Alcor A-3570

Internal Case

LIFE EXTENSION FOUNDATION
The World's Leader in Cryonics
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Prepared by:

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1. Summary

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

A-3570 was a 45-year-old member with neuro cryopreservation arrangements who was a last-minute, third-party sign-up. Per the death certificate the cause of death was acute respiratory failure. On T-0 days the member went into cardiac arrest at approximately 20:37 hrs and was pronounced legally deceased at 20:42 hrs in California in 2022.

After Field Cryopreservation (FCP), the patient was air transported to Alcor for cryogenic cooldown. The patient arrived at Alcor on T+2 days at 15:36 hrs. The cooldown was initiated on T+2 days at 16:47 hrs and terminated on T+7 at 00:30 hrs. The patient was transferred to long-term maintenance at liquid nitrogen temperature on T+49 days at 10:28 hrs. CT scans were made of the patient's brain on T+92 days at 11:00 hrs.

2. Patient Assessment and Deployment

T-0 days

Alcor received a message from the medical answering service at 18:17 hrs that a person was dying from acute septic shock from a cancerous tumor that had burst. Friends and family were inquiring about having this person vitrified. Alcor's CEO contacted them to check on the status of the patient and to give them information on how to proceed. Per the death certificate, the time of pronouncement of legal death was 20:42 hrs and it was estimated that the cardiac arrest was not more than five minutes prior to pronouncement, or at approximately 20:37 hrs.

T+1 days

The family called at 05:45 hrs for more information and to inquire further about Alcor's procedures and what would be needed for this patient to be cryopreserved. They were particularly interested in vitrification, not freezing. They had placed water ice around, and on the patient, at approximately 05:45 hrs, per instructions from a friend who was a former Alcor employee.

Alcor's CEO called Alcor's Scientific Advisor to see how to best proceed with this patient. The Scientific Advisor pointed out that for there to be any chance at vitrifying this patient, the cryoprotectant perfusion would need to be started within 24 hours of cardiac arrest and that since more than an hour had already lapsed since cardiac arrest, no stabilization medications should be administered, but the cryoprotectant perfusion should be started as soon as possible. The circumstances made a field cryoprotection the best option.

International Cryomedicine Experts (ICE), one of Alcor's strategic partners for providing standby, stabilization and transport (SST) as well as field cryoprotection, was deployed at 13:00 hrs.

3. Field Surgery and Washout

The ICE team arrived at the funeral home at 19:32 hrs and found the patient covered with bags of water ice. Surgical supplies were set up, and the patient was draped and prepped for surgery by 20:00 hrs.

The left carotid artery was isolated and cannulated at 20:15 hrs using a 90-degree metal cannula, paired with 20-gauge red Robinson cannula. The right carotid artery was similarly cannulated at 20:27 hrs. The gravity-induced perfusion flow was initiated on the left carotid artery at 20:45 hrs with Bladder #2 containing nM22 cryoprotectant with a concentration of 0.05 concentration needed to vitrify (CNV) (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).

Cryoprotectant perfusion was started (T+1, 20:45 hrs) within 24 hours after cardiac arrest (T-0, 20:37 hrs). At 20:51 hrs 10 ml of sodium citrate, an anticoagulant, and 25,000 IU of streptokinase, a thrombolytic used to break up existing blood clots, were injected into the first bladder #2. 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 (see the Discussion section for a more detailed explanation of the field equipment).

The height of the bladders on the teeter totter was 39 inches which is (39” x 2.054 mmHg per inch of height =) 80 maximum arterial pressure 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.

The patient’s head was shaved and prepped. At 21:20 hrs two burr holes were made using a Codman perforator and distilled water for cooling the perforator and the skull. A thermocouple was inserted into the right burr hole and sutured to the skin. The data logger was started at 22:40 hrs; the nasopharyngeal temperature (NPT) was 9°C and the burr hole temperature was -0°C.

The cephalic isolation was started at 21:45 hrs and completed at 21:55 hrs with a slotted head screwdriver and mallet (see the discussion section). The patient was septic and had a pungent odor emanating from the body following severing the trachea during the cephalic separation. Copious amounts of fluid drained out of lungs. Perfusion was paused at 21:57 hrs to move the patient into the perfusion container and perfusion restarted at 22:02 hrs.

To increase the flow rate, perfusion was paused at 22:10 hrs on the left carotid artery while the 90-degree metal cannula was removed. The remaining red Robinson cannula was again secured, and flow was restarted at 22:15 hrs. Perfusion was paused at 22:20 hrs on the right carotid artery while the 90-degree metal cannula was removed. The remaining red Robinson cannula was again secured, and flow was restarted at 22:26 hrs.

At 22:48 hrs bladder #6 was started, which represents the 30-minute pause to allow the patient to equilibrate.

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 6 & 7 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.

T+2 days

The field cryoprotectant perfusion was discontinued at 02:20 hrs. The final refractive index (RI) reading as taken from the venous effluent was 50.7 Brix. The final temperatures were 1.4°C nasopharyngeal and -3°C at the burr hole. The cephalon was placed in the neuro shipper and covered with dry ice at 02:35 hrs.

4. Transport

The funeral home called the ICE team leader at the hotel at 07:51 hrs and said they wanted to depart for the airport cargo department immediately to make the first available flight. ICE was unaware of this plan and let Alcor make the decision to depart or not, as ICE had not yet topped off the neuro shipper with dry ice. Alcor approved with the understanding that the funeral home personnel would add extra dry ice prior to dropping off the shipper at cargo.

5. Cooling to Liquid Nitrogen Temperature

The patient arrived at Alcor at 15:36 hrs on T+2 days and there was approximately 1” of dry ice covering the patient. The patient temperatures were 47°C at the burr hole and - 40°C NPT.

Computer controlled cryogenic cooldown was initiated at 16:47 hrs T+2 days, plunging to -110°C and descending thereafter at -1°C/hour to liquid nitrogen temperature. An uneventful cooldown was terminated on T+7 days at 00:30 hrs. On T+49 days, the patient was transferred to long-term maintenance at liquid nitrogen temperature. On T+92 days, CT scans were made of the patient’s brain.

6. Timeline and Time Summaries

Timeline

T-0	20:37	Estimated time of cardiac arrest
T-0	20:42	Pronouncement of legal death
T+1	05:45	Estimated time the family placed ice bags on patient
T+1	20:15	Start of field surgery
T+1	20:45	Start of open circuit bladder system cryoprotection (FCP)
T+1	21:45	Start of cephalic isolation
T+1	21:55	Completed cephalic isolation (end of field surgery)
T+1	22:48	Start 30-minute pause for equilibration
T+2	02:20	End of FCP (final RI = 50.7 Brix, NPT=3.7°C, BH= - 3°C)
T+2	02:35	Start of dry ice cooling
T+2	15:36	Arrival of patient at Alcor (- 40°C NPT)
T+2	16:47	Start of patient cryogenic cooldown
T+7	12:30	End of cooldown
T+49	10:28	Transfer of patient to long-term maintenance at LN2 temperature
T+92	11:00	CT scan at LN2

Time Summaries

Event Duration hr:min		days	time	
FIELD SURGERY AND CRYOPROTECTANT PERFUSION				
00:05	From: Till:	T-0 T-0	20:37 20:42	Estimated time of cardiac arrest Pronouncement of legal death
23:38	From: Till:	T-0 T+1	20:37 20:15	Estimated time of cardiac arrest Start of field surgery
01:40	From: Till:	T+1 T+1	20:15 21:55	Start of field surgery Completed cephalic isolation (end of field surgery)
24:08	From: Till:	T-0 T+1	20:37 20:45	Estimated time of cardiac arrest Start of open circuit bladder system cryoprotection (FCP)
05:35	From: Till:	T+1 T+2	20:45 02:20	Start of open circuit bladder system cryoprotection (FCP) End of FCP (final RI = 50.7 Brix, NPT=3.7°C, BH= - 3°C)
29:43	From: Till:	T-0 T+2	20:37 02:20	Estimated time of cardiac arrest End of FCP (final RI = 50.7 Brix, NPT=3.7°C, BH= - 3°C)
00:30	From: Till:	T+1 T+1	20:15 20:45	Start of field surgery Start of open circuit bladder system cryoprotection (FCP)
06:05	From: Till:	T+1 T+2	20:15 02:20	Start of field surgery End of FCP (final RI = 50.7 Brix, NPT=3.7°C, BH= - 3°C)
DRY ICE AND LIQUID NITROGEN COOLDOWN				
29:58	From: Till:	T-0 T+2	20:37 02:35	Estimated time of cardiac arrest Start of dry ice cooling
00:15	From: Till:	T+2 T+2	02:20 02:35	End of FCP (final RI = 50.7 Brix, NPT=3.7°C, BH= - 3°C) Start of dry ice cooling
42:59	From: Till:	T-0 T+2	20:37 15:36	Estimated time of cardiac arrest Arrival of patient at Alcor (- 40°C NPT)
01:11	From: Till:	T+2 T+2	15:36 16:47	Arrival of patient at Alcor (- 40°C NPT) Start of patient cryogenic cooldown

7. Table of Concentrations (Brix) of nM22 Solution

A-3570 step-ramp, nM22						
Preferred endpoint is effluent over 49.9 Brix for 1/2 hr						
2-liter bag called #	[nM22], CNV	Brix (calc)	bag started, hr:min MST	bag started, hr:min post-pro-nouncement	bag flow rate, ml/min	effluent, Brix
1	0.05	11.81	20:45	23:23		
2	0.08	13.14	21:02	23:40	118	
3	0.14	15.35	21:25	24:03	87	
4	0.23	19.03	22:04	24:42	51	
5	0.50	29.85	22:28	25:06	83	
6	0.50	29.85	22:48	25:26	100	29.7
7	1.06	52.31	23:08	25:46	100	
8	1.06	52.31	23:27	26:05	105	
9	1.06	52.31	23:47	26:25	100	
10	1.06	52.31	0:08	26:46	95	
11	1.06	52.31	0:31	27:09	87	46.3
12	1.06	52.31	0:54	27:32	87	49.6
13	1.06	52.31	1:17	27:55	87	50.2
14	1.06	52.31	1:40	28:18	87	50.3
15	1.06	52.31	2:04	28:42	83	50.5
END			2:20	28:58		50.7

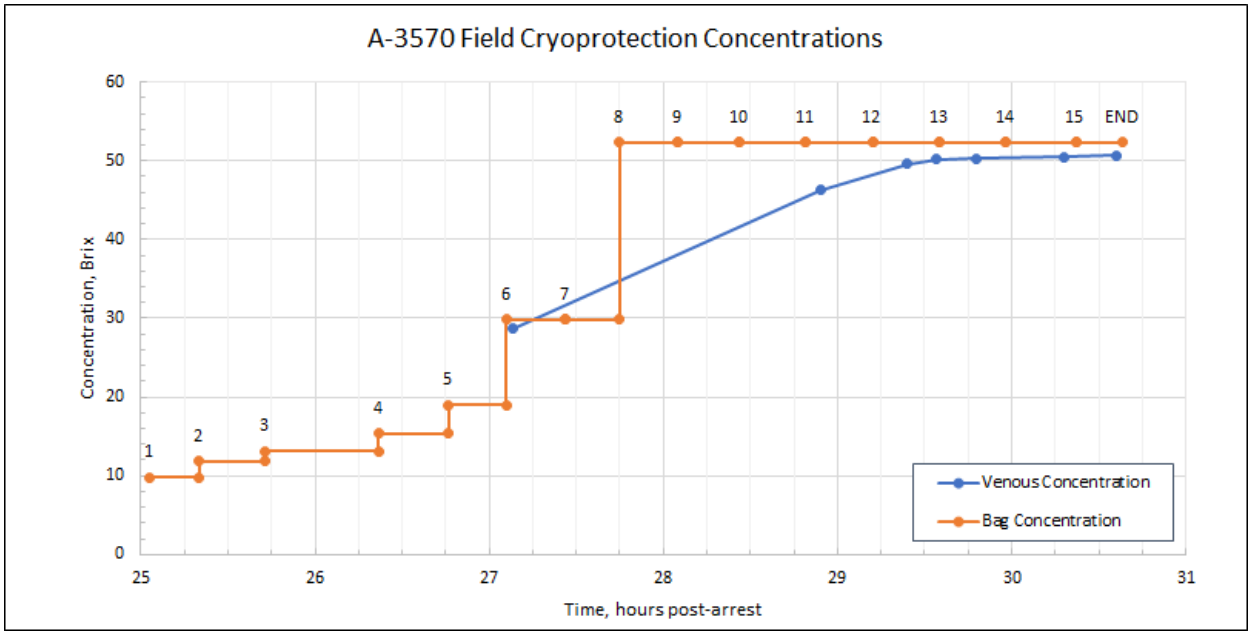
When the bladders with precalculated concentrations of cryoprotectant are made up in the lab, the first bladder in the series contains only the B1 carrier solution with no cryoprotectant and was intended to be used for purging air bubbles. Bladder #2 contains the lowest concentration of cryoprotectant. Limited experience with the bladder system, however, has shown that better edema control is provided when the initial perfusion is done with cryoprotectant. As a result, cryoprotectant perfusion is initiated with Bladder #2. When there is sufficient experience to make this the standard protocol, the lab procedure for creating the Bladders will be changed so that Bladder #1 will contain cryoprotectant.

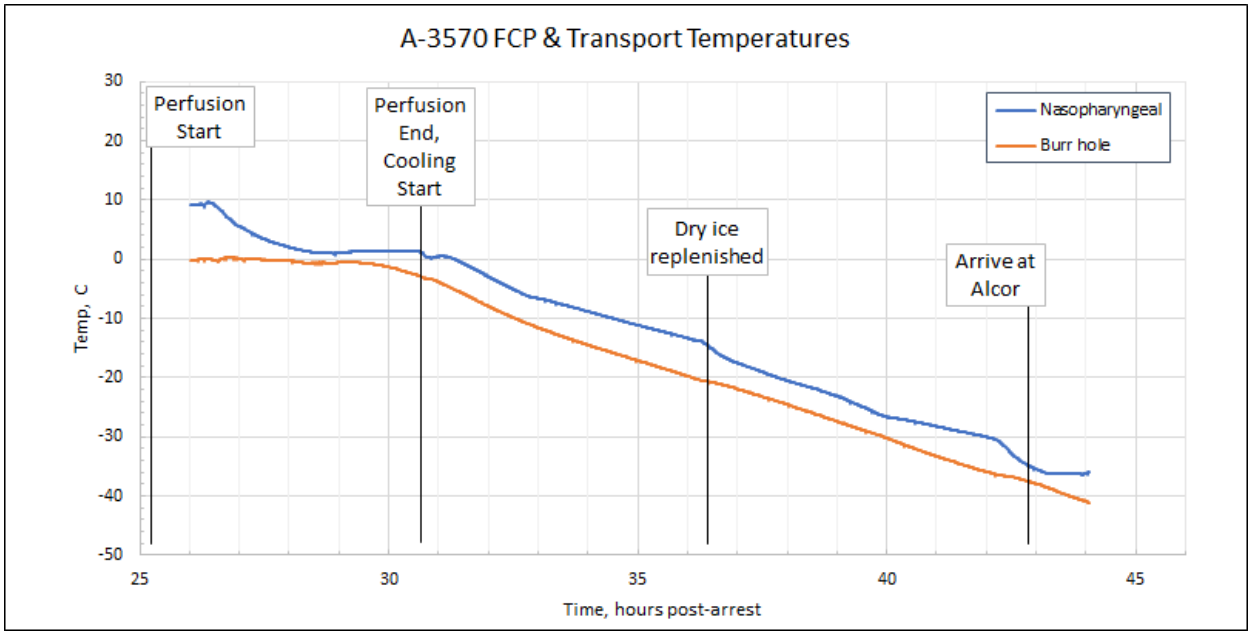
8. Discussion

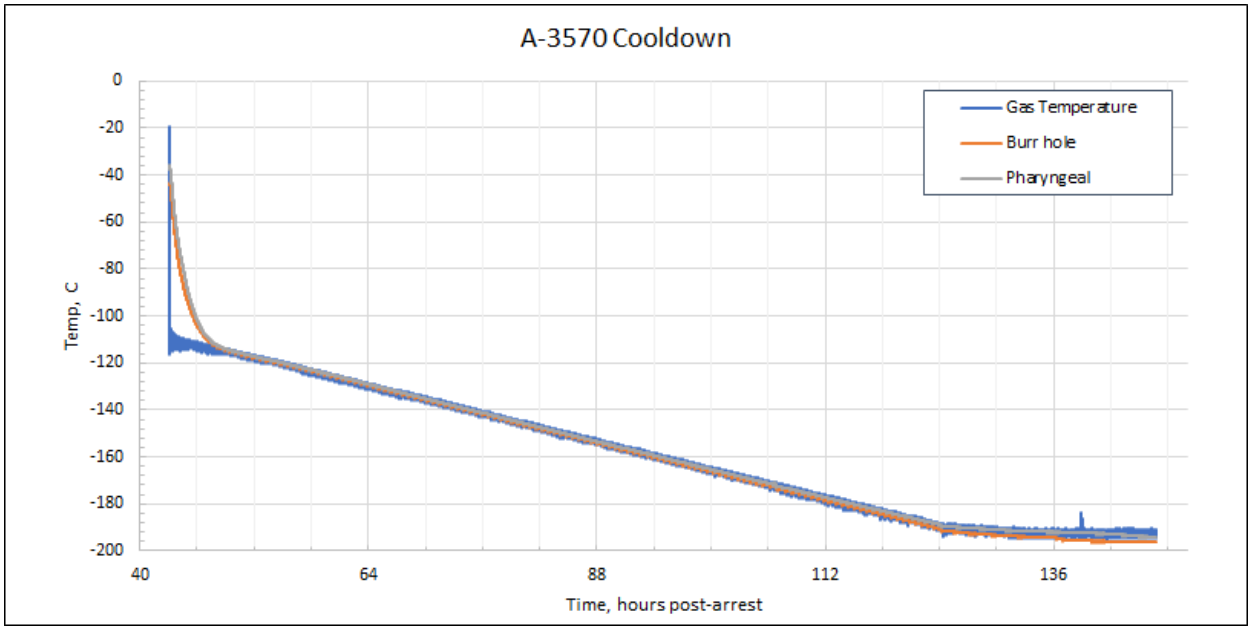
Standby and Stabilization

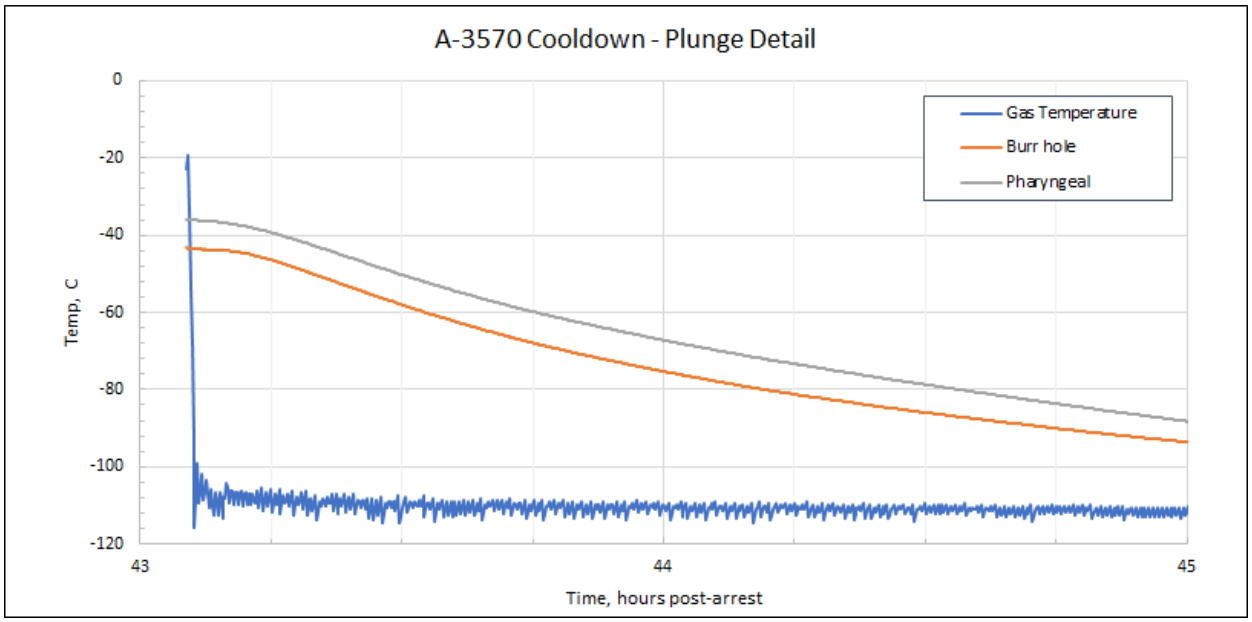
There was no surgical stapler in the kit. Extra silk and surgical needles helped secure both thermocouple probes. There was no osteotome in the kit, a slotted head screwdriver was used instead. Mortuary isolation gowns were used. This case took place at a time when there was little opportunity between cases to replenish the kits. Alcor staff will make every effort in the future to not allow this to happen again. The ICE team was resourceful in finding solutions.

9. Cryoprotection and Temperature Graphs






A-3570 Cooldown
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
Temp, C
40
64
88
112
136
Time, hours post-arrest
Gas Temperature
Burr hole
Pharyngeal


A-3570 Cooldown - Plunge Detail
0
-20
-40
-60
-80
-100
-120
Temp, C
43
44
45
Time, hours post-arrest
Gas Temperature
Burr hole
Pharyngeal

10. S-MIX

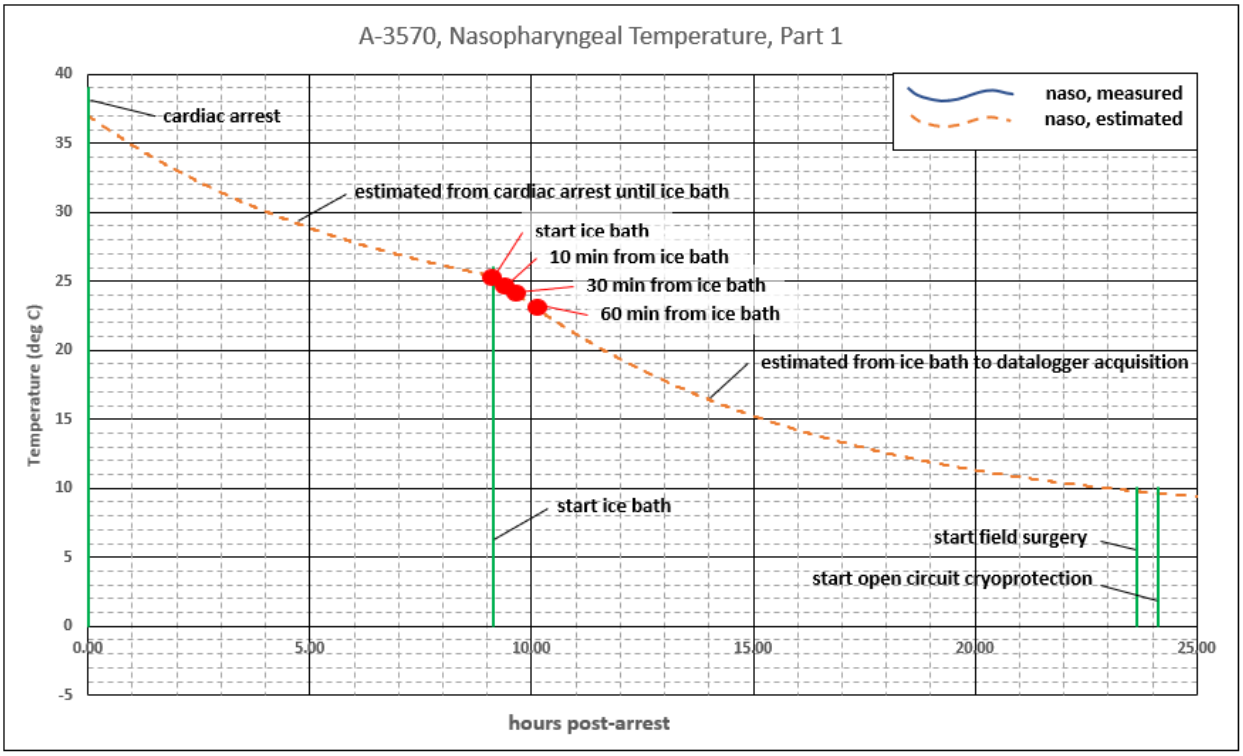
The Standardized Measure of Ischemic Exposure (S-MIX) expresses the total ischemic exposure prior to the start of cryogenic cooling as the equivalent duration of normothermic ischemia. An S-MIX of 00:00 (hh:mm) is the ideal case of no ischemic damage. The higher the S-MIX time, the more damage. Factors 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 31:25. As shown below, and due to lowering of the body temperature, S-MIX duration is shorter, at 09:24.

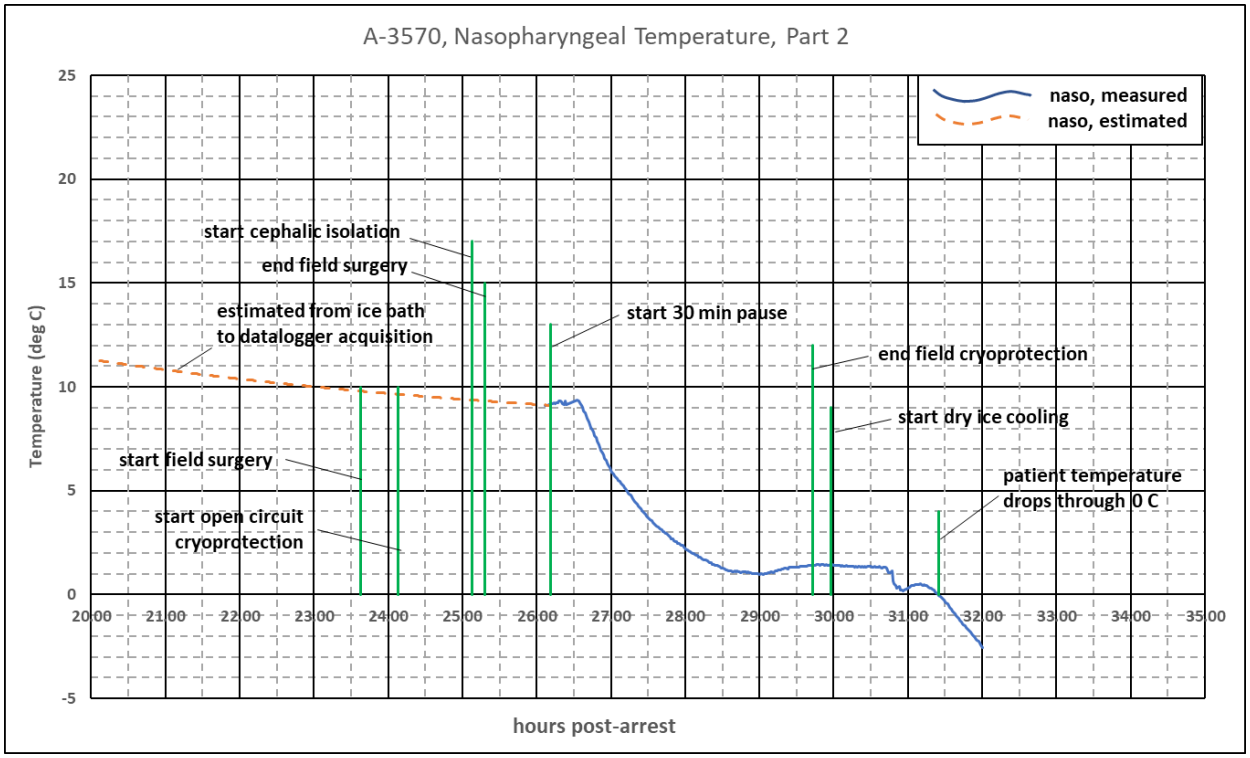
event	segment #	days (T+X)	time (MST) duration	post-arrest	Tnaso (deg C)	CPS w/ ventil.	washout oxygen.	S-MIX (hh:mm)
Estimated time of cardiac arrest		T-0	20:37	00:00	37.0			
	seg 1		09:08	09:08	-11.7	no	no	05:46
Patient packed in water ice		T+1	05:45	09:08	25.3			
	seg 2		14:30	14:30	-15.6	no	no	03:20
Start of field surgery		T+1	20:15	23:38	9.8			
	seg 3		00:30	00:30	-0.2	no	no	00:05
Start of open circuit bladder system		T+1	20:45	24:08	9.6			
	seg 4		00:60	00:60	-0.3	yes	no	00:04
Start of cephalic isolation		T+1	21:45	25:08	9.4			
	seg 5		00:10	00:10	0.0	no	no	00:01
Completed cephalic isolation (end of field		T+1	21:55	25:18	9.3			
	seg 6		00:53	00:53	-0.2	no	yes	00:00
Start 30-minute pause for equilibration		T+1	22:48	26:11	9.1			
	seg 7		03:32	03:32	-7.7	no	yes	00:00
End of FCP (final RI = 50.7 Brix, NPT=3.7°C, BH= -		T+2	02:20	29:43	1.4			
	seg 8		00:15	00:15	0.0	no	no	00:01
Start of dry ice cooling		T+2	02:35	29:58	1.4			
	seg 9		01:27	01:27	-1.5	no	no	00:07
patient temperature drops thru 0 deg C		T+2	04:02	31:25	0.0			
totals:			31:25	31:25	-37.0			09:24

The below plots show events related to the S-MIX calculation. Two multi-hour estimates are shown (orange lines) for patient temperature prior to the data logger coming online. The first estimate starts at normal body temperature and declines due to room temperature. The second estimate cools further once water ice is applied.

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 10, 30, and 60 minutes after the team first applies water ice.

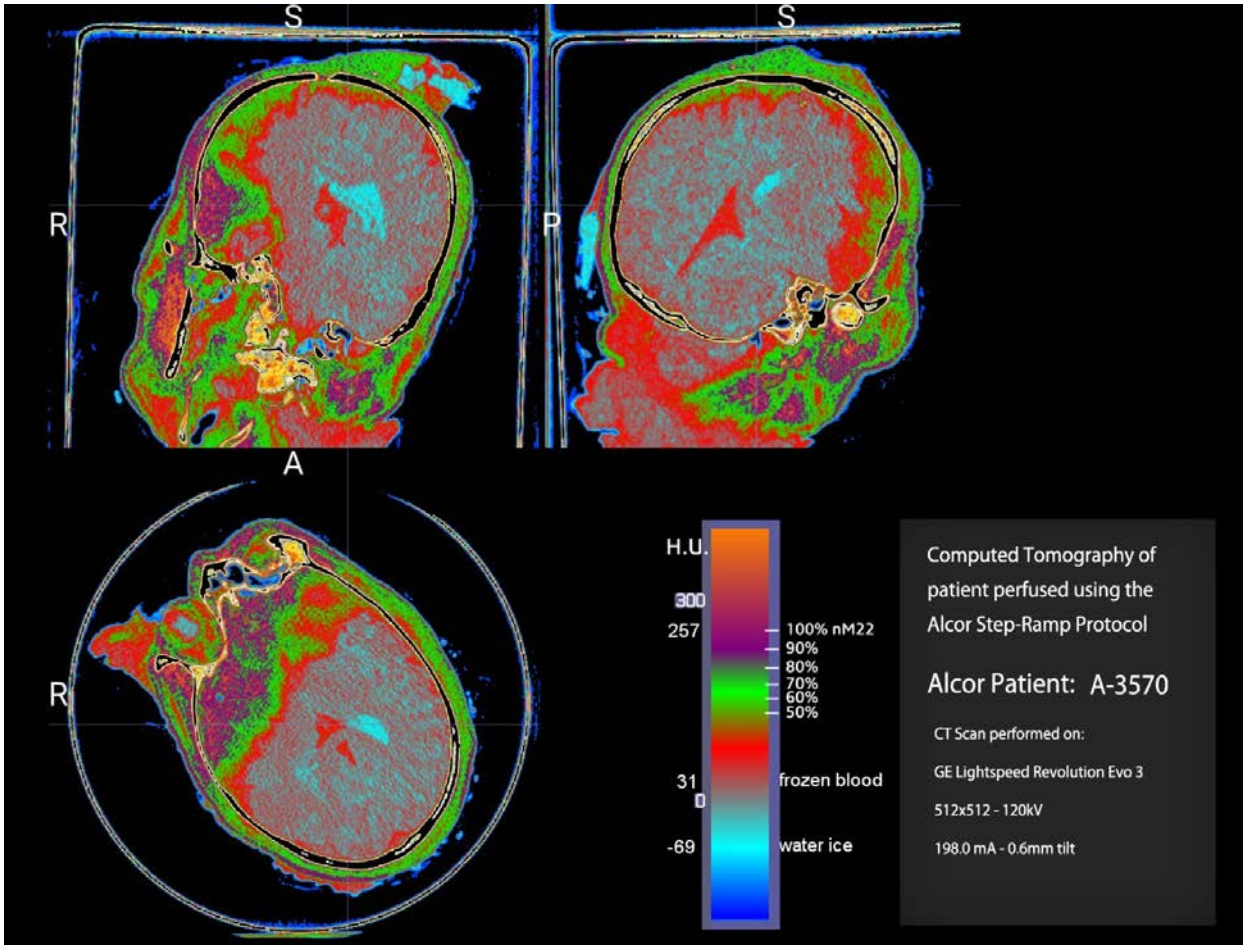
Patient Cooling Rate				
Note: time = 0 at start of ice bath	0 min elapsed	10 min elapsed	30 min elapsed	60 min elapsed
Naso temperature (°C)	25.4	24.9	24.1	23.0
Temperature drop (°C) from t = 0	0.0	-0.4	-1.2	-2.4
Cooling rate (°C/min) from t = 0	N/A	-0.04	-0.04	-0.04


A-3570, Nasopharyngeal Temperature, Part 1
naso, measured
naso, estimated
cardiac arrest
estimated from cardiac arrest until ice bath
start ice bath
10 min from ice bath
30 min from ice bath
60 min from ice bath
estimated from ice bath to datalogger acquisition
start ice bath
start field surgery
start open circuit cryoprotection
Temperature (deg C)
hours post-arrest


A-3570, Nasopharyngeal Temperature, Part 2
naso, measured
naso, estimated
start cephalic isolation
end field surgery
estimated from ice bath
to datalogger acquisition
start 30 min pause
end field cryoprotection
start dry ice cooling
start field surgery
patient temperature
drops through 0 C
start open circuit
cryoprotection
Temperature (deg C)
hours post-arrest

11. CT Scans

Cryoprotectant Distribution (Post-cryopreservation CT scan)



The post-cryogenic cooldown CT scan was obtained on December 6, 2022, at 11:00 hrs; the patient was at liquid nitrogen temperature (-196°C).

The CT scan result of this attempted field perfusion started at 20 hours postmortem. The scans show poor perfusion overall with minimal cryoprotectant uptake observed through the external carotid, maxillary, and facial arteries. Poor cryoprotectant uptake into the brain is consistent with high levels of edema preventing adequate vascular flow.