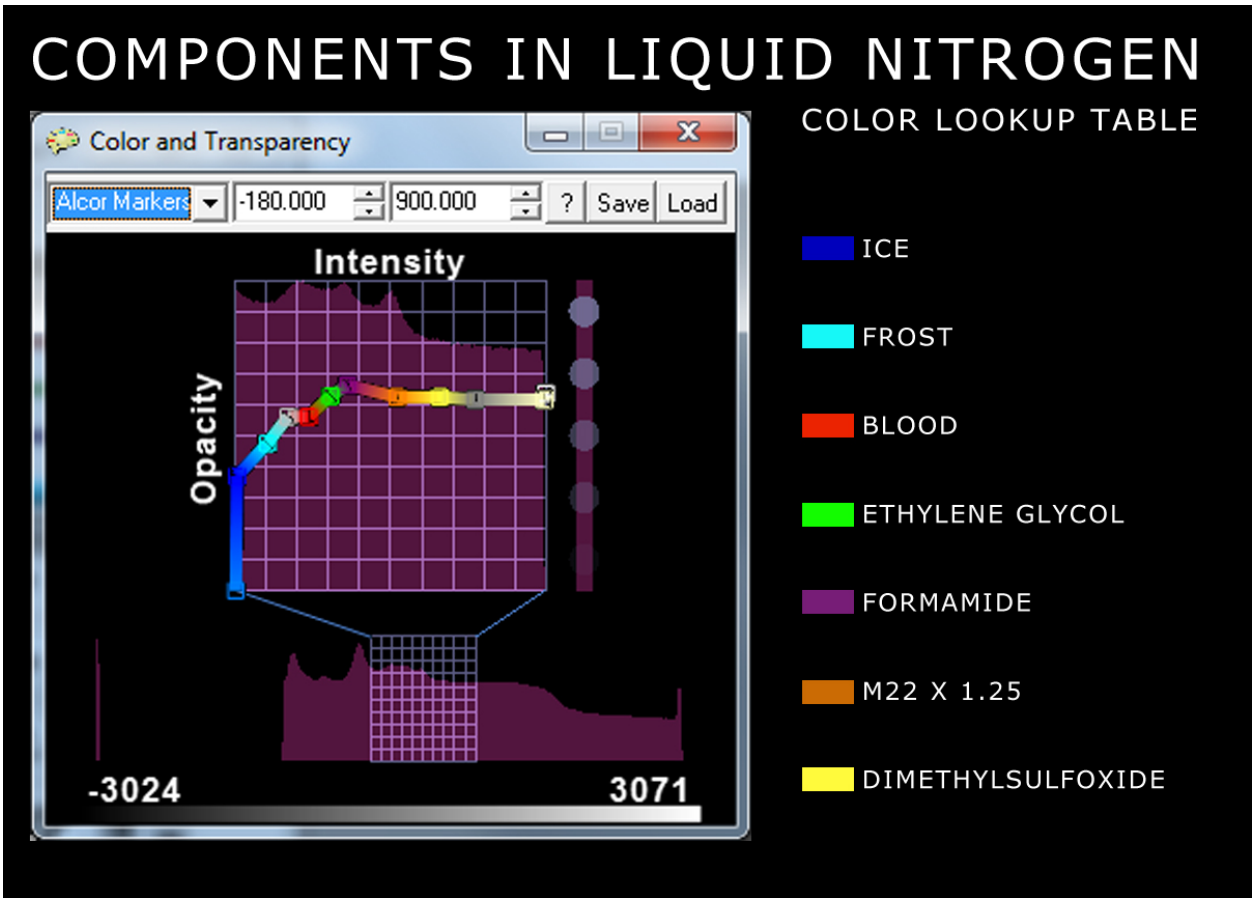
04:07:37
04:23:29
TT_gas -control- temp
burhole
pharyngeal
room temp
left sensor
right sensor
antenna

11. Post-Cryopreservation CT Scans

These cross-sectional images are created using 3-D reconstruction software from non-invasive CT scanner data. They allow a view through the top of the skull; however, the actual patient's skull is fully intact. The control sample color legend is posted as the final image.







-End of report –