Independent Cryonics Educators Program

3.2: Stabilization and transport

When the standby ends, stabilization and transport begin. There are essentially three main scenarios:

- Stabilization and transport directly to Alcor
- Remote blood substitution (also called "blood washout")
- Field cryoprotection
- Straight freeze

1. If a patient is located close to Alcor, a team may carry out stabilization by external cooling and medication and then transport the patient directly to Alcor for cryoprotective perfusion.

2. When transport to Alcor's operating room may take up to 24 hours, the patient's blood may be replaced with an organ preservation solution (blood substitution) to enhance cooling, prevent blood clotting, and protect against cold ischemia.

3. If blood substitution is not feasible, or more than six hours has passed since legal death, or the transport time at above-zero temperatures will be too long – as is typical in an overseas case – the team may perform a field cryoprotection. The goal is to minimize time between pronouncement of legal death and the start of cryoprotection. Field cryoprotection is the replacement of blood and tissue water by solutions of cryoprotective agents (CPAs) near the location of legal death, followed by prompt cooling to dry ice (–79 degrees C) or lower temperatures at the same remote location. Currently Alcor is only able to perform field cryoprotection of the head only.

4. If field cryoprotection isn't possible, and long distance transport is required, cooling to dry ice temperature may be performed without any cryoprotection. This is sometimes called "straight freezing." Straight freezing is highly suboptimal, but is sometimes the best that can be done.

Initial stabilization will be much the same in each of these kinds of cases (other than the last). The exception is that stabilization may be bypassed if too much time has passed since legal death. Stabilization cannot begin until legal death has been pronounced. At that point, rapid cooling is initiated, circulation is restored, the lungs may be ventilated, and medications are administered to protect against blood clotting and keep the brain viable.

If begun promptly after pronouncement of legal death, the goal of stabilization is to cool the cryonics patient while maintaining biological viability of the brain. Viability in this context means preserving the ability of the brain to be resuscitated by ordinary means. Even though the intention isn't contemporary resuscitation, minimizing injury to the brain maximizes the efficiency of later circulation of cryoprotectant chemicals. To achieve this, four procedures are ideally employed:

1. Cardiopulmonary Support. Circulation is restored to provide oxygenated blood to the brain and to enhance cooling. Depending on specific circumstances, the lungs may be ventilated.

2. Induction of Hypothermia. The temperature of the patient is lowered to just above 0 degrees Celsius to depress metabolism.

3. Administration of Medications. Drugs are administered to improve circulation, inhibit blood clotting, and to protect the brain.

4. Blood substitution. If the patient is distant from Alcor's facilities, and if it is logistically possible to do so, the blood of the patient is substituted with an organ preservation solution to enhance cooling, prevent blood clotting, and protect against cold ischemia.

Cardiopulmonary Support Cardiopulmonary support (CPS) differs from cardiopulmonary resuscitation (CPR) because the goal of circulation and ventilation in cryonics is not resuscitation of the patient but the reduction of ischemic injury. Ischemic injury means injury caused by reduced or absent blood circulation, a condition called ischemia. The three objectives of cardiopulmonary support are:

1. Restore circulation of oxygenated blood to the brain.

2. Circulate medications.

3. Improve the rate of external cooling.

Unless surgical expertise is available to perform surgery with minimal interruption of circulation, CPS should continue until the patient has reached a core temperature of approximately 20° Celsius to prevent ischemic injury during later surgical preparation for blood substitution or cryoprotective perfusion. The exact temperature to reach before stopping CPS for surgery depends on how long blood circulation must be stopped for the surgery.

The second aspect of stabilization is **induction of hypothermia.** As temperature is lowered, metabolism slows and the rate of accumulation of damage slows. During CPS, the reduction of metabolism results in less damage than would otherwise occur from the low blood flows produced by chest compressions. After CPS is completed, or in cases where CPS wasn't possible, lower temperature (cold ischemia) preserves tissue viability longer than absent blood circulation at warm temperature (warm ischemia). That is why it is crucial to begin cooling a cryonics patient as soon as possible after pronouncement of legal death. However, temperature must not be reduced below the freezing point before cryoprotection has taken place.

Cooling is carried out by moving the patient from the bed to a portable ice bath containing ice and cold water. Immersion in ice water and circulation of the water around the patient accelerates cooling. Ice alone is not used because dry cubed ice will have less contact with the skin than water ice and therefore cooling will be slower. In a stabilization using Alcor's protocol, a system of perforated tubing is used to circulate the water and emphasize cooling of the head and areas with major surface blood vessels. Combining cooling with CPS accelerates cooling by moving warm blood from the core of the patient to the surface.

As soon as the patient has been placed in the portable ice bath, **administration of medications** should be started. As previously noted, legal death must have been declared before this point. All medications fall into one of four categories:

1. Small volume medications (such as heparin and streptokinase)
2. Large volume fluids (such as Decaglycerol/THAM)
3. Fluids that require gastric administration (antacid)
4. Medications to add to blood substitution solution

Small-volume medications and large-volume fluids are administered at the same time. This is especially important if the patient is dehydrated. If there is no delay between pronouncement of legal death and the start of stabilization procedures the full set of medications should be administered. If there has been a delay of more than an hour after cardiac arrest, a shorter list of medications is given.

The first medication given is propofol. This has two purposes. The first is to reduce the metabolism of the brain to reduce oxygen and glucose requirements. The second is to prevent the theoretical possibility of recovery of awareness due to aggressive cardiopulmonary support. Some of the other medications include: Heparin to prevent the formation of blood clots; vasopressin to increase blood pressure during CPS; an antibiotic; a neuroprotectant; an acid buffer; an agent to prevent cerebral edema (swelling of the brain); and a thrombolytic (to break up blood clots).

The final part of stabilization to maintain viability of the brain is **remote blood substitution**. "Remote" in this context means "remote from Alcor". If the patient is close enough to Alcor, this step will be skipped and cryoprotection begun in Alcor's operating room.

In this procedure, the patient's blood is replaced with an organ preservation solution. The solution used by Alcor is known as MHP-2. (If you're interested in its chemical composition, you will find it in the reference at the end of this section.) The blood substitution begins with an open circuit in which MHP-2 is continuously added. This continues until venous effluent (the fluid coming out of the veins) is clear in color, indicating that the blood has been washed out. The perfusion device will then switch to a closed circuit (recirculating) mode. Circulation with MHP-2 will continue until the core temperature of the patient falls below 5 degrees Celsius.

Remote blood substitution is performed for three reasons: 1. To rapidly induce profound hypothermia. 2. To prevent clotting, red cell sludging, and "no-flow". 3. To maintain viability of the brain during transport. Sometimes the procedure may be terminated before reaching 3 degrees Celsius if there is a need to do so, for instance in order to meet

the available air transport schedule. At the end of this procedure, surgical incisions are closed and the patient is prepared for transport.

References

https://www.alcor.org/docs/cryopreservation-procedures-section-03-protocol.pdf

Next: 3.3: Cryoprotective perfusion

ICE Program
