SPOTLIGHT

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Clinical Considerations of Normothermic Regional Perfusion (NRP)

Normothermic regional perfusion (NRP) is an in-situ perfusion of a portion of the donor's body with the aid of mechanical organ support. This practice is utilized in a growing number of donation after circulatory determination of death (DCD) cases. The overall advantage of NRP is that organs previously not utilized can now be utilized for transplantation, allowing for improved stewardship of the gift from the donor and their family and providing hope for those in need of a life-saving transplant.

As with many new approaches or procedures in medicine, NRP comes with legal and ethical considerations, clinical considerations, as well as operational considerations. This issue will focus on the clinical aspects of NRP.

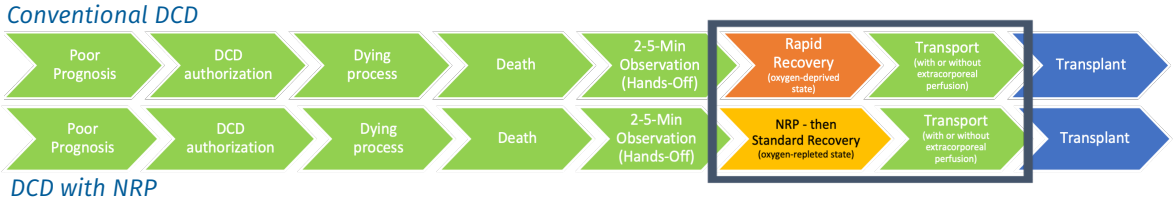
There are two approaches to NRP:

1. Thoracic-abdominal (TA)-NRP – in which the thoracic and abdominal organs are perfused. This approach is utilized for DCD heart recovery.
2. Abdominal (A)-NRP – in which only the abdominal organs are perfused.

How does the use of NRP change the current DCD process?

Following the required "hands-off" period of 2-5 minutes after the patient has been declared dead according to circulatory and respiratory criteria, a full upper and lower midline incision is made. The next step is to re-establish perfusion within a specific region of the body, i.e., thoracic and abdominal or just the abdominal area. To isolate the perfusion to the thoracic and abdominal area, the arch vessels are clamped (including the cerebral arteries) and vented to prevent brain perfusion, and the aorta and right atrium are cannulated. Oxygenated blood flow is then reinitiated to the designated regional area with the aid of mechanical organ support.

Conventional DCD



DCD with NRP

Overall Risks & Benefits of NRP

With every clinical procedure, risks and benefits must be weighed. Overall, the risks of NRP include:

- Risk of primary graft dysfunction (PGD): This risk is no different than in a brain dead donor.
- Ethical concerns: This will be further discussed in a separate Spotlight publication.
- Technically challenging: It takes practice.
- DCD protocols vary between hospitals and OPOs: Standardization is currently being addressed.

RISKS & BENEFITS FOR HEART

RISKS	BENEFITS
• Aortic dissection • Aortic intramural hematoma • Right ventricular injury *(the above three are risk factors in rapid recovery DCD cases as well)* • Cannula removal or mal-positioned • Hypovolemia or low flow ◦ Termination of process will occur after 45-60 mins if this challenge is observed • It is technically challenging	• Hearts can now be recovered in DCD cases, adding to availability for those in need of transplant. • Successful recovery of other potentially high-quality organs that were previously compromised in DCD (e.g., the liver). • Perfusion of organs with oxygenated blood allows visual and functional assessment in a warm (normothermic) physiologic environment. • The recovery of organs can occur in a manner similar to standard brain dead procurement, reducing the risk of organ injury. • The mechanical organ support can be weaned, and the heart evaluated against a physiologic systemic vascular resistance to assess suitability for transplant.

RISKS & BENEFITS FOR LIVER & KIDNEYS

RISKS	BENEFITS
At this stage, there have been no risks identified and some surgeons may even suggest that all DCD cases should be done with NRP due to the benefits observed.	• Improves organ utilization, i.e., more organs are viable for transplant. • In kidneys, a statistically significant reduction in recipient delayed graft function and graft failure were observed. • Improved graft and patient outcomes. • In livers, it appears to reduce postoperative biliary complications and graft loss. • Successful transplantation of medically complex organs (e.g., fatty livers, high Kidney Donor Profile Index (KDPI) kidneys, older donors, hepatitis positive donors, etc.) from DCD donors is more feasible.

Conclusions

- NRP mitigates the detrimental impact of warm ischemic time (WIT).
- NRP can improve graft and patient outcomes in multiple organs.
- NRP can increase the number of potential organs for transplant.
- NRP has significant cost savings in comparison to ex-vivo perfusion machines.

Moving forward, ongoing monitoring of outcome data is needed, the impact of NRP on lung donors should be explored, and the ability of NRP to increase utilization of organs from Extended Criteria Donors should be evaluated.

Helpful Resources:

- Brubaker AL, Urey MA, Taj R, et al. Heart-liver-kidney transplantation for AL amyloidosis using normothermic recovery and storage from a donor following circulatory death: Short-term outcome in a first-in-world experience. https://doi.org/10.1016/j.ajt.2022.11.003
- Hessheimer AJ, Coll E, Torres F, et al. Normothermic regional perfusion vs. super-rapid recovery in controlled donation after circulatory death liver transplantation. https://doi.org/10.1016/j.jhep.2018.12.013
- Hoffman JRH, McMaster WG, Rali AS, et al. Early US experience with cardiac donation after circulatory death (DCD) using normothermic regional perfusion. https://doi.org/10.1016/j.healun.2021.06.022
- James L, LaSala VR, Hill F, et al. Donation after circulatory death heart transplantation using normothermic regional perfusion. https://doi.org/10.1016/j.xjtc.2022.11.014.
- Sellers MT, Nassar A, Musab Alebrahim, et al. Early United States experience with liver donation after circulatory determination of death using thoraco-abdominal normothermic regional perfusion https://doi.org/10.1111/ctr.14659
- Shah AS. Normothermic regional perfusion in donor heart recovery: Establishing a new normal. https://doi.org/10.1016/j.jtcvs.2021.11.084

For additional references & resources; or to learn more, please visit:
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