Summary of Cryopreservation Procedures Provided by Suspended Animation for Patient CI-81

Commencing Monday, June 4, 2007

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Preface

Appropriate format and content for cryonics case reports

There are two schools of thought regarding the style, format, and content that may be appropriate in reports of cryonics cases. Some people feel that since a report is a description of an experimental procedure, it should concern itself only with experimental data. Others feel that details regarding personnel, logistics, decision-making processes, and human factors are important since they affect the outcome of a case and may have instructional value for future teams doing field work. The issue of errors has also been mentioned, with some feeling that errors should be summarized briefly, while others advocating a full, frank, and detailed discussion even where the errors may reflect badly on the participants and the organization that managed the case.

In this report we have taken the broadest possible approach. We have included all forms of information available. We believe that any attempt to conceal negative factors will tend to damage credibility in cryonics, while full disclosure ultimately will encourage trust. Our only omission has been the names of personnel, since at least one person asked not to be named in the document.

We thank the participants in this case for their very hard work and their willingness to assist us in compiling this report.

1. Protocol

The protocol in this case was established previously by Suspended Animation in its contractual agreement with the Cryonics Institute. This protocol is included as Appendix 5 in this document. Deviations from it are noted as and when they occurred.

2. Personnel

Participants in this case

Because only three people were deployed to perform field work in this case, their roles overlapped and were not precisely defined.

Team Leader
Deployment of equipment, primary treatment decisions, cardiopulmonary support, administering medications, liaison with health care givers and the patient's relatives, assistance at mortuary.

Second Team Member
Participation in deployment, medications, cardiopulmonary support, collaboration with Team Leader at the hospital, running the Air Transportable Perfusion system (ATP).

Third Team Member
Participation in deployment, cardiopulmonary support, setup of ATP at mortuary.

Team Coordinator
Selection of team members, initial protocol and deployment decisions, remote follow-up.

Consulting MD
Medical and procedural advice.

Procedures Consultant
Advice and information on standby-stabilization procedures.

CI President
Information and authorization for procedures from the Cryonics Institute.

CI Facility Manager
Information and assistance from the Cryonics Institute.

Regional Funeral Director
Surgical procedures, legal paperwork.

Michigan Funeral Director
Supervision of cryoprotective perfusion.

SA Administrator
Financial and other decisions re deployment, assistance in planning, and logistics.

3. Medical and Personal History

Evidence of prior interest in cryonics

The patient was a member of the Cryonics Institute who had a long-standing interest in cryonics and a well-documented desire for cryopreservation. Since his family prefers to maintain confidentiality, and since he was the 81st patient at the Cryonics Institute, he is referred to as CI-81 throughout this document.

During the 1990s CI-81 had been a member of CryoCare Foundation. He made arrangements with the Cryonics Institute after CryoCare lost its primary service provider in 1999. A chemical engineer by profession, CI-81 was 77 years old when he suffered a hemorrhagic stroke on June 3rd, 2007, resulting in a coma from which he never regained consciousness.

According to the CI President, Suspended Animation's Consulting MD felt that the risk of additional brain damage could increase if the patient was maintained on a ventilator. However, family members requested that the ventilator should not be removed until they had assembled at the hospital the following day.

Time and cause of legal death

The patient was pronounced legally dead at 4:11 pm CST on June 4, 2007, with cause of death reported as "intra-cerebral hemorrhage, spontaneous."

CI-81 had established a prior relationship with the Regional Funeral Director and had visited his funeral home on more than one occasion. The Regional Funeral Director fully understood the fundamentals of cryonics and was very willing to cooperate. He had agreed to do manual chest compressions to circulate heparin (which the hospital agreed to inject before removal of life support) before packing the patient in ice. The son of CI-81 also expressed a strong desire to obtain optimal treatment for his father, even though the son did not have arrangements for cryopreservation himself.

4. Deployment

Initial contact with Cryonics Institute

On June 3, 2007, at 9:48 pm Eastern Daylight Time (EDT), the Team Coordinator received a call from the CI President notifying him that CI-81 had suffered a hemorrhagic stroke and was on life support in a hospital in the Great Lakes area. The patient's son was said to be interested in the possibility of having Suspended Animation administer medications, cooling, and cardiopulmonary support after legal death, followed by extracorporeal cooling and blood substitution before moving the patient to the Cryonics Institute. Since CI-81 had no prior legal or financial arrangement with Suspended Animation, the Team Coordinator recommended that the CI President should consult the SA Administrator for a decision on whether Suspended Animation would accept the case.

Slightly more than two hours later, shortly after midnight EDT, the SA Administrator confirmed that Suspended Animation would participate subject to logistical feasibility.

According to the SA Administrator, the next of kin planned to disconnect the ventilator at 11 am Central Daylight Time (CDT). The Team Coordinator was skeptical that equipment and personnel could be deployed to the bedside before this deadline, and he noted that he might be unable to participate because he was recovering from minor surgery and had been instructed by his doctor not to travel for another 10 days. The SA Administrator agreed that the Team Coordinator should not take part in the field work but authorized him to coordinate the case from Florida, and suggested that the patient's son might delay withdrawal of the ventilator if this would give team members sufficient time to arrive.

The Team Coordinator telephoned the CI President and obtained phone numbers of the patient's son and of the Regional Funeral Director, with authorization to contact both of them. The Regional Funeral Director had already conferred with the CI Facility Manager and was expecting to retrieve the patient from the hospital after legal death, take care of the necessary paperwork, and drive the patient to a point midway between the hospital and Cryonics Institute. At this location the Michigan Funeral Director would rendezvous, transfer CI-81 to his own vehicle, and drive the rest of the distance. The entire two-part drive was expected to take about 10 hours.

The Team Coordinator had no way of knowing whether the Regional Funeral Director would allow Suspended Animation team members to set up and supervise the ATP (Air Transportable Perfusion kit) in his facility, especially at such short notice. Since it seemed unwise to wake up the funeral director in the middle of the night to raise this issue, the Team Coordinator resolved to continue setting up the case on the assumption that he could probably obtain consent to perform bypass as soon as he could speak to the funeral director the next morning.

Initial contact with next of kin

Since the CI President believed that the patient's son would still be awake, the Team Coordinator telephoned him. He found that the son was extremely tired and distraught over the loss of his father, but was adamant that his father's wishes regarding cryonics should be honored as faithfully as possible. The son agreed to delay removal of the ventilator if necessary to allow the Suspended Animation team members to arrive, but since friends and family members were planning to be present, the delay before discontinuing life support should be as short as possible. The Team Coordinator promised to call back as soon as he had a better idea of the likely arrival time of Suspended Animation personnel at the bedside. The son also mentioned that he had asked that two IVs and an endotracheal tube should be left in place after pronouncement, and he said that the hospital would cooperate with this request.

Air travel options

The Team Coordinator and the SA Administrator conferred on the phone while using Internet travel services and airline web sites to review flights from West Palm Beach airport (PBI, located 15 minutes from Suspended Animation), Fort Lauderdale airport (FLL, located 45 minutes from Suspended Animation), and Miami Airport (MIA, approximately 75 minutes from Suspended Animation). No nonstop flights were available from any of these airports to the airport near the hospital where CI-81 was located. Moreover, all available flights involved commuter-sized aircraft for the final leg of the journey, apparently because the airport near the patient was not large enough for full-size commercial aircraft. The Team Coordinator was concerned that Suspended Animation's 12 pieces of standby equipment might not be accepted for a commuter aircraft, or might be split into more than one load, causing confusion and unacceptable delays.

The SA Administrator suggested flying to a larger city located some distance away. From there, the team could travel to the hospital in a rented van. Google Maps indicated that the distance from the larger city's airport to the hospital was 212 miles, entailing a road trip of up to four hours, which the Team Coordinator estimated would bring the team to the patient's bedside by around 2 pm CDT. Since nonstop flights were available to the larger city, the fly-drive combination probably would not add significantly to total transit time. Also, team members would be able to use the van ride as an opportunity to prepare themselves and draw medications, so that they would reach their destination fully equipped and ready to intervene. The Team Coordinator and the SA Administrator decided to proceed on this basis, using a three-hour flight that would leave PBI around 7 am EDT and reach its destination around 9 am CDT. The Team Coordinator notified the patient's son, who agreed with the plan.

Initial contact with team members

At approximately 1:15 am EDT the Team Coordinator telephoned the Team Leader. Although the Team Leader did not respond to the phone immediately, she returned the call within two minutes and agreed to participate in the case. The Team Coordinator asked her to contact other Suspended Animation employees and then meet him at the Suspended Animation facility, while he telephoned a consulting paramedic who is retained by Suspended Animation to provide emergency medical service in conjunction with half-a-dozen other paramedics and other medically qualified personnel. The consulting paramedic said that he was sick, and was not willing to fly out of PBI at 7 am. He said he would call other personnel on the emergency list. When he called back, he said that none of them was available to assist.

Subsequently the Team Coordinator spoke to another paramedic who had expressed a strong prior interest in participating in a cryonics case. The paramedic explained that less than half an hour earlier he had been the victim of a car accident involving an uninsured driver, entailing formalities and police paperwork that would extend into the next day. As a result he much regretted that he would be unable to participate in the case.

Two other candidates normally would have been asked to participate as team members, since the first was a former Suspended Animation employee with a strong interest in cryonics, and the second had played an active role in numerous cryonics cases. The first was in Arizona, and determined that even if he took the best available flight, he could not arrive in time. He made himself available as the Procedures Consultant by phone during the case. The second candidate was away on a trip to Europe.

Other people on the Suspended Animation call list as candidates for standby participation were in California, too far away to reach the hospital within such a short window of time.

Subsequent attempts to contact team members

Around 2:15 am the Team Coordinator drove to the Suspended Animation facility and met the Team Leader there. She reported that one employee had told her over the phone that he could not participate in the case because if he did, he could not report for work the next day at his part-time job at a local supermarket. (Subsequently he noted that he had warned some people at Suspended Animation that he might have limited availability for cases as a result of this part-time job.)

The Team Coordinator was concerned by the absence of this employee, who had prior experience in cryoprotective perfusion and could have been expected to run the Air Transportable Perfusion kit (ATP) if he had participated in the case. Other personnel had received some training in running the ATP but had not practiced with it significantly.

The Team Leader reported that she had been unable to get through to the Second Team Member; she had left a message on his voicemail.

At about 2:30 am EDT the Team Coordinator telephoned the Third Team Member, who answered the phone immediately and agreed to come to the Suspended Animation facility. The Team Coordinator now made a second call to the Second Team Member, and got voicemail. He also tried another potential team member, who did not answer.

Since the Team Coordinator felt that the presence of the Second Team Member was essential, he drove to his home located a couple of miles from the Suspended Animation facility, and woke him. The Second Team Member promised to join him back at the Suspended Animation facility within a short time.

Selection of stabilization equipment

The Team Leader assembled necessary containers, including medications and organ preservation solution from the refrigerators. She and the Team Coordinator decided to omit the Thumper, a mechanical device to give chest compressions and ventilations, since acquiring local supplies of compressed gas to power it would have been problematic. Precut thermal insulation for patient transport was also omitted, since the CI Facility Manager had assured the Team Coordinator that an insulated Ziegler transport container was already available at the local cooperating mortuary. Lastly the separate folding legs for the collapsible ice bath were omitted because the Team Coordinator saw no possibility that they could be used during this case.

The Third Team Member and the Second Team Member arrived at the Suspended Animation facility between 3:30 am and 4 am. Both were casually dressed, and the Team Coordinator suggested changing into clothes which would make a better initial impression on family members and hospital staff. They agreed to do this.

The Team Coordinator and the Team Leader made air reservations for all three team members and attempted to find a cargo van rental. None of the companies offering cargo vans (i.e. vans without seats or side windows in the load area) was available to take a reservation until normal business hours, so the Team Coordinator decided to make the reservation later, while the Suspended Animation team members were in transit. He then printed a series of maps from Google Maps showing the route from the destination airport to the hospital where the patient was located.

Personnel considerations

At this point the Team Coordinator considered calling other people to participate in the case. He felt reluctant to do so, for three reasons.

1. Financial. CI-81 had made no prior arrangements with Suspended Animation, and the case would be underfunded. While every effort would be made to assure full deployment, there was

a need to contain expenditures. (All clients with whom Suspended Animation has executed formal agreements are funded sufficiently to enable a minimum of four personnel, as is specified in the Protocol for SA-CI Standby. See Appendix 5.)

2. Personnel compatibility. The Team Leader, the Second Team Member, and the Third Team Member had worked together during several training sessions and case simulations. They had performed well and had derived a clear shared understanding of the tasks involved. The Team Coordinator believed they would function well as a team, and he was reluctant to experiment with the mix.

3. Favorable circumstances. No hostile family members were known to exist, and the Cryonics Institute had already established that the hospital and the local funeral director seemed willing to provide extensive cooperation including leaving the IV and endotracheal tube in place. Therefore, the case should be relatively easy to complete.

On balance the Team Coordinator decided to proceed with three team members. The ramifications of this decision, and lessons which may apply to future cases, are discussed in Section 9, Discussion and Recommendations, below.

Preparations for departure from Florida facility

The Team Leader expressed some trepidation about performing her role. The Team Coordinator spent half an hour with her reviewing the principal duties and procedures that would be involved, most of which had been rehearsed in training and practice sessions. Together they did some role-playing simulations to explore typical problems and their solutions.

The Second Team Member and the Third Team Member moved all the standby containers into a pickup truck owned by Suspended Animation, since in this case there was no advantage in driving Suspended Animation's transport vehicle to the airport. The Second Team Member suggested bringing the Autopulse cardiopulmonary support unit, which had been converted to be compatible with an ice bath but had not been extensively tested. The Team Coordinator agreed, since use of the Thumper had been ruled out.

The Team Coordinator left the team members and went back to his apartment around 4:30 am, where he sent emails to the SA Administrator and the CI Facility Manager confirming that a limited Suspended Animation team would be deployed as planned. Meanwhile the team members set out in the pickup truck to PBI, probably leaving the Suspended Animation facility around 5:30 am, although there are conflicting recollections regarding the exact time. The gasoline tank of the pickup truck was approximately one-quarter full, providing sufficient fuel to reach PBI, although it might not have been sufficient to reach FLL.

While two team members hauled the 12 containers into the airport and checked them as personal baggage, the Third Team Member parked the truck and returned to join his companions. The total excess baggage charge for all of the containers was about $800. With very little time to spare, all three team members boarded the flight.

Final logistical preparations

At 8 am EDT the Team Coordinator began checking cargo-van rental companies online, but could not determine whether any of them had a rental location sufficiently close to the destination airport. He started using the phone instead, and made a reservation for one van. He also made a backup reservation with a second company and then verified the locations on Google Maps.

Around 9 am EDT he called the Regional Funeral Director, who seemed very willing to assist Suspended Animation personnel in the initiation of rapid cooling and cardiopulmonary support

Decisions in conjunction with the Regional Funeral Director

and the administration of medications. Since the Regional Funeral Director appeared to be on good terms with hospital staff, the Team Coordinator asked him to provide additional verification that they would allow any IVs to remain in place, and to leave the patient intubated. The Regional Funeral Director promised to deal with this. He then explained that he had arranged to take CI-81 to a mortuary near the hospital, instead of using his own mortuary, because his was a one-hour drive away. The owner of the nearby mortuary would allow it to be used for packing the patient in ice for ground transport to Michigan.

At this point the Team Coordinator introduced the idea of using the ATP. The funeral director expressed concern that the local mortuary might not permit this. He was willing to allow it in his own location, however. Therefore the Team Coordinator faced the following choice:

a) Use the local mortuary. Transport time would be reduced by one hour, but blood washout probably could not be done, and the patient would receive surface cooling only. Possibly negotiations would enable use of the ATP, but the Team Coordinator felt he had to make a quick decision, and also felt inclined to trust the Regional Funeral Director's judgment.

b) Use the Regional Funeral Director's own mortuary. An initial hour (minimum) would be added to transport time, but blood washout and substitution would be possible, with rapid cooling to around 5 degrees Celsius prior to the ten-hour drive to Michigan.

The Team Coordinator chose option b). He offered an additional fee to the Regional Funeral Director to cover the unexpected procedure. The fee was accepted, and the plan for the case was now complete.

Arrival of team members at airport

Around 10 am EDT the Team Coordinator received a call from the Team Leader notifying him that their airplane had just landed on schedule. About half an hour later the Team Coordinator spoke to the Third Team Member and told him how to find the van rental office. While the Team Leader and the Second Team Member waited by the baggage carousel, the Third Team Member took a taxi to the van rental location and completed formalities there.

The Team Coordinator remained by the phone in Florida for the rest of the case, maintaining contact with team members on an intermittent basis. In addition he spoke several times with the Consulting MD and the Procedures Consultant. The latter was skeptical about the wisdom of using the ATP, since none of the team members had been extensively trained with it, and anecdotal observations from other cryonics organizations suggest that more edema is observed in patients that receive remote washout. The issue of whether blood washout and replacement should have been attempted is discussed in Section 9, Discussion and Recommendations, below.

At the destination airport, eleven of the twelve transport containers were collected from the baggage carousel without any problem, but the twelfth item, a black nylon bag containing the collapsible portable ice bath, did not appear. The Second Team Member found that it had been taken off the airplane separately and was waiting at an area reserved for unusually heavy, bulky, or fragile items.

Team members begin road trip

At approximately 10:15 am CDT the team loaded all standby containers into the rented van. By 10:30 am CDT they were on the road with the Third Team Member driving, the Second Team Member providing directions, and the Team Leader in the rear of the vehicle. The Team Leader telephoned the patient's son and the Regional Funeral Director to inform them of the team's likely arrival time. According to the Team Leader, the patient's son sounded exhausted and

deeply upset, but thanked the team for coming all the way from Florida, and pledged to wait until the team arrived before allowing hospital staff to remove the ventilator. The Team Leader then called the Team Coordinator to update him.

Preparation of medications

Around 10:40 am CDT the Team Leader began drawing medications while the van ride continued. Since she knew she had plenty of time, she was able to work slowly and carefully to minimize the risk of errors. She called the CI Facility Manager to obtain the patient's weight, so that she could calculate the correct dosage for medications that vary by body weight. She encountered a problem, however, when following instructions to add citrate-dextrose to dissolve NiKy, a combination of two neuroprotective dry chemicals. It had formed hard lumps in its vial ranging in size from around 1 mm to 5 mm each. These lumps would not dissolve, would not break up, and could not be filtered. The Team Leader telephoned the Team Coordinator, who advised her to call the Consulting MD. She did so, but obtained no reply. She next tried the Procedures Consultant, who advised her to remove the stopper of the vial and try to use the needle tip to break up the lumps, and emphasized the need to filter-sterilize the solution. Instead she passed the vial to the Second Team Member and asked him to keep shaking it in the hope that the lumps would dissolve.

The Consulting MD returned the Team Leader's call a short time later and advised her that the NiKy should dissolve if it was agitated sufficiently. After the Second Team Member had continued shaking it for a while without noticeable improvement the Team Leader drew some of the solution into a syringe, but only with great difficulty, and she could not pass it through a 0.2 micron syringe filter. At this point she gave up on it and continued with the other medications. She finished drawing medications at 12:52 pm CDT.

The Team Leader spoke again with the Procedures Consultant to verify medications sequence and priorities. He emphasized that she should push Propofol, streptokinase, heparin, and vasopressin as soon as possible after pronouncement, before the patient was moved. He also emphasized the importance of using the inspiratory impedance valve to improve cardiac output during cardiopulmonary support.

The Team Leader telephoned the Regional Funeral Director and updated him with the current location of the team. He assured her that he would meet her at the hospital. The Team Leader now estimated that they would arrive about 1:30 pm CDT.

The Second Team Member was able to catch one hour of sleep during the drive, and also had time to review a document outlining standby procedures.

Acquiring supplies

At 1:30 pm CDT the team arrived in the town where the hospital was located. At 1:50 they stopped at a CVS pharmacy to buy four 48-quart ice chests, five 20-lb bags and fourteen 7-lb bags of ice, and six gallons of bottled water. They continued to the hospital where they met the Regional Funeral Director around 2 pm CDT. The Team Leader described the planned procedures to the Regional Funeral Director and verified that he understood and would assist. He assured her that the hospital would leave two IVs in place, along with the endotracheal tube.

Arrival at hospital

The Regional Funeral Director advised the team to park their rented vehicle across the street from the hospital. They moved their equipment into the building via a tunnel and took it up in an elevator to the floor where the patient was located. The Team Leader met the patient's son and expressed her sympathies. He introduced her to a nurse who had been informed about the impending procedures, and she promised to help in any way she could.

Equipment setup

The standby equipment was transferred to a small room near the patient's room. The Suspended Animation portable ice bath was unfolded and assembled, but the telescopic IV pole, which is normally included in the bag with the ice bath, was not found. (After the team returned to Florida they discovered that the pole had been placed erroneously with the set of folding legs for the ice bath, which the Team Coordinator had decided to omit.)

The Second Team Member attempted to start a voice recorder, but found that it would not go into record mode. A second voice recorder appeared to have dead batteries, but worked when he transferred batteries from the first recorder.

The Team Leader prepared the first four medications while the Second Team Member unpacked the Autopulse. A nurse asked the Team Leader how much longer she would be, and she asked for fifteen minutes. The nurse went to confer with the patient's son, then returned and said that the son wished to discontinue the ventilator immediately. The Team Leader felt unable to refuse. The ventilator was disconnected soon after 3:00 pm CDT, but voice records suggest that the patient continued breathing without assistance.

As soon as the primary equipment was ready, the Team Leader and the Second Team Member wheeled it to a position just outside the door to the patient's room. At this time, approximately eight family members were gathered in the room. Possibly because the presence of the team members outside the room was considered a distraction, a nurse asked them to move their equipment back to the room where they had deployed it originally. They complied and waited there.

At 3:50 pm CDT approximately, they were informed that the patient's heart was still "beating very slowly." Around 4 pm CDT a nurse came and asked the Second Team Member if he wanted her to administer heparin. The Second Team Member said yes. The team was unable to act yet, since no one had pronounced legal death.

Around 4:05 pm CDT the Team Leader attached the ResQpod impedance valve to the bag valve. At 4:11 pm CDT the patient was pronounced, enabling the Team Leader and the Second Team Member to go to the bedside and commence procedures.

5. Cardiopulmonary Support and Initial Cooling

Initial procedures after pronouncement

The Team Leader and the Second Team Member moved their equipment into the patient's room, including ice bath with privacy cover, two ice chests, icewater recirculation assembly, lifting sling, medications, Ambu CardioPump, and Autopulse. The nurse whom the Team Leader had dealt with previously was present and stated that she had already pushed heparin, although the precise dosage was unclear. The Team Leader asked her if she would push the next three medications (Propofol, streptokinase, and vasopressin), and she agreed. Meanwhile the Second Team Member connected the impedance valve to the endotracheal tube and applied chest compressions with the CardioPump, supplying occasional ventilations via bag valve. The colorimetric end tidal CO2 detector was not placed.

After the first four medications were administered, the sheet-drag method was used to move the patient and lower him into the ice bath with assistance from some nurses and the Regional Funeral Director. The patient had to be moved upward slightly in the ice bath to achieve proper alignment with the Autopulse. The Team Leader inserted the rectal plug with temperature

probe and inflated its collar to retain it in place. Ice was added to the head, groin, armpits, and other areas. The Team Leader added all the water that the team had brought, but it was insufficient, and she had to fetch more. After that she started the icewater recirculation assembly and noted that it distributed water over the body.

Cardiopulmonary support

Because the patient had a relatively large chest and was heavyset, the Second Team Member experienced some difficulty fitting the belt of the Autopulse around the chest. When he started the Autopulse it ran for three cycles and then stopped, showing an error message. The Second Team Member tried it twice more, with the same result each time. He felt that the problem was caused by the belt binding in contact with the body fat of the patient, and he saw no easy way to address this problem. He removed the Autopulse and resumed chest compressions manually with the CardioPump.

Transport to mortuary

Shortly thereafter the privacy cover was placed over the patient, the ice bath was rolled out, and Suspended Animation containers were stacked on a gurney. Everything was relocated downstairs to wait for the Regional Funeral Director's Chevy Suburban. The Team Leader and the Second Team Member took turns doing chest compressions while waiting. The Team Leader contacted the Regional Funeral Director via his cell phone, and learned that he was finishing the necessary paperwork. After he arrived, the patient in the ice bath was loaded into the rear of the Suburban with the Team Leader and the Second Team Member, while transport containers were stacked on the front passenger seat. The ice chests were abandoned.

The Second Team Member continued to apply chest compressions with the CardioPump, and ventilated the patient with bag valve. Pulling up on the CardioPump was awkward and strenuous in the confined space at the rear of the vehicle. In any case, the patient's chest had not been shaved, and there was no way to access the razor in its standby container during the drive. Still, the Second Team Member felt he was able to exercise some upward pull.

Additional medications

The Team Leader administered the remaining small-volume injectable medications, including the second half of the vasopressin (100 IU). The epinephrine was accidentally administered as one single bolus instead of intermittently. She then started the high-volume fluids. She relieved the Second Team Member doing chest compressions from time to time.

In the absence of the IV pole (for which there would have been insufficient headroom anyway) she hung medication bottles from coat hooks and grab handles built into the vehicle. At 5:15 CDT the Team Leader started a drip but experienced difficulty obtaining sufficient flow with Vital-Oxy (a proprietary antioxidant emulsion supplied by Critical Care Research). She hooked up the Dextran 40 at 5:25 pm and experienced the same problem with slow flow

She called the Procedures Consultant about the problems in getting adequate flow and he advised her to draw the Vital-Oxy in large syringes instead. The Second Team Member pulled about 50 ml of Vital-Oxy into a syringe, and pushed it around 5:57 pm CDT. They pushed about 250 ml of Dextran 40 around 6:07 pm, and an unknown amount of THAM at 6:13 pm (some of the THAM was spilled accidentally). Kneeling in the rear of the vehicle while administering medications and chest compressions was extremely difficult and physically taxing. No attempt was made to administer Maalox (an antacid).

The team reached the mortuary around 6:15 pm CDT.

6. Blood Washout and Substitution

ATP setup at mortuary

The Third Team Member had left the hospital and set out to the mortuary in the rented van soon after 2 pm CDT, so that he could set up the ATP and have it ready before the other two team members arrived with the patient. Although the Third Team Member's assistance at the hospital would have been welcome, it was felt that getting the ATP fully deployed and primed was a higher priority.

The Third Team Member had been given good directions to find the mortuary once he was in its local vicinity, but he did not have directions to get onto the main highway from his location near the hospital. He stopped at a gas station, bought a map, and continued onward at 2:26 pm CDT. He reached the mortuary at 3:30 pm CDT and by 4 pm he was setting up the ATP. He placed the container of MHP2 on a table, with the ATP on the floor below it. He saw no evidence of mold growth or other deterioration in the MHP2, which had been refrigerated at Suspended Animation for several months.

The Third Team Member was not familiar with setup procedure for the circuit pressure monitor. He spoke to the Team Coordinator by phone, who explained the importance of the height of the pressure sensor relative to the position of the patient. The Team Coordinator also suggested a conservative value of 90 mm mercury for the high pressure alarm (so long as the alarm was at a height equal to that of the patient's heart) and advised that since no oxygen was available for this case, the gas inlet to the heat exchanger could remain unused.

The Third Team Member tried to reach a consulting perfusionist for additional advice but was unable to do so. The Procedures Consultant then called the Third Team Member and advised him of the importance of adding insulin to the MHP2 organ preservation solution before the patient went on bypass.

The Third Team Member went out to buy ice and returned to the mortuary around 5:50 pm CDT. He debubbled the ATP circuit and used a syringe to add 15 ml insulin to the perfusate reservoir and 5 ml insulin to the MHP2 that was already in the circuit. He then waited for the other team members to arrive with the patient.

Arrival of patient at mortuary

At approximately 6:18 pm CDT the ice bath containing the patient was lifted out of the Suburban and rolled into the mortuary. A voice recorder was used throughout the procedures at the mortuary, and its record was a primary source for many of the events described below.

The Third Team Member provided chest compressions with the CardioPump until other personnel were ready to move the patient from the ice bath onto the table in the prep room, at approximately 6:30 pm CDT. The patient was moved in the Suspended Animation lifting sling. During this procedure the rectal plug became dislodged, even though its collar was still inflated. Since no fecal matter was visible, the plug was not reintroduced.

The patient's head was packed in bags of ice. The Third Team Member inserted a temperature probe through one of the patient's nostrils, into the sinus cavity, connected it with a DuaLogR temperature logger (additional to the one that had been used previously), and started the logger.

Patient is moved to prep room

About five minutes after the patient was moved onto the table in the prep room, the Team Leader wanted to administer mannitol but found that it had crystallized. She applied one of the heating pads supplied with the kit but didn't see any noticeable improvement. She telephoned the Procedures Consultant who felt that the mannitol could be ignored at this stage because

by the time mannitol would have been crystal free the patient would be on bypass. The MHP2 organ preservation solution also includes mannitol as a core component.

Surgical procedures

The Team Leader contacted the Consulting MD and notified him that only some of the Vital-Oxy had been administered. He suggested that she should draw the rest of it into syringes and add it to the MHP2. She drew it into two 60 ml syringes and one 20 ml syringe. The Second Team Member subsequently added the Vital-Oxy while the patient was on bypass.

The Third Team Member continued applying chest compressions with the CardioPump during any window of opportunity when he felt that this would not interfere with the surgical procedures. At approximately 6:40 pm CDT the Regional Funeral Director asked what kind of instrument the team wished him to use "to get into the vessel." The Second Team Member asked the mortician if he had cannulae of his own, at which point the Team Leader mentioned that the Suspended Animation washout kit contains cannulae of French sizes 15, 17, 19, and 21. The Regional Funeral Director noted that "he has a huge artery down here," suggesting that he had already exposed the femoral artery. A few minutes later the voice record made at the mortuary indicates that the pressure alarm on the ATP went off. The patient was not yet on bypass. The Second Team Member felt that the pressure monitor was not showing a valid reading, and he substituted a manometer. No pressure transducer was available to separate the manometer from fluid in the line, but the Second Team Member felt that the fluid was sufficiently far from the manometer to protect it from damage. Where information about circuit pressure is included, below, it is based on readings from the manometer.

Pressure monitoring issues

The Third Team Member repacked the patient's head in ice, using a total of ten bags, so that all exposed areas of skin around the head and neck were covered.

Cannulation

At approximately 6:45 pm CDT the Regional Funeral Director selected a 17 French cannula. This was actually a venous cannula, which the mortician inserted on the arterial side. The Third Team Member asked the Regional Funeral Director if he was planning to drain blood from the venous side into the mortuary sink, and the Regional Funeral Director confirmed that this was his plan. Two minutes later he exclaimed in surprise as he made an incision and found blood spurting onto him under pressure from the cannula that was already attached to the ATP on the arterial side. He was heard to ask if the ATP pump was running. The Third Team Member confirmed that it was.

Pressure and venous drainage

At around 6:50 the Regional Funeral Director inquired about the pressure in the ATP, in pounds per square inch, and was told that the pressure monitor displays data in millimeters of mercury.

On the femoral vein, the Regional Funeral Director began using a drain tube—a metal tube with a plunger in it, designed to promote flow and clear blood clots. He noted a few minutes later that he saw no clots, and attributed this to the anticoagulants administered earlier. He was unable to get good steady flow, however, and the Second Team Member increased pressure on the arterial side to a figure which he estimated as being near 300 mm mercury. Note that whereas perfusionists in conventional medicine are able to measure arterial pressure directly, pressure values in cryonics cases are measured as fluid pressure in the circuit on the arterial side, before the perfusate reaches the cannula, which can cause significant back pressure, or "pressure loss," depending on flow rate and cannula size. Therefore the term "arterial pressure," which has often been used in cryonics case reports, can be misleading, since actual arterial pressure may be lower by a value of 100 mm mercury or more. This issue is discussed in Section 9, Discussion and Recommendations, below.

In a further attempt to obtain flow, the Regional Funeral Director asked for additional chest compressions. At approximately 7:00 pm CDT he noted that this resulted in an improvement.

Around 7:05 the Third Team Member inquired about arterial pressure. The Second Team Member noted that it was "high" but since he could see no sign of edema, he felt it was justifiable. He noted subsequently that the circuit pressure stabilized between 140 mm and 160 mm mercury. There was speculation that a kink in the tubing circuit might have caused the higher pressure previously.

Repositioning of nasopharyngeal probe

By 7:15 the Third Team Member had noted that no bubbles were visible in the lines, while the Team Leader expressed concern that the nasopharyngeal probe showed insufficient decline in temperature. In response, the Third Team Member inserted it further. This resulted in a reading that is closer to what one would expect.

Reduced pressure and improved flow

At approximately 7:27 pm CDT the Second Team Member noted that circuit pressure had diminished to about 100 mm mercury, and flow had improved markedly. The Second Team Member noted some minor leakage from IV sites, and stated that two-thirds of the washout solution had been used.

Around 7:39 the Second Team Member refreshed ice in the cooling reservoir. The ice was refreshed one more time during the remainder of the procedure. The ATP went into closed-circuit mode at approximately 7:43 pm CDT. Five minutes later the Second Team Member noted the circuit pressure on the arterial side as varying between 100 and 110 mm mercury.

Beginning of closed-circuit bypass

Bypass continued without noticeable edema, and around 8:13 pm CDT the Third Team Member noted that the temperature logged by the probe on the arterial side of the heat exchanger was 3.3 degrees Celsius, while venous fluid was 10.8 degrees and the nasopharyngeal probe gave a reading of 9.0. A discussion of the temperature data from the temperature probe in the thermowell on the venous side is included in Section 9, Discussion and Recommendations, below.

Termination of bypass

At 8:24 the venous fluid was reported as being at 10.2 degrees Celsius while the nasopharyngeal probe indicated 7.8. The ATP was shut down at approximately 8:45 pm CDT because team members felt that it had achieved its purpose, with a venous temperature just below 10 degrees. The Second Team Member placed a call to the Consulting MD and asked for advice on best technique to close the incisions. The Regional Funeral Director proceeded to suture the vessels and close the incisions with staples.

Patient leaves mortuary

At 9:00 pm CDT the Team Leader placed a call to the Team Coordinator to ask if a body bag should be used to line the interior of the Ziegler case before the patient was placed in it. The Team Coordinator felt this was advisable, and the lighter-weight, white vinyl bag from the Suspended Animation kit was used. A few minutes later the bag was in the Ziegler case and loose ice was distributed across the bottom. The Ziegler case was moved into the prep room, ice bags were removed from the patient's head, and the patient was moved into the Ziegler case around 9:11 pm. Bagged ice was added to the head, groin, and any other location where the team could find sufficient space. The Third Team Member screwed the lid shut at 9:28 pm. Five minutes later the Ziegler case was loaded into the Chevy Suburban for transport. The driver arrived at 9:36 pm and was on the road at 9:39.

The team members finished cleaning up the mortuary and left to find a motel for the night.

7. Transport, Cleanup, and Review

The patient reached the Cryonics Institute according to plan, and surgery prior to cryoprotective perfusion began at 7:40 am EDT on Tuesday, June 5th.

Subsequent procedures at Suspended Animation

Shortly after 9 am EDT on June 5th, the Team Coordinator telephoned an employee of Suspended Animation who had not gone on the case and asked him to load the backup ("B" kit) standby equipment containers into the transport vehicle, to be ready for use until the "A" kit containers returned with the team and were restored for subsequent use.

The team members arrived at PBI on June 5th, 2007 at approximately 11 pm EDT. The pickup truck was retrieved from the parking lot and loaded with the twelve transport containers, and was driven to the facility for unloading.

Cleaning and refurbishing the equipment and replenishing the supplies took place during the ensuing week. Sound files from the digital voice recorders were uploaded and were transcribed manually as plain text. Temperature data from the DuaLogRs were uploaded and saved in an Excel document. Subsequently these data were imported into the graphing tool of Adobe Illustrator and are presented in Appendix 4, below. The returning standby kits were reviewed and documented for quality control purposes.

The supply of approximately 30 liters of MHP2 organ preservation solution was replenished within two weeks. During that period, Suspended Animation had 20 liters of MHP-2 of a slightly different composition that had been previously received from Life Extension Foundation as a backup. Solutions for the NiKy and mannitol problems were investigated.

All three team members were asked to write descriptions of the case as they had experienced it. The Team Coordinator also contributed his recollections of events. Team members were able to determine times of significant events by referring to the call logs in the memories of their cell phones.

On June 6th, 2007 at 2:20 pm EDT, Suspended Animation hosted a debriefing session attended in person by all available staff members, plus the Team Coordinator and Procedures Advisor, plus California advisors participating via phone. The debriefing lasted approximately 90 minutes and resulted in a list of action items and lessons that had been learned from the case.

Creation of case report

Subsequently the Consulting MD wrote a lengthy review of the case, focusing in particular on surgery and ATP issues. Aschwin de Wolf assembled all the available records, created a timeline, and submitted the data to Charles Platt, who wrote the first draft of this report. This was corrected, amended, and elaborated by Aschwin de Wolf.

The corrected draft was circulated to all persons who participated in the case, and corrections were invited. Five people responded with requests for edits, and significant discussions ensued on some points. The edited text was again circulated for comment. The SA Administrator acted as final arbitrator regarding amendments to the text. The document was then converted from Microsoft Word document format (which had been used with its Track Changes feature active) into a plain text document, from which a PDF file was created in Quark XPress. After formatting, the coauthors of the case report viewed the text again and gave their final approval.

8. Cryoprotective Perfusion and Cryopreservation

A separate report describing cryoprotective perfusion, cryogenic cooling, and cryopreservation has been published by the Cryonics Institute. It can be viewed by clicking the Case Reports link in the contents list at www.cryonics.org/refs.html.

9. Discussion and Recommendations

General validation

For almost three years prior to this case, Suspended Animation did not participate in any standby-stabilization-transport procedures. Despite this long hiatus, employees were able to respond rapidly, energetically, and effectively. Most medications were administered, surface cooling was applied, cardiopulmonary support was maintained for a considerable period, and blood washout was completed, despite a very tight deployment schedule.

Equipment validation

The collapsible portable ice bath, the icewater recirculation system, the medications packaging, the revised ATP with hard-shell reservoir, the watertight cases for DuaLogR data recorders, the patient lifting sling, and other pieces of Suspended Animation equipment had been used during practice and training sessions but had never been deployed in an actual case before. All equipment worked without problems, with the exception of the ATP pressure monitor (which was not set up correctly) and the Autopulse, which was still in its development phase. A new configuration of the Autopulse has already been developed for use in conjunction with a portable ice bath.

Suspended Animation deploys almost 30 liters of MHP2 organ preservation solution instead of the 20 liters that has been customary in cryonics in the past. The 30 liters are packaged in a medical-grade plastic bag inside a plastic box, inserted in an aluminum shell which is embedded in lightweight closed-cell insulating foam inside a Pelican-brand transport container. This containment system had been drop-tested from a height of four feet onto a concrete floor but had not gone through airline baggage handling before. It survived the process without any leaks or other problems.

Personnel

The Suspended Animation team members worked well together without interpersonal friction. Advisors were quickly available via phone. Cooperation with staff at the Cryonics Institute was excellent. Relations with hospital staff and with relatives of the patient were extremely good. No personality-related issues occurred.

Lack of participation by emergency personnel

The lack of response from paramedics retained by Suspended Animation was very disappointing. Although this can be ascribed partly to exceptional circumstances, Suspended Animation must take action to find additional contractors who can guarantee their availability even where a case occurs without prior warning.

Incomplete telephone response

Five people did respond to phone calls that were placed to them after midnight, but two others did not. One had turned his phone off, while the other did not wake up when his phone rang. Subsequently the latter stated that if more than one attempt had been made to reach him, probably he would have woken up, and he would have wanted to take part in the

case. The Team Coordinator should make multiple attempts to reach personnel who do not answer immediately. Staff should never turn off their cell phones without prior warning and should try to have their cell phones with them all the time. Suspended Animation will conduct periodic tests of telephone response.

The decision to deploy three personnel

As has been noted in the body of this report, the decision to limit the number of personnel was affected by financial considerations (the patient was not a client of Suspended Animation and was underfunded), good prior experience of the three team members working together, and known factors that were expected to minimize the duration and challenges in the case.

A research surgeon in North Carolina who is available for cryonics cases could have been called, but the Team Coordinator was concerned about the difficulty of finding additional flights and arranging a rendezvous between him and the other team members.

The Team Coordinator could have called another research surgeon located south of Fort Lauderdale, who might have been willing to assist. Whether this surgeon would have felt sufficiently confident of procedures to supplant the mortician in his own prep room is a matter for speculation. Also, while a third team member at the hospital would have been very welcome, adding him to the overloaded vehicle that transported the patient to the mortuary would have been problematic, since the passenger seat was loaded with equipment in containers. In the future, the Team Coordinator should make additional calls when trying to gather personnel for a case.

Minimum recommended number of bedside personnel

This case demonstrated yet again that while two people can perform the most necessary procedures after cardiac arrest, they may omit to obtain good temperature data and almost certainly will have insufficient time to take written notes or photographs. Three people at the bedside should be considered the minimum number, and four are preferable where a patient is sufficiently funded to cover the full range of procedures. All clients with whom Suspended Animation has executed formal agreements are funded sufficiently to enable a minimum of four personnel.

Deployment of distant personnel

The Procedures Consultant initially chose not to participate in the case because he determined that if he took the first available flight from his home in Arizona, the local time would be 2:30 pm when he reached the airport near the hospital where CI-81 was located. In retrospect he realized that even though he would have arrived at the hospital later than the other team members, he might still have been useful, or could have traveled directly to the mortuary. In the future, personnel may choose to fly out even if they believe they may be unable to reach the case in time.

Cases that are staffed by "noncryonicists"

This case was staffed by team members who had not made arrangements for future cryopreservation personally. In the past, some activists have theorized that "noncryonicist" team members will be insufficiently motivated to extend themselves in the interests of the patient, since they may be unconvinced that future revival is possible. In this instance the theory turned out to be untrue, since the team members worked extremely hard to achieve the best outcome within their abilities.

Cases that are staffed by team members lacking formal medical training

Some commentators have advocated "professionalizing" cryonics. In this instance, none of the eight professionals who had undergone training and agreed to be on call was willing or able to participate at very short notice. Because Suspended Animation was unable to deploy a paramedic or any other individual with experience in intubation and/or administering medications (outside of training sessions) the team lacked proven skills in these important areas.

Suspended Animation had received assurances in this particular case that hospital personnel were willing to leave not only IVs but the endotracheal tube in place. Since the next of kin had also pledged that the patient would remain on a ventilator until the team arrived, there were good reasons to believe that the Team Leader would be able to verify that the hospital personnel would follow through on their commitment. However, there was of course a chance that the commitment would not be honored, or the endotracheal tube might have become dislodged accidentally. If this had happened, the team would have had difficulty intubating the patient and might not have been able to administer medications.

Overall, it remains Suspended Animation policy to deploy at least one and ideally two people with experience in emergency medicine, as stated in the Protocol for SA-CI Standby reproduced in Appendix 5.

Other team members may serve competently without medical experience in tasks such as scribing, surface cooling, and mechanical or manual cardiopulmonary support. What constitutes "enough" prior experience in cryonics cases is another matter for debate, since extensive case experience doesn't necessarily indicate great skill or extensive knowledge in cryonics. Unlike conventional medicine where an endpoint such as resuscitation without neurological damage can be observed, evaluating the quality of care in cryonics requires a lot of subtle indirect observations and data that are rarely collected in cases.

Seeking guidance

Team members must be willing at all times to recognize their limits and seek advice from others. During the case of CI-81 the team did call frequently for advice regarding medications, ATP setup, and other issues. The team did not call for advice while the Regional Funeral Director was performing surgery and initiating washout. As a result the team lacked guidance regarding choice of cannulae, the details of gravity-assisted venous drainage, and customary limits on arterial pressure. While washout and cooling were achieved despite the lack of expert advice, seeking advice is generally desirable. One team member stated subsequently that no one intentionally neglected to call, and oversights resulted simply from fatigue and lack of experience.

Vehicle readiness

As a general rule, since the pickup truck at Suspended Animation may be used in emergencies, its tank should be kept at least half full of fuel.

Route planning in remote locations

A global positioning system (GPS) fitted with a street-finding feature would be a useful addition to standby kits, to guide team members when they find themselves in a place where they have never been before.

Airline issues

The team allowed a normal amount of time for check-in to their flight out of PBI, but found that airline staff were confused and overwhelmed by the 12 heavy containers of standby equipment to be processed as checked baggage. In the future, wherever possible, a team should allow at least an extra half-hour for check-in, and should use curbside check-in if available.

Three or four of the transport containers were opened during transit by the Transportation Security Administration. None of them was delayed as a result. So far as we can determine, Suspended Animation's standby-stabilization supplies conform with all airline and security regulations.

The question of whether commuter-size aircraft can carry large quantities of checked baggage (such as the Pelican brand containers used by Suspended Animation) should be resolved definitively.

The fly/drive logistical decision

The decision to deploy the team via a nonstop flight to a city 200 miles from the ultimate destination was fortuitous. The rented van enabled the team to prepare medications and pick up supplies en-route. The van also enabled one team member to continue onward to set up the ATP at the mortuary, while two team members performed duties at the hospital. The fly/drive combination may be used advantageously where future cases occur beyond the range of Suspended Animation ground vehicles.

Verifying the inventory of equipment before departing the facility

The medications container in the refrigerator at Suspended Animation is prominently labeled with a reminder to bring additional medications, one of which is frozen, and one of which must be kept at room temperature. However, there is no equally prominent reminder to bring MHP2 organ preservation solution, which is kept in a separate refrigerator. The MHP2 could have been left behind accidentally in this case. Labeling is necessary to prevent this.

Rapid intervention at the bedside

This case served as a reminder of the need for a portable ice bath that can be deployed easily, with cardiopulmonary support, to the patient's bedside in a remote location. This remains true even for cases in which a fully equipped transport vehicle is available nearby. The vehicle can enable prompt blood washout and rapid cooling, but the patient should begin to receive cooling, chest compressions, and medications *before* reaching the vehicle.

If a noncollapsible ice bath in a vehicle is equipped with multiple resources including oxygen cylinders and washout equipment it may become so heavy that it cannot be moved over curbs or other obstacles, and cannot be located easily at the patient's bedside. Therefore, an additional, collapsible, easily deployed ice bath should be included on any future vehicle developed by Suspended Animation, and should have ends that articulate to reduce its effective length so that it can enter small elevators and negotiate turns in hallways. Without such an ice bath there will be at least some lag time before procedures can begin, and the team may find itself without any purpose-built container at all, to move the patient to the vehicle. A hospital is likely to provide a gurney for this purpose, but patients do not always die in hospitals. Currently Suspended Animation is commencing the fabrication of a second fully collapsible ice bath for future deployment with its smaller transport vehicle, which will be relocated in California.

Problems associated with cardiopulmonary support

The Michigan Instruments Thumper requires at least one H-size cylinder of compressed gas and, ideally, two smaller additional E cylinders, to maintain operation continuously from bedside to blood washout. Since cylinders are not air transportable, any remote deployment beyond the range of a ground vehicle will negate use of the Thumper unless enough time is available for team members to locate a source of welding gas, execute necessary paperwork, and install the gas cylinders safely in a rented van.

The electrically driven Autopulse provides an elegantly simple answer to this long-standing problem, but in its off-the-shelf configuration it is vulnerable to water, making it incompatible with an ice bath. While Suspended Animation had attempted to convert the Autopulse for use with an ice bath, the conversion was incompatible with the physical attributes of the patient in this case. (We note that the LUCAS, a Swedish competitor to the Thumper which is also driven by compressed gas, very likely would have been unable to accommodate a patient of this size.) Suspended Animation already has a functional prototype of a new Autopulse modification which we believe should overcome the problems experienced in this case.

Quality of cardiopulmonary support, and reperfusion injury

The time between cardiac arrest and start of blood washout exceeded 2.5 hours. During this interval the patient received chest compressions and was ventilated with ambient air at a ratio of approximately 30:1. Although cardiopulmonary support was augmented by vasopressor support and the impedance valve, this case involved a very long period of manual chest compressions which we doubt were sufficient to produce adequate cerebral perfusion pressure at normothermic temperatures.

Whether induction of hypothermia and administration of neuroprotective medications outweighs the risk of reperfusion injury in cases like this is a matter that cannot be settled without extensive case data and research. Because chest compressions are necessary to circulate the medications and improve cooling rates, the question is not so much whether to do chest compressions but whether to ventilate—and if the patient will be given oxygen, at which rate and whether 100% oxygen or room air is desired.

It's clear that doing vigorous chest compressions manually (even with more team members) cannot be maintained for such a long time without extreme fatigue. The successful use of a mechanical chest compression device is extremely desirable during cases in which long transport times are expected.

End tidal CO2 monitoring

Although the impedance valve was placed immediately after pronouncement of legal death the team omitted to attach the end tidal CO2 monitor to the airway. As a result, the team was deprived of an opportunity to assess the efficacy of cardiopulmonary support and maintenance of correct endotracheal tube placement. The importance and techniques of end tidal CO2 monitoring will be emphasized in future trainings.

SA's standby kit includes a disposable colorimetric end tidal CO2 detector. Some limitations of the disposable ETCO2 detectors are that they are not quantitative, not continuous, hard to read in the dark, and can give false readings. A significant benefit of continuous quantitative ETCO2 measurements is that we will have a better understanding of the efficacy of CPS and the hemodynamic effects of the various medications. Suspended Animation is currently investigating the possibility of obtaining a new, relatively inexpensive prehospital quantitative capnography device.

Data acquisition and monitoring

Data acquisition was incomplete in this case. This has been an issue in cryonics cases generally during the past ten years. While some temperature data were collected, there was no point during the case where temperature readings from different locations in the body were collected concurrently as the protocol prescribes. Because of poor placement of the nasal probe, some of its readings have been rejected as unreliable. In addition, as is common in cryonics cases, there was no blood and fluid sampling during stabilization or washout. Suspended Animation will emphasize the need for this during future training.

Use of the funeral director's vehicle

Administering medications and performing chest compressions in a Chevy Suburban was difficult and strenuous. Ideally the Suburban should have been used to take the ATP ahead to the mortuary, while the van remained near the hospital for patient pickup. However, the Regional Funeral Director stated initially to the Team Coordinator, over the phone, "You're not going to use your own vehicle to pick up the patient, are you?" which suggested he would have disliked this arrangement. The Team Coordinator chose not to force the issue. Possibly the team could have rented two vehicles instead of one, but in that case one of the two team members performing chest compressions and administering medications would have had to drive a vehicle, and the procedures would have been severely compromised.

Using an ice bath in a general-purpose vehicle

When the collapsible, portable ice bath is used in conjunction with a vehicle such as an SUV or a van, some kind of restraint should be provided to prevent it from rolling from side to side in the vehicle.

The need for skin contact with the CardioPump

A battery-powered electric razor is included in the standby equipment, for shaving chest hair so that the suction cup of the CardioPump will make good contact with the skin, provided the time of complete ischemia is minimized. This razor could be attached to the CardioPump so that it is readily available.

Alternatives for chest compressions

The team used an Ambu Cardiopump to administer active compression-decompression chest compressions. They also had a prototype device available, employing a belt that is tightened repeatedly with a pair of hand-powered levers. This device could have reduced the effort required to administer chest compressions, but might have failed to work in conjunction with this patient for the same size-related reasons that defeated the Autopulse. During the stress of the case, the team members did not consider using the prototype. Its suitability remains unknown at this time.

Rectal temperatures, pro and con

The Consulting MD has suggested that a rectal temperature probe provides readings which are generally not useful, since feces may possess heat conduction characteristics different from those of the body and the brain. The Team Coordinator has argued that a rectal probe will at least confirm that some cooling did occur, and this alone is a useful piece of information. A rectal plug must be inserted anyway to diminish the risk of fecal matter entering the portable ice bath when the sphincter muscles relax after cardiac arrest. Since each plug is equipped with a temperature probe, this is a simple way to insure that some temperature data will be

collected. The Consulting MD has responded that the existence of rectal probes may make team members feel less motivated to place a nasopharyngeal temperature probe. The Team Coordinator finds no evidence for this, and also feels that the nasal probe is so vulnerable to icewater, its readings have been unreliable (as was shown initially in the case of CI-81, before the probe was pushed deeper). The Consulting MD feels that a nasal probe can produce good data if it is placed properly, at sufficient depth, with wax sealing the nostrils, and the wire secured with surgical staples or adhesive tape. The Team Coordinator agrees but finds numerous cryonics cases where personnel have been too pressed by time to follow this procedure. On the other hand, rectal temperatures have also been found to be less reliable in cases of reduced blood flow to the rectum and hypothermia induced temperature changes. Perhaps bilateral tympanic temperature measurement needs to be revisited again. The question of the rectal probe remains unresolved.

The use of the air transportable perfusion kit (ATP)

The question of whether the ATP should have been used remains open to debate. The ATP offers the unique, irreplaceable capability of blood substitution with organ preservation solution, with very rapid cooling. However, since blood washout enables direct access to the circulatory system, it also opens up the possibility of doing great harm. Perfusionists normally require extensive training at an appropriate medical school. During 2006 Suspended Animation was pleased to have a qualified perfusionist as one of its fulltime employees, and accepted her recommended improvements to the ATP circuit that had been used formerly. Regrettably, when she left Suspended Animation in 2007 she refused to make herself available to assist in future cases even as an independent contractor.

To address this problem the company ran some ATP training/familiarization sessions for team members, using assistance from an employee who had participated for many years in cryoprotective perfusion procedures. When this employee stated that he could not participate in the case of CI-81, the Procedures Consultant expressed an opinion that the wisest course of action might be to eliminate use of the ATP. The Consulting MD, on the other hand, felt that with telephone support, the ATP could be used safely enough. Since the duration of subsequent ground transport had been estimated at 10 hours, the benefit from prior cooling to 5 degrees Celsius was obvious, and washout with organ preservation solution would probably make a significant difference.

The Team Coordinator ended up agreeing with the Consulting MD, and team members went ahead with blood washout. While this may have been the correct decision, Suspended Animation remains very concerned about the lack of experienced personnel to run the ATP. As a first step the company has already obtained assistance from another professional perfusionist who provided training for three potential team members, and assisted in making a video which is being edited at the time of writing. This training video may also be offered to other cryonics organizations.

Possibly excessive arterial pressure

Several factors may explain the need for high arterial pressure before good flow was achieved with the ATP. As the Regional Funeral Director suggested, a piece of tubing may have been kinked. The lack of gravity-assisted venous drainage during the open-circuit phase of the procedure would have contributed to flow problems. The erroneous use of a long venous cannula on the arterial side, instead of a shorter arterial cannula, would have increased back pressure slightly.

Subsequently at Suspended Animation, a test using Viaspan (which has similar viscosity to MHP2 washout solution) indicated that even with a short arterial cannula of size 17 French (believed to be the size used in the case of CI-81) back pressure from the cannula alone can reach 100 mm mercury if the pump is running at 3.5 liters per minute. An official data sheet supplied by Bio-Medicus, the manufacturer of the cannulae, shows slightly lower back pressure when water was used as perfusate at 37 degrees C.

The need for high initial arterial pressure remains unexplained, but as a general principle, a consulting perfusionist has advised that the circuit pressure on the arterial side should not be greater than 100 mm mercury above the back pressure (also referred to as "pressure loss") created by the chosen cannula at any given flow rate.

Although versions of the ATP have been used in cryonics for more than 20 years, we have been unable to find training materials suggesting the relationship between circuit pressure, cannula size, and flow rate. Suspended Animation will address this oversight by including a laminated chart in standby kits showing the recommended circuit pressure for commonly used cannula sizes at various pump speeds.

Achieving rapid and sufficient cooling with the ATP

During this case, ice was not added as frequently to the ATP icewater reservoir as one would have expected. Significantly better cooling can be achieved if team members maintain a high ratio of ice to water in the reservoir. Also, the team felt that a terminal temperature of 10 degrees Celsius was acceptable, and discontinued the ATP at this point. Since the nasopharyngeal probe was still showing some decline in temperature, additional cooling should have been attempted.

Temperature probe problems with the ATP

The higher reading of the venous temperature probe, compared with the nasopharyngeal probe, suggests that the venous probe may have been returning bad data. Thermowell connectors which accommodate temperature probes in the ATP tubing circuit almost certainly conduct significant ambient heat to the probe tip, creating an artificially high reading. During a recent test at a California laboratory, ice-cold fluid was passed through tubing while one probe was threaded into the tubing and another was inserted into a thermowell. The tip of the loose probe was 5 mm or less from the interior point of the thermowell. The readings from the two probes differed by 6 degrees Celsius, and this difference remained constant over more than a minute. Thermowell probes are widely used elsewhere, but at temperatures more than 30 degrees higher than may be found in an ATP circuit. At low temperatures a substitute for thermowells is necessary.

MHP2

Some questions relating to remote blood substitution for cases with long transport times remain unresolved. Upon receipt of the patient, the Cryonics Institute case report mentioned a "swollen abdomen and…general edematous appearance". This appears to be consistent with other anecdotal observations of patients who received remote blood substitution and long transport times. MHP2 has never been fully validated for use on ischemic patients and/or long transport times without flow. At the 2007 Suspended Animation conference a prominent cryobiology researcher reported extensive tissue injury for brains that were stored for 24 hours without flow. An independent cryonics consultant has suggested that one reason why MHP2 blood substitution may have stopped producing benefits in cryonics is because the solution is

no longer prepared as a hypertonic solution (~400 mOsm). In this case this argument is less persuasive because the batch of MHP2 that was used in this case was prepared in agreement with the hypertonic formulation as a quality control. The new batches of MHP2 are now prepared with hypertonicity as an endpoint.

In this case 40 IU of insulin per liter was added to MHP2 and the circuit during washout. During the debriefing, questions were raised about the wisdom of adding (large) amounts of insulin to MHP2. After extensive investigation by the Procedures Consultant and a cryobiology researcher it was established that Viaspan includes the same amount of insulin, and insulin also is specified in some formulas for MHP2. The question whether to add insulin to MHP2 remains unresolved. Some cryonics advisors belief that it may be essential to support non-neural glucose metabolism and to prevent rigor mortis. Other cryonics advisors belief that there is no evidence that this component is essential for asanguineous hypothermic resuscitation, and may be detrimental.

MHP2 includes the antioxidant tripeptide glutathione to scavenge free radicals. Because glutathione oxidizes during prolonged storage it's generally agreed that it would be better to add glutathione at the last minute during a case. Before this can be accomplished a number of challenges need to be overcome: The glutathione needs to be kept chilled during transport, a practical method of introducing it to the solution needs to be found, an undesirable drop in final pH (gluthathione is acidic) needs to be avoided, and addition of the glutathione in the field should not increase osmolality excessively.

All these issues indicate a fair amount of confusion regarding the history and clinical and practical aspects of organ preservation solutions in cryonics. This needs to be addressed.

Oxygen or air supply for the membrane oxygenator/heat exchanger

Optimal performance of the heat exchanger requires a minimum gas flow of 0.5 liters per minute from an outside source, according to documentation supplied with the unit. In the weeks following this case, Suspended Animation tested a variety of small air pumps and chose one that will be used with the heat exchanger in future instances if oxygen is unavailable.

Using voice recorders

The value of voice recorders was established during the case which Suspended Animation performed during 2004. The time-stamp applied automatically by each voice recorder greatly simplifies the process of determining a timeline for subsequent events. Suspended Animation has a voice recorder in each standby kit, plus an additional recorder in each personal overnight kit. However, during this case the team members omitted to use the lapel microphones provided. This created inconvenience and discouraged use of the voice recorders. We have verified that all recorders are packed with lapel microphones for future use.

The batteries in one of the voice recorders may have lost their charge as a result of someone failing to switch off the recorder after a practice session. All team members will benefit from additional practice with voice recorders during future training events. Voice recorders provide the only way for team members to perform procedures and be "scribe" at the same time. The use of voice recorders is especially helpful while administering medications, and during procedures such as surgery, where the scribe doesn't always have a clear view.

Time synchronization

Initial setup of voice recorders and of DuaLogR data loggers should include synchronization of their internal clocks, to insure that all records are time-compatible. Team members should also synchronize their watches with each other and the monitoring equipment. This step was forgotten during the rapid deployment in this case. It will be emphasized during future training. Fortunately cell-phone records helped us to establish time points accurately.

Difficulty administering medications

Although vasopressin was given intermittently as a high priority medication in this case, the complete dose of the other vasoactive agent, epinephrine, was given at one time. SA protocol recommends giving 1 mg every 3 minutes because repeated administration is desirable during long periods of cardiopulmonary support due to the short half life of the medication. Historically, this protocol has not been used during any cryonics case, and in this case the need for manual chest compressions, in a very confined space in the rear of a vehicle, interfered with a methodical approach to medications. The Team Leader in this case believes that the recommended protocol for epinephrine can be followed in the future.

Administration of a viscous fluid such as Vital-Oxy may benefit from drawing it into a series of large syringes (as has been done by Alcor in the recent past), instead of giving it as a drip. Other large-volume medications may be similarly administered. Other alternatives include placing a large bore intraosseous line and pressure infuser, if the required skills are present. Because the large-volume fluids mitigate ischemia-reperfusion injury and acidosis, and can improve blood pressure and cerebral blood flow, the delayed administration (or omission) of these fluids that has come to characterize many recent cryonics cases is highly undesirable.

Crystallization of Mannitol

Another persistent problem in recent cryonics cases is crystallization of mannitol. Because current SA staff has only observed crystallization of mannitol after the solution had been refrigerated we suspect that the low temperatures of the cargo area in the airplane may have contributed to the crystallization. The warming pads that were included in the kits were not effective in solving the problem in a timely fashion.

During the debriefing the Consulting MD communicated that Mannitol does not crystallize when it is packaged in glass containers. Since Suspended Animation has already made provision for other medications to be transported safely in glass bottles, it has substituted eight small-volume glass bottles for the 500 ml bags used previously. Because this will necessitate multiple drawings of mannitol in large syringes and may increase administration times, SA will keep exploring alternative solutions such as in-house preparation of mannitol or alternative solutions with similar clinical properties.

NiKy problem

Because one of the components of NiKy, niacinamide, is easily soluble in water it was suspected that the other component, L-kynurenine, was responsible for the problems that were encountered during reconstitution of the NiKy. Although the team could have tried to use the backup bottle of NikY in the kit it's not likely that this would have solved the problem because SA staff failed to get L-kynurenine and the racemic variant, DL-kynurenine, into solution during a number of lab experiments subsequently.

Because the Procedures Advisor was not able to reconcile these results with Alcor's (apparent) success to dissolve and filter the NiKy during their cases he investigated the matter in more detail and discovered that through a fortuitous accident, Alcor had been using L-kynurenine sulfate instead. Suspended Animation personnel tried some samples of L-kynurenine sulfate and found this to produce a clear and filterable solution. Because L-kynurenine ionizes to the free base in the blood and has been found to be neuroprotective as well, SA has substituted L-kynurenine sulfate for L-kynurenine. The dose of L-Kynurenine has been increased to reflect the higher molecular weight of the sulfate variant of the molecule. To err on the side of caution we have still decided to separate the niacinamide and l-kynurenine administration in our protocol.

Maalox

The antacid Maalox was not administered during this case. Although Maalox has been routinely omitted during recent cryonics cases, it is doubtful that the current team would have been willing to take the risk to extubate the patient and place a Combitube to administer the Maalox through one of the lumens. An additional gastric tube has been added to the kits. Perhaps the lack of Maalox administration explains some of the abdominal swelling that CI observed upon arrival of the patient but this is highly speculative.

Surgical issues

Team personnel were insufficiently familiar with surgical instruments and procedures. Of course, staff members are never expected to perform surgical procedures or cannulation themselves, and historically procedures have been handled many times by morticians who are well practiced in raising femoral vessels. Suspended Animation can call upon research surgeons to go out and participate in field work. On the other hand, team members should be able to recognize whether a procedure is being performed correctly. To address this issue Suspended Animation has already provided some surgical practice sessions for staff members and will continue to do so.

10. Conclusion

When Suspended Animation received the first call notifying the company regarding patient CI-81, only thirteen hours remained before the patient's relatives intended to enable pronouncement of legal death by removing a ventilator. Team members had no prior knowledge of the patient or his location, which was more than 1,500 miles from the company's facility in Florida. No health records or other information for the patient were immediately available. Next of kin were willing to postpone the patient's death by only a few hours. Despite these challenges, team members were able to deploy twelve transport containers of equipment and have everything ready, with medications drawn, when legal death was pronounced. This is notable at a time when the rapid air deployment of a standby team and equipment to a remote location has become vanishingly rare in cryonics.

Errors may have included the decision to limit the team to three members, the decision to use the ATP, and willingness to trust the expertise of a funeral director instead of using Suspended Animation equipment according to standard protocol.

Prior training and practice sessions enabled the team to work effectively despite their lack of experience. They tried extremely hard to assure a good outcome, regardless of getting virtually no sleep in 36 hours. Good relations were maintained with family members, hospital staff, and the cooperating mortician. The patient was delivered to the Cryonics Institute after receiving most of the medications, chest compressions over a prolonged period, and rapid cooling via extracorporeal bypass.

The case was accepted on an underfunded basis. Although the patient's brain was injured to an unknown degree by a prior hemorrhagic stroke, intervention reduced warm and cold ischemic exposure and, very probably, blood clotting. Issues concerning reperfusion injury and remote blood substitution in cryonics remain elusive.

Timeline for Patient CI-81

June 3 (Eastern Daylight Time)

21:58 CI informs SA of potential case

June 4 (Eastern Daylight Time)

00:05 SA accepts case
02:15 Team Leader and Team Coordinator rendezvous at facility
04:45 SA truck loaded with stabilization kits
05:30 SA team leaves for Palm Beach Airport
06:00 SA team arrives at Palm Beach Airport

June 4 (Central Daylight Time)

09:00 SA team arrives at airport
10:25 SA team leaves for hospital
10:55 Drawing medications
12:52 Medications drawn
13:40 SA team arrives at hospital
13:50 Coolers, ice and water purchased
14:00 Arrival at bedside
14:00 onward Assembly of ice bath and preparation for stabilization
15:30 Team member arrives at funeral home to set up ATP
16:06 Heparin administered by nurse?
16:11 Pronouncement of legal death
16:12 Start stabilization procedures, CPS+administration of propofol, streptokinase and vasopressin
16:14 Patient moved to ice bath; rectal plug+ice packing+water circulation
16:20 Patient moved to vehicle
16:30 SA team drives to funeral home
16:30 onward Administration of remaining medications and fluids Chest compressions and ventilations
18:16 Arrival at funeral home
18:27 Patient moved to prep table
18:30 Patient's head surrounded with ice
18:48 Vessels raised and clamped
18:55 Start washout and blood substitution
19:40 Start recirculation
20:41 End of washout and blood substitution
20:46 Dual LogRs turned off
20:53 Vessels closed and sutured
21:13 Patient moved to Ziegler case
21:33 Patient moved to transport vehicle
21:39 Transport of patient to CI facility

Time from pronouncement to blood washout: ***2 hours 44 minutes***

Time from pronouncement to completion of blood washout: ***4 hours 30 minutes***

Time from pronouncement to start of cryoprotective procedures: ***14 hours 29 minutes***

Time from pronouncement to end of cryoprotective procedures: ***16 hours 19 minutes***

Time from pronouncement to start of cryogenic cooldown: ***17 hours 33 minutes***

June 5 (Eastern Daylight Time)

07:40 Start of cryoprotective procedures at CI
09:30 End of cryoprotective perfusion at CI
10:44 Start of cryogenic cooldown at CI

Time from pronouncement to long term care: ***5.5 days***

June 11 (Eastern Daylight Time)

Morning Transfer of the patient to cryostat for long term care

Stabilization Medications

1	Heparin	30,000 IU +	Anticoagulant
2	Propofol	20 mg	General Anaesthetic
3	Streptokinase	250,000 IU	Fibrinolytic
4	Vasopressin	200 IU	Vasopressor
5	Aspirin (Aspegic)	200 mg	Antiplatelet
6	Epinephrine	30 mg	Vasopressor
7	SMT	400 mg	i-NOS Inhibitor
8	Ketorolac	7.5 mg	Anti-inflammatory
9	Gentamicin	80 mg	Antibiotic
10	Vital-Oxy	80 ml	Free Radical Scavenger Cocktail
11	Dextran 40	250 ml	Volume Expander
12	THAM (0.6M)	<250 ml*	pH Buffer

+ *Exact dosage of heparin is unknown.*

* *An unknown quantity of THAM was spilled on the floor of the vehicle.*

Note:

The following 5 stabilization medications and fluids were not administered but should have been administered:

NiKy consisting of Niacinimide, 500 mg, a PARP-inhibitor, and L-Kynurenine, 1 g, an exitotoxicity-inhibitor

Citrate Dextrose, a calcium chelator / anticoagulant / solvent for L-Kynurenine

Mannitol, 100 g (500 ml), an osmotic agent

Maalox, an antacid

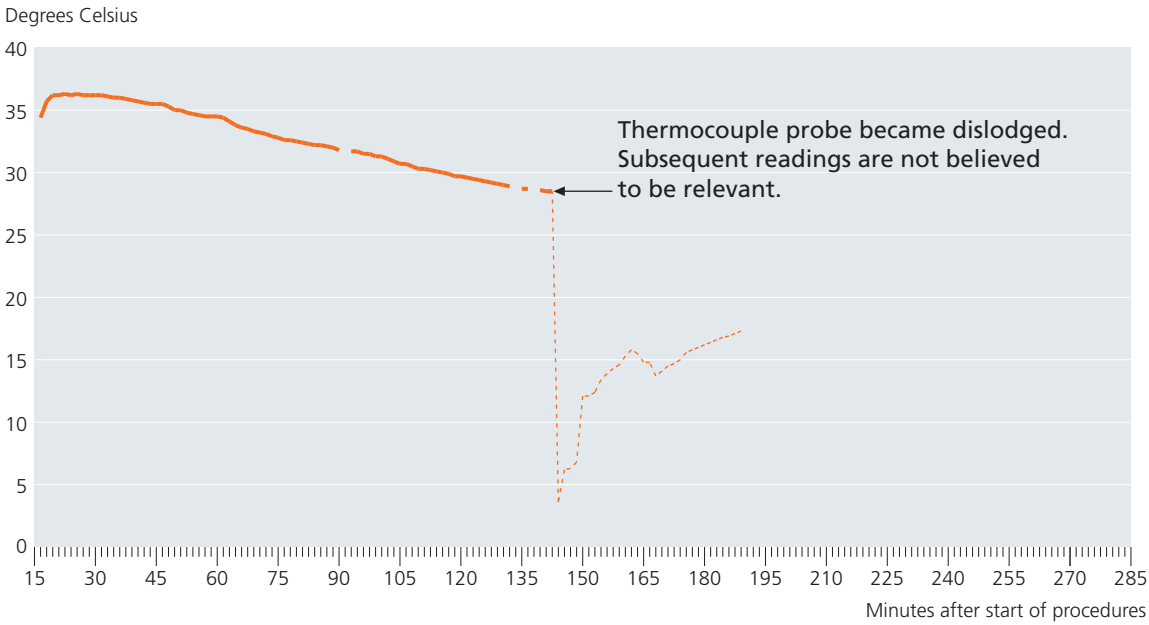
MHP2 Composition

Component	Molar Concentration	MW	Grams/Liter
Mannitol	170.0	182.20	30.97
Adenine HCl (Hemihydrate)	0.94	180.6	0.17
D-Ribose	0.94	150.2	0.14
Sodium Bicarbonate	10.00	84.0	0.84
Potassium Chloride	28.3	74.56	2.11
Calcium Chloride (Dihydrate)	1	147.01	0.147
10% (w/v) stock solution			(1.47 ml)
Magnesium Chloride (Hexahydrate)	1	203.30	0.203
20% (w/v) stock solution			(1.02 ml)
Sodium HEPES	15	260.3	3.90
Glutathione (free acid)	3	307.3	0.92
Hydroxyethyl Starch			50.00
Glucose	5	180.2	0.90

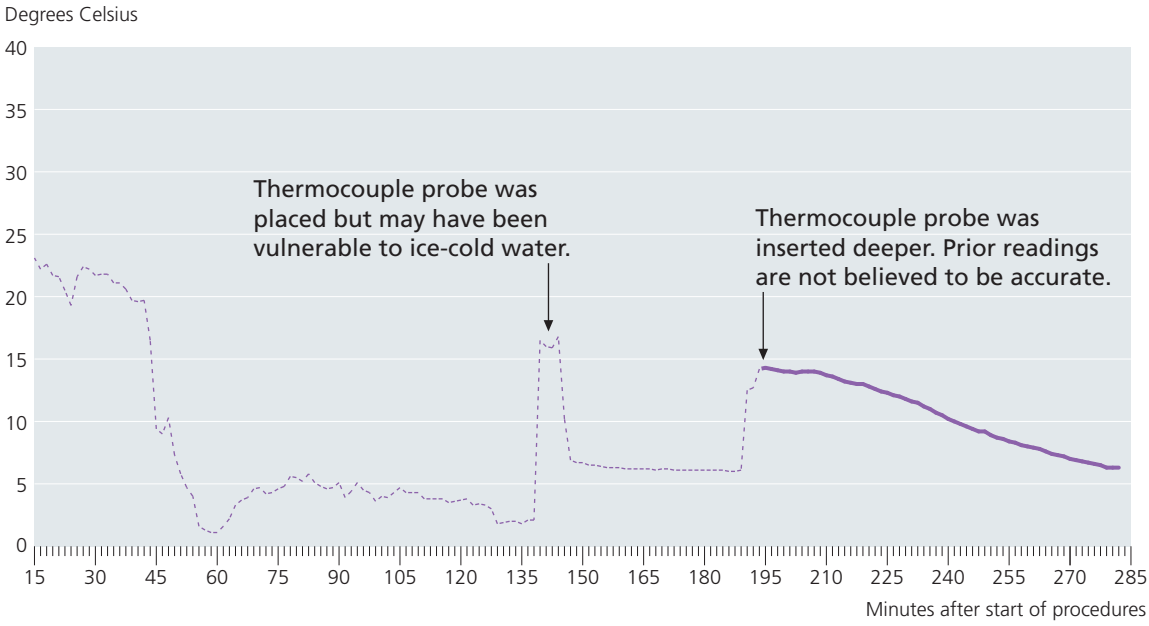
Component	IU/Liter
Heparin	1,000
Insulin (Humulin U-100)	40

Cooling Curves

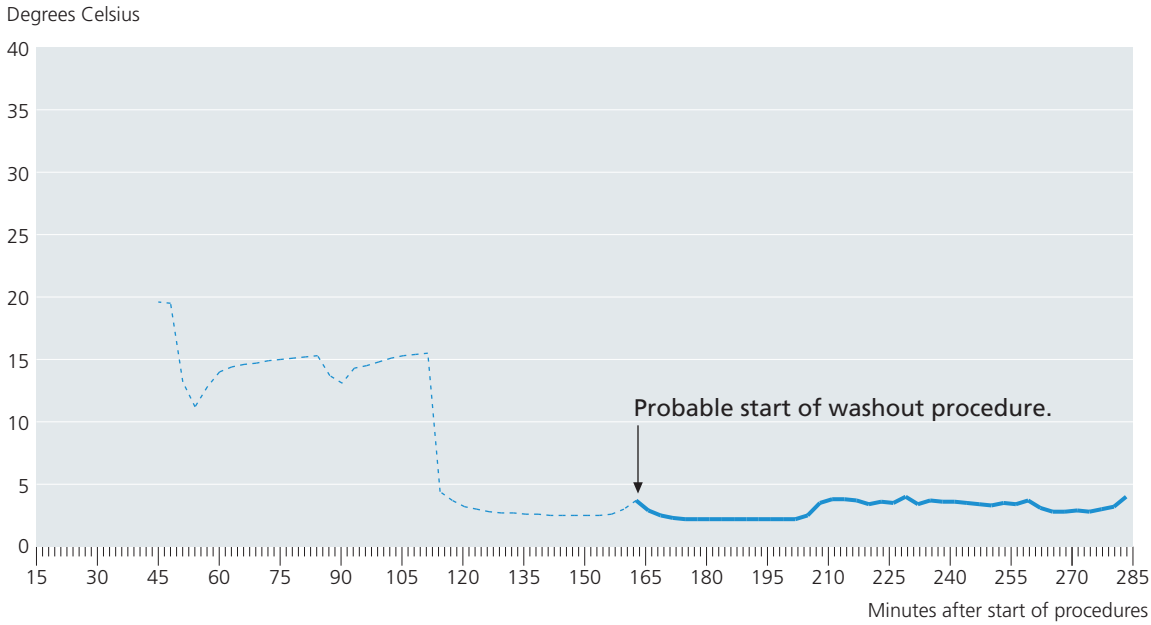
Rectal Temperature



Nasopharyngeal Temperature

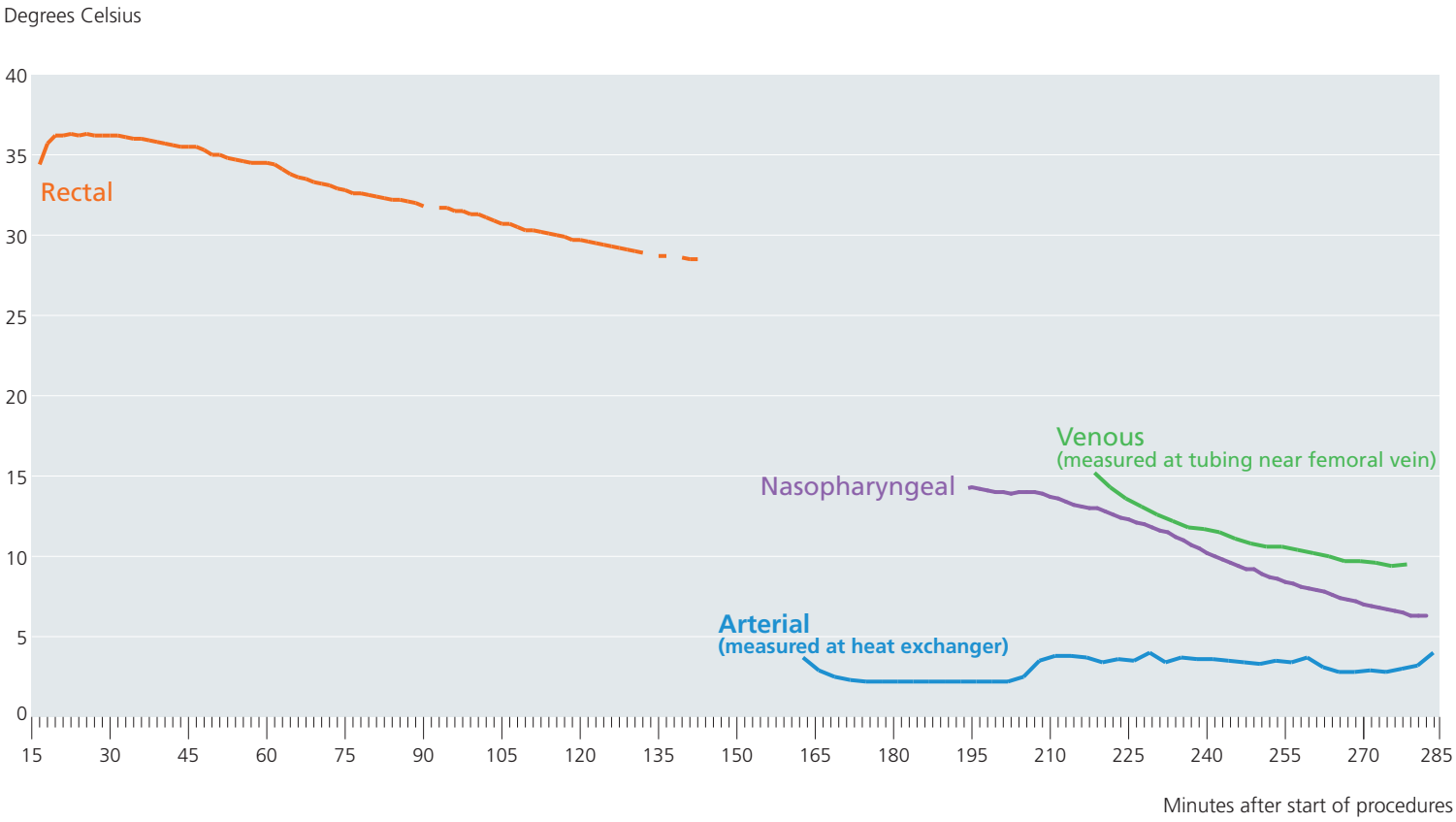


Arterial Temperature Measured at Heat Exchanger of ATP

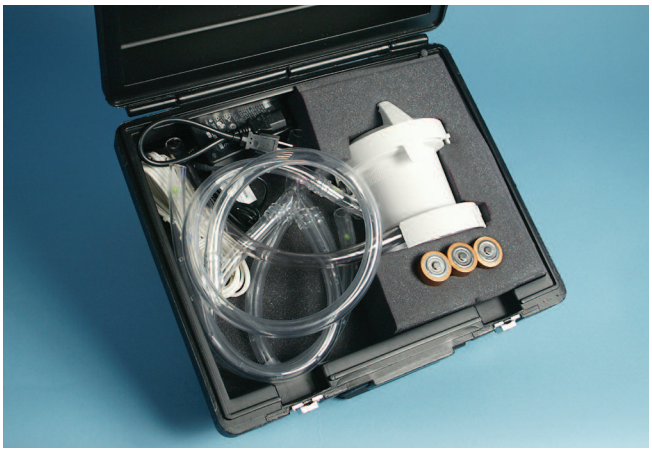


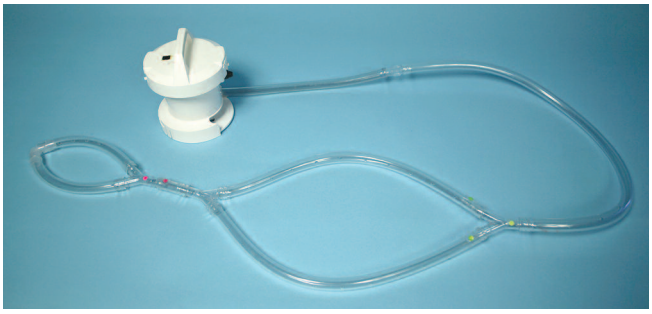
Venous Temperature Measured at Tubing near Femoral Vein

Patient Temperatures: Edited Data



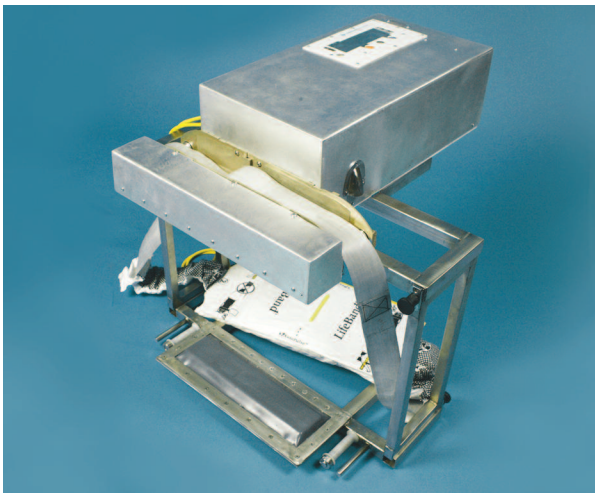
The collapsible, portable ice bath that was used in the case of CI-81 is transported in a zippered nylon bag. After the ice bath is unfolded, a plastic protective sheet is unrolled over the expanded metal base. A watertight vinyl liner (not shown here) is then inserted and held in position with Velcro. The IV pole visible in the first photograph was omitted during this case.

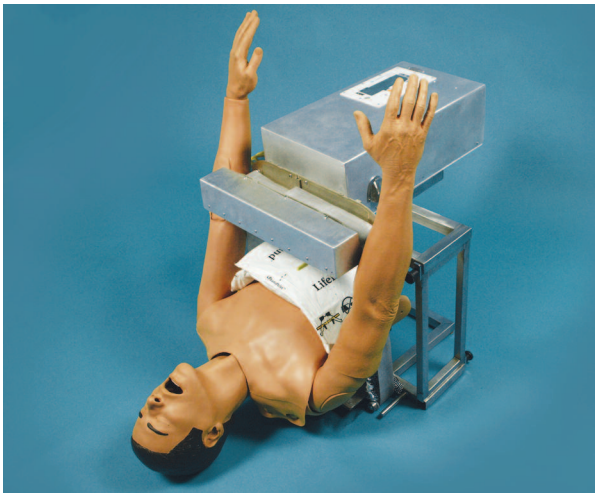




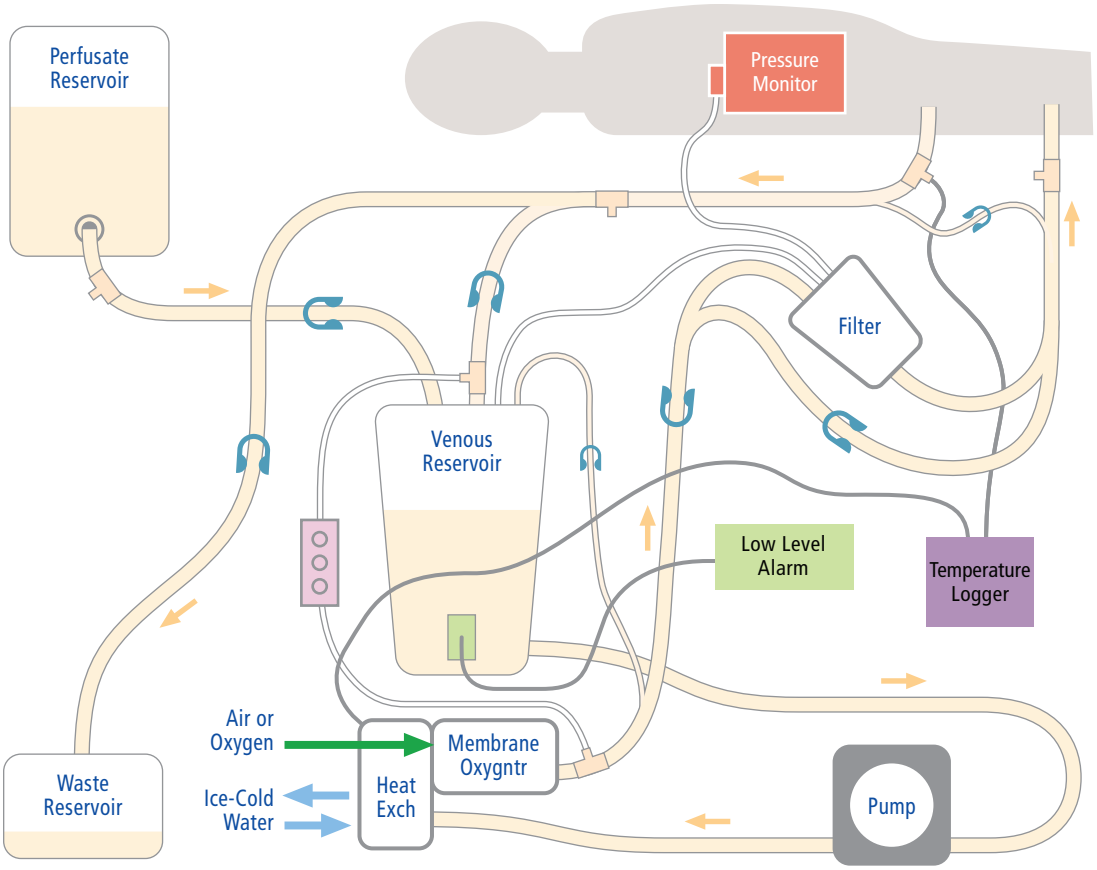
The icewater recirculation assembly is packaged for transport with three D cells and an alternate 115v AC power supply. After the tubes are plugged together, they are placed over the chest and face of the patient. The submersible pump circulates water which is distributed via perforations in the tubing.

Suspended Animation medications are packaged for transport in two containers, one of which is shown here. The beige tray fits across the ice bath, allowing medications to be arrayed prior to use. The two pages visible in the tray are laminated sheets summarizing dosages and other information. Detail changes have been made to the packaging since this picture was taken.

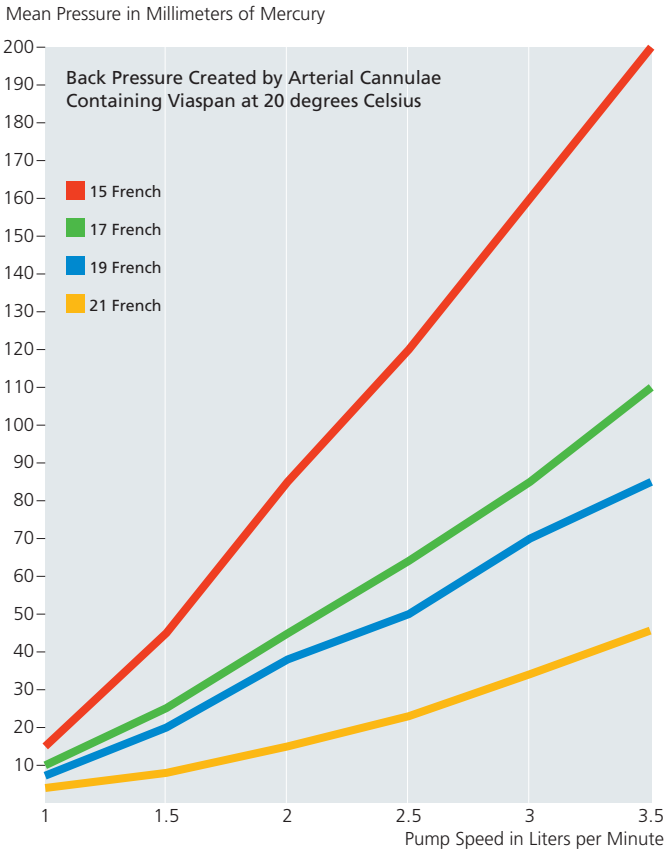




The Autopulse is a commercially available battery-powered device to administer chest compressions. This radically modified version was deployed in the case of CI-81. The mannikin demonstrates the position of the patient during use, with the arms raised to enable the belt to move more freely around the chest. As a result of the experience gained with CI-81, a completely new version of the Autopulse is under development at Suspended Animation.



During the case of CI-81 an air-transportable perfusion kit (ATP) was used for blood substitution and rapid cooling. The tubing circuit is depicted in this diagram. Small modifications are now being contemplated, including a high-liquid-level alarm. The entire circuit is packaged for transport inside an ABS plastic tray and aluminum framework that unfolds for use.



Following the case of CI-81 a test was performed at Suspended Animation to measure back pressure (pressure loss) with various sizes of cannulae at different pump speeds, with Viaspan as the perfusate. Back pressure shown by these curves is slightly higher than comparable numbers for water perfusate supplied by Bio-Medicus, the manufacturers of the flatwire cannulae used by Suspended Animation. In the case of CI-81 a venous cannula was used on the arterial side, probably creating slightly more back pressure as a function of its greater length.

Protocol for SA-CI Standby to be Performed for the Cryonics Institute by Suspended Animation

While Suspended Animation (SA) shall make every possible effort to administer this protocol, SA reserves the right to make modifications if circumstances warrant it to do so. SA shall notify CI immediately of any significant deviation from the Protocol, generally or in one-time specific instances, and CI shall have the right to request alternatives.

Special terms below, identified with initial capitals, are defined in the Cryopreservation Agreement between the Cryonics Institute and Suspended Animation.

I. Premortem

a) SA shall make best efforts to maintain the following equipment in a state of good repair:

i) Transport vehicle (converted ambulance or specially modified van).

ii) At least three "H" size and at least six "E" size cylinders of oxygen.

iii) At least two portable ice baths, each with a vinyl liner and privacy cover.

iv) At least three Michigan Instruments "Thumpers" modified to fit the ice baths.

v) At least two fully packed and inventoried SA-CI Standby kits, each including:

1. A set of anti-ischemic medications provided by Critical Care Research.

2. Intubation equipment.

3. Two thermocouple probes and a data logging device for placement immediately after pronouncement of legal death, and two thermocouple probes and a data logging device for use during blood washout, and to accompany the SA-CI Standby Recipient during shipment to CI.

4. Safety equipment to protect personnel.

5. Other equipment commonly used to mitigate ischemic injury following cardiac arrest.

6. Portable perfusion equipment suitable to replace blood with an organ preservation solution prior to transport of the SA-CI Standby Recipient to a cryonics organization. The perfusion equipment shall include a heat exchanger capable of oxygenating the perfusate and reducing its temperature to 5 degrees Celsius.

7. Surgical instruments and other equipment to perform a femoral cutdown or similar procedure to access the vasculature and perfuse the SA-CI Standby Recipient.

8. 40 liters of MHP2 solution, prepared in conformity with specifications received from 21st Century Medicine.

vi) An additional SA-CI Standby Kit located in California.

vii) An additional nonsterile standby kit for training purposes.

b) When SA manages an SA-CI Standby it shall make best efforts to deploy team members as follows:

i) Team Leader, being an individual who has participated in at least three prior standbys.

ii) Paramedic, Emergency Medical Technician, or similarly qualified individual able to intubate, establish an intravenous line, mix and push medications, and perform similar tasks.

iii) Surgeon, with the capability to raise femoral (or other suitable) vessels, cannulate, and perfuse with blood washout solution. Either the Team Leader or the Surgeon must be able to push meds, place the Thumper, assess vital signs, and perform other medically-related tasks.

iv) At least two additional team members who have been trained in SA-CI Standby fundamentals.

v) No fewer than two team members shall be awake and as near the SA-CI Standby Recipient as possible during each 12-hour period of the SA-CI Standby, while the remaining team members rest in accommodations nearby.

c) SA shall make best efforts to deploy equipment for a SA-CI Standby as follows:

i) One complete SA-CI Standby kit as described above.

ii) 200 lbs of ice, and ice chests sufficient to contain this quantity.

iii) A transport vehicle (ambulance or rented van) suitable to move the SA-CI Standby Recipient to a nearby location for blood washout, unless other arrangements have been made for this purpose.

iv) At least one "H" size oxygen cylinder and at least four "E" size oxygen cylinders, except where prohibited or unavailable.

v) "Ziegler case" or similar appropriate container, plus body bag, for transporting the SA-CI Standby Recipient in water ice.

d) During the SA-CI Standby, premortem, SA shall make every effort to:

i) Track the SA-Affiliated CI Member's condition and update the member's prognosis, where permitted by healthcare providers, family members, and any persons with authority to make decisions on behalf of the SA-Affiliated CI Member.

ii) Record all relevant member data, and other information describing the progress of the SA-CI Standby.

iii) Liaise with relatives, healthcare providers, and others in the vicinity, in an effort to establish a relaxed and friendly rapport so that postmortem procedures may be performed quickly and cooperatively

iv) Provide all pertinent information to CI at least once every 24 hours.

v) Provide general information about cryonics procedures to people who are concerned with the SA-Affiliated CI Member's welfare.

e) During the SA-CI Standby, premortem, SA Team Members shall NOT:

i) Intrude upon the SA-Affiliated CI Member unnecessarily.

ii) Adopt a confrontational relationship with health-care providers or family members, or attempt to promote the concepts of cryonics in an intrusive or persistent manner.

iii) Obtain vital signs or otherwise interfere with the SA-Affiliated CI Member without permission from the Member's healthcare providers, if applicable, or in the alternative, authorized family member or personal representative.

iv) Offer or administer any kind of treatment, medication, or medical procedure before legal death is pronounced.

II. Postmortem

a) Immediately after legal death, SA Team Members shall intervene as rapidly as possible, making best efforts to perform the following tasks in this order of priority:

i) Administer propofol, streptokinase, and heparin in that sequence.

ii) Move the SA-CI Standby Recipient into the portable ice bath. Add all available ice to the ice bath, paying special attention to the head, armpit, and groin areas.

iii) Begin administering the remaining meds in the list recommended by Critical Care Research.

iv) If cardiac arrest occurred more than 45 minutes previously, provide cardiopulmonary support for a brief time sufficient to circulate medications. If cardiac arrest occured less than 45 minutes previously, continue applying cardiopulmonary support, using mechanical means if available.

v) Place a nasopharyngeal temperature probe and a rectal temperature probe, and begin data logging.

vi) Compile temperature data by hand, as backup to the automated data logging. Also make full notes of the times and other pertinent details relating to procedures.

vii) Compile a video and photographic record if this is permitted and does not conflict with the preferences of healthcare providers and family members.

viii) Move the SA-CI Standby Recipient to a transport vehicle.

ix) Transport the SA-CI Standby Recipient to a mortuary or similar location where blood washout can be performed.

x) Raise the femorals or other appropriate vessels for cannulation, followed by blood washout with MHP2. Establish closed-circuit perfusion while monitoring the temperature and pressure, and continue perfusion until the venous effluent is cooled below 10 degrees Celsius.

xi) Pack the SA-CI Standby Recipient inside a body bag with at least 100 lbs of ice sealed in leakproof bags.

xii) Place the bagged SA-CI Standby Recipient inside an additional heavy-duty body bag, which shall be placed inside a Ziegler case or similar shipping container suitable for human remains.

xiii) If the SA-CI Standby Recipient is to be transported via scheduled airline, apply styrofoam or similar insulation around the Ziegler case and place it on a standard air-shipping tray under a standard cardboard cover.

xiv) Transport the SA-CI Standby Recipient to CI by the fastest and most reliable method consistent with SA-CI Standby Recipient funding arrangements.

b) SA team members shall be entirely responsible for cleanup after perfusion, repacking supplies, returning supplies to SA, and cleaning and refurbishing equipment.

c) If the SA-Affiliated CI Member has requested participation from SA in cryoprotection procedures, at least one SA Team Member shall make every effort to accompany the SA-CI Standby Recipient to an airport near CI, designated by CI. Preferably this Team Member shall have surgical skills necessary to raise and cannulate femoral (or larger) vessels. In the event that a Team Member with surgical skills cannot arrive at the same time as the SA-CI Standby Recipient (or earlier), SA shall notify CI as quickly as possible, so that CI can make alternate arrangements for cryoprotection.

III. Cryoprotection

The following shall apply only in cases where an SA-Affiliated CI Member has requested participation from SA in cryoprotection procedures, and the member has requested glycerol cryoprotection or has allowed SA to determine the mode of cryoprotection and SA has selected glycerol protection.

a) SA shall make every effort to transport a set of glycerol solutions to Michigan with the SA-CI Standby Recipient, or earlier.

b) SA shall make every effort to transport a portable perfusion kit to Michigan with the SA-CI Standby Recipient, or earlier.

c) If SA has successfully deployed a Team Member with surgical skills, a portable perfusion kit, and a set of glycerol solutions to the location specified by CI, SA shall manage the perfusion of the SA-CI Standby Recipient with the glycerol solutions.

IV. Post-Cryopreservation Procedures

a) SA shall make best efforts to compile a full record of the SA-CI Standby, including clinical data, video, photography, and audio recordings.

b) SA shall provide original copies of all clinical data, notes, photographs, videos, and audio recordings to CI, if permission to do so is granted by the SA-CI Member in the "Suspended Animation Local Help Rider."

c) SA shall conduct a debriefing among participants no longer than two weeks after the end of the SA-CI Standby.