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The anesthetist perspective: optimization of cardiac allograft from withdrawal of life support to reperfusion in the controlled donation after circulatory death

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Donation after circulatory death (DCD) donors are subjects undergoing a planned withdrawal of life-sustaining therapies (WLST), leading to an 'observed' cardiac arrest or controlled DCD (cDCD). Typically, these patients have sustained catastrophic, irreversible cardiorespiratory or neurological injuries but do not meet brain death criteria. The main concern associated with using hearts from cDCD is the exposure to warm ischemia and the subsequent risk of graft failure (1).

The coordination and success of DCD heart transplantation involve a multidisciplinary team, including intensivists, organ retrieval coordinators, surgeons and cardiac anesthesiologists. The intensivist is responsible for patient management, including WLST, until the declaration of death, while the anesthesiologist or donor care practitioner manages the process afterward. The intensivist team involved in the retrieval portion or care of the donor should not be involved in recipient care to maintain the ethical boundaries between recipient and donor. While practices may vary between countries, this distinction is particularly important for anesthesiologists who practice in both the intensive care unit (ICU) and the operating room (OR).

From the timing of the WLST to the management of organ reperfusion, the intensive care team and the anesthesiologist play pivotal roles in optimizing the viability and function of DCD hearts.

WLST, usually consisting of the removing respiratory and/or cardiovascular support, maintains a central role in

the DCD process. No standardized procedure exists for end-of-life (EoL) management, evaluation, and monitoring of parameters (2). Sparse literature examines the WLST process in DCD donors in detail. Predicting the time to death after WLST is difficult; following WLST, organs are subject to variable periods of hypoxemia, hypotension and acidosis, resulting in ischemic injury. Two primary issues must be addressed: managing of EoL medications, which must not intentionally hasten death, and the type of monitoring (invasive *vs.* non-invasive) required to confirm cardiac arrest. Minimizing donor warm ischemia time (DWIT) and mitigating the effects of reperfusion injury are paramount, as they are the major contributors to irreversible myocardial damage.

Standardizing EoL management protocols and methodology of hemodynamic monitoring by dedicated ICU physicians is crucial. This standardization can help minimize WIT, particularly during the functional WIT (fWIT) in countries where the no-touch period is prolonged (3). Future research should consider evaluating other relevant patient characteristics and comparing institutional withdrawal practices against the time to death to better estimate its duration, its impact and finally its optimal management.

After death declaration, DCD hearts can be retrieved using either direct procurement or *in situ* reperfusion techniques, such as normothermic regional perfusion (NRP) (4). The thoraco-abdominal NRP (TA-NRP)

facilitates, through extracorporeal membrane oxygenation (ECMO) technologies, restoring circulation to organs in the abdominal and thoracic cavities. TA-NRP starts when the surgical team has clamped the supra-aortic trunks to prevent the resumption of intracranial blood flow. All brain circulation must be excluded and not restored by TA-NRP or any other means (5).

Using NRP/TA-NRP has raised different ethical concerns. Restoring circulation after determination of death could invalidate the diagnosis of death despite clamping the arch vessels. While some human studies are emerging, more research and evidence is needed to conclusively show brain circulation can be effectively excluded (5). Proper assessment and monitoring of brain activities are difficult during the cDCD process. However, a panel of experts have recommended appropriate technical measures to effectively avoid brain reperfusion (5,6). Further investigations should focus on monitoring modalities to definitively demonstrate the permanent cessation of brain circulation and the absence of cerebral activity in this setting.

The TA-NRP method varies depending on country and institutional policies. Some countries allow antemortem interventions, such as heparin administration and peripheral ECMO cannula placement into the femoral vessels before WLST. Others permit only postmortem intervention, including heparin administration once a period of hands-off time is maintained.

After TA-NRP is started, several steps are usually performed: (I) the donor is reintubated, to maintain adequate oxygenation and ventilation; (II) the reanimated heart's function may differ from its pre-arrest state, and minimal inotropes and vasopressors may be required to restore of myocardial function (7). Evaluation includes hemodynamic, ultrasound and biochemical parameters. Assessing heart viability requires separating the donor from NRP (8). Cardiac anesthesiologists play a crucial role beyond maintaining hemodynamics to ensure the restoration and viability of all organs. They complement their surgical and perfusion colleagues to rapidly and effectively optimize the donor.

Finally, intensivists and anesthetists play a key role in 'protecting' the whole donation process regarding other solid organs (i.e., lungs, liver, kidneys), during the 'critical' phases of donation: (I) the time from TA-NRP weaning; (II) the opportunity to assess the heart; and (III) the need to continue abdominal NRP in the case of heart failure.

In conclusion, the role of anesthetists remains underexplored, yet crucial for ensuring optimal outcomes

in DCD heart transplant programs. The meticulous orchestration of WLST marks the transition between the donation process and the transplant journey. Intensivist and cardiac anesthesiologist collaboration offers several benefits: (I) standardizing the WLST by dedicated ICU physicians and staff who understand the process; (II) standardizing the methodology of organ reperfusion and monitoring to ensure safety and reproducibility; (III) reducing variability in organ management and assessment; and (IV) focusing expertise by integrating multiple experienced teams in cardiothoracic surgery, cardiology, critical care, anesthesiology, and abdominal transplant surgery. Alignment between NRP protocols and prevailing clinical, ethical and legal standards remains necessary.

We need a common language to evaluate viability data during TA-NRP and after weaning from extracorporeal support. With an effective protocol algorithm, cardiac anesthesiologists and intensivists can complement their surgical and perfusion colleagues to rapidly and effectively optimize the heart for donation in the DCD donor (8). Finally, to support best practices for the heart DCD process, providing appropriate information to donor families and staff, maintaining transparency in ethical and practical management, and preserving dignity in the dying process ensures public trust in the system of organ donation.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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