Independent Cryonics Educators Program

3.4: Field cryoprotection (FCP)

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 °C) or lower temperatures at the same remote location. If a temperature cold enough to achieve a solid state is attained (approximately -130 °C), the procedure can be called field vitrification.

As we have seen earlier (and will delve into further in Section 5), in cryonics we want to minimize time and temperature after pronouncement. The shorter the time and the faster the rate of cooling, the less ischemic injury incurred before placing the patient in long-term cryostasis. A potential drawback of remote blood washout and replacement with organ preservation solution is the prolonged period of cold ischemia between the end of blood washout and the start of cryoprotective perfusion. The length of that period depends on airline schedules and distance to Alcor. Field cryoprotection emerged as a way to eliminate the prolonged cold ischemic time typical of remote cryonics cases.

The perfusion circuit design described in the previous explainer is called a "**closed circuit**" system. This is the preferred system in cryonics. Closed circuit perfusion is used in cardiopulmonary bypass for heart surgeries and for organ cryopreservation research. The main advantage of this approach is that cryoprotectant concentration can be controlled continuously over as many hours as needed to achieve effective cryoprotection of tissues while minimizing consumption of perfusate.

Alcor presently uses an "**open circuit**" approach for field cryoprotection involving a series of increasing concentrations, without recirculating the perfusate. A set of bags are used, each containing a special level of concentration of perfusate. The step up in concentration is smoothed out between steps by using a "teeter-totter" to blend one level of concentrate into the next. The more bags used, the closer the ramp will approximate a closed-circuit ramp.

The field cryoprotection system presently used by Alcor perfuses only the head with cryoprotectant via the carotid arteries. After field cryoprotectant perfusion is complete, the patient will be cooled and shipped at dry ice temperature (-79 degrees Celsius) to Alcor where further cooling occurs. Tissue remains in a liquid state at this temperature, and ice formation can occur, so minimizing transport time is important.

If used for whole body cryopreservation, the present "neuro" FCP system will result in the whole body outside the head freezing without any cryoprotectant. This is justified if

logistical circumstances are such that not performing field cryoprotection would result in extensive freezing injury to both the body and brain.

Field cryoprotection is not the same as field vitrification. In field cryoprotection the patient is cooled below 0 degrees Celsius after cryoprotective perfusion but not to a temperature where the vitrification agent solidifies into a glass. Field vitrification would require on-site cryogenic cooling followed by shipping the patient at around -130 degrees Celsius (below the glass transition temperature of the vitrification agent) or -196 degrees Celsius (liquid nitrogen temperature). Shipping the patient at these temperatures would add several substantial technological and logistical challenges.

Advantages of field cryoprotection (FCP) as presently implemented by Alcor:

- Elimination of cold ischemic injury that would otherwise occur during long distance transport near 0 degrees Celsius to Alcor. Without FCP, such injury can compromise later cryoprotective perfusion at Alcor, or make cryoprotective perfusion at Alcor impossible if transport time is much greater than 24 hours.

- An extra team and cryoprotectant perfusion procedures at Alcor are not required when FCP is used.

Disadvantages of field cryoprotection (FCP) as presently implemented by Alcor:

- Less sophisticated control and monitoring of cryoprotectant perfusion.

- Extra equipment and specialized training for field teams is required.

- More difficult low-temperature (dry ice) transport logistics, especially for whole body patients.

- Suboptimal cooling profile for vitrification, and potential for some ice growth during transport.

- “Straight freezing” of the entire body below the head, and compromised cryoprotective perfusion of the part of the brain called the cerebellum, when FCP is used for whole body cases.

When possible, FCP is the preferred procedure for cases outside the continental United States. Within the continental United States, decisions of whether to use FCP are made on an individual case basis depending on case logistics.

References

Field Cryoprotection
https://www.alcor.org/library/field-cryoprotection/

https://www.alcor.org/docs/cryopreservation-procedures-section-18-cryoprotection.pdf

"How Cryoprotectants Work" in *Cryonics* magazine, 3rd Quarter 2007.

Next: 3.5: Monitoring and feedback for cryonics procedures

ICE Program
