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Johari Window: heart transplant following donation after circulatory death. Expanding the donor pool in Mexico

Ventana de Johari: trasplante de corazón tras la donación después de la muerte circulatoria. Aumentando el número de donantes en México

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ABSTRACT

This statement discusses how Donation after Circulatory Death (DCD) can expand the heart donor pool and improve access to transplantation, particularly in Mexico. It reviews key barriers to DCD implementation, including unavoidable warm ischemia, cost and logistical complexity, and ethical/legal concerns surrounding certain procurement strategies. Two established approaches are summarized: Direct Procurement and Perfusion (DPP) using *ex situ* normothermic perfusion platforms, and Thoracoabdominal Normothermic Regional Perfusion (TA-NRP), which allows *in situ* assessment but may raise "dead donor rule" concerns. Using the Johari Window framework, the author argues that some feasible solutions remain in a national "blind spot". The paper highlights Rapid Recovery with Extended Ultra-Oxygenation Preservation (REUP) as a promising, lower-cost, reanimation-less strategy that may avoid expensive technology and ethical issues tied to reperfusion or *ex situ* systems. Early reported outcomes are presented as comparable to DPP and TA-NRP, including feasibility with prolonged "no-touch" periods and extended ischemic times. The author concludes that REUP could enable broader DCD adoption in Mexico, while emphasizing the need for further comparative and long-term studies.

RESUMEN

Este documento analiza cómo la donación tras la muerte circulatoria (DCD, por sus siglas en inglés) puede ampliar el grupo de donantes de corazón y mejorar el acceso al trasplante, particularmente en México. Se revisan las principales barreras para la implementación de la DCD, incluyendo la inevitable isquemia caliente, la complejidad logística y de costos, y las preocupaciones éticas y legales que rodean a ciertas estrategias de obtención. Se resumen dos enfoques establecidos: la procuración directa y perfusión (DPP, por sus siglas en inglés) mediante plataformas de perfusión normotérmica ex situ, y la perfusión regional normotérmica toracoabdominal (TA-NRP, por sus siglas en inglés), que permite la evaluación in situ, pero puede plantear dudas sobre la "regla del donante muerto". Utilizando el marco de la ventana de Johari, el autor sostiene que algunas soluciones viables permanecen en un "punto ciego" nacional. El artículo destaca la procuración rápida con preservación por ultraoxigenación extendida (REUP, por sus siglas en inglés) como una estrategia prometedora, de menor costo y sin necesidad de reanimación, que podría evitar la tecnología costosa y los problemas éticos vinculados a la reperfusión o a los sistemas ex situ. Se presentan informes de resultados tempranos comparables a los de DPP y TA-NRP, incluyendo su factibilidad con periodos prolongados

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de observación ("no-touch") y tiempos de isquemia extendidos. El autor concluye que la técnica REUP podría permitir una adopción más amplia de la DCD en México, enfatizando la necesidad de realizar más estudios comparativos y de largo plazo.

Keywords: death by circulatory determination, thoracoabdominal normothermic regional perfusion, direct procurement and perfusion, rapid recovery with extended ultra-oxygenation preservation, heart transplantation, Johari Window.

Palabras clave: *donación por muerte circulatoria, perfusión regional normotérmica toracoabdominal, procuración directa y perfusión, procuración rápida con preservación por ultraoxigenación extendida, trasplante de corazón, ventana de Johari.*

Abbreviations:
CPB = Cardiopulmonary Bypass
DBD = Donation after Brain Death
DCD = Donation after Circulatory Death
DPP = Direct Procurement and Perfusion
DPP = Direct Procurement Protocols
ECMO = Extracorporeal Membrane Oxygenation
NRP = Normothermic Regional Perfusion
OCS = Organ Care System
REUP = Rapid Recovery with Extended Ultra-Oxygenation Preservation
TA-NRP = Thoracoabdominal Normothermic Regional Perfusion

This document explores the transformative potential of Donation after Circulatory Death (DCD) for expanding the heart donor pool in Mexico. Using the Johari Window framework, the author analyzes how institutional blind spots and knowledge asymmetries hinder the adoption of innovative DCD techniques. The paper reviews established procurement methods like Direct Procurement and Perfusion (DPP) and Thoracoabdominal Normothermic Regional Perfusion (TA-NRP),[1] while highlighting the novel Rapid Recovery with Extended Ultra-Oxygenation Preservation (REUP) technique. REUP enables reanimation-less recovery of DCD hearts, offering comparable early outcomes to traditional approaches while reducing costs and logistical complexity.[2] The paper argues that integrating REUP could help Mexico overcome technical, ethical, and legislative barriers, transforming hidden institutional limitations into opportunities for equitable access to heart transplantation. Ultimately, the piece calls for greater transparency, collaboration, and openness to innovation, positioning REUP as a promising solution for countries facing resource constraints and prolonged ischemic times.

Approximately 6.7 million Americans are afflicted with heart failure, of whom roughly 5% progress to refractory, end-stage disease (American Collegue of Cardiology/ American Heart Association stage D/New York Heart Association class IV [ACC/AHA Stage D/NYHA IV]), yielding a subset of roughly 335,000 patients grappling with advanced heart failure at any given time. This Stage D cohort, though numerically small, represents an exceptionally high-risk population for whom advanced therapeutic interventions (including left ventricular assist devices and transplantation) become imperative.

The most up-to-date publicly available data show that the United States heart transplant waiting list includes approximately 3,289 patients nationwide.[3]

The number of heart transplants performed in the United States annually continues to increase, reaching approximately 4,000 in 2024. Altogether, despite increases in heart transplantation, the current incidence of surgical treatment of end-stage heart failure does not meet the need of patients suffering from advanced heart failure.[4,5] This increase was mostly driven by the 68% increase in the use of DCD donors with a smaller increase of 4.6% in Donation after Brain Death (DBD) donors.[6,7] Some of this increase is also related to liberalization of qualifications of potential recipients, such as increased age and comorbidities that were previously prohibitive (human immunodeficiency virus [HIV], hepatitis C) but now are treatable.[8,9]

DCD refers to organ procurement from donors who, though not meeting brain death criteria, suffer irreversible cessation of circulatory and respiratory function following withdrawal of life-sustaining therapy, a practice distinct from donation after brain death.[10] Though pioneered by Christiaan Barnard in 1967, DCD heart transplantation lay largely dormant until its revival in the 2000´s, spurred by successful transplants in Australia[11] and the United Kingdom,[12] and later adopted in the US in 2019.[13] While DCD donors have expanded the cardiac allograft pool (a critical step given transplant demand) their utilization introduces a clinical challenge: inevitable warm ischemic injury during therapy withdrawal, demanding meticulous donor-recipient matching and logistical coordination.

To ensure graft viability, DCD heart procurement employs distinct strategies, each with unique procedural nuances and trade-offs: DPP, TA-NRP, and select modified protocols. These approaches aim to mitigate ischemic injury, though optimal techniques remain under evaluation.

Before exploring potential adaptations to expand DCD heart procurement in Mexico (a country with unique healthcare constraints) let's examine current strategies and their applicability. Given the technology and investment required, leveraging international experience via the Johari Window framework may illuminate pathways to increase donor utilization and transplants locally.

The Johari Window (a four-quadrant model of knowledge distribution) proves useful beyond interpersonal dynamics. In DCD transplantation, it highlights knowledge asymmetries: open (known to all: brain death vs. DCD), hidden (local expertise undisclosed), blind (unseen barriers), and unknown (untapped innovations). Disclosure and collaboration expand the "open area", informing strategies to increase donor utilization.

The blind area (those truths known to others but obscured to oneself) contracts as feedback refines self-perception. Within this quadrant reside overlooked techniques, latent knowledge, and procedural alternatives that remain invisible to dominant paradigms. For instance, a DCD heart procurement method exists that bypasses both Direct Procurement Protocols/ Organ Care System (DPP/OCS) and Normothermic Regional Perfusion (NRP). It is simpler, more cost-effective, and reproducible, yet remains largely unrecognized in certain national programs. This gap is not merely technical, it reflects a deeper institutional blind spot, where innovation is constrained not by feasibility but by visibility. Bridging this divide requires not only procedural awareness but philosophical openness to what others already see. The hidden area reflects intentional modulation of information; we found here things that you know about yourself, but are unknown to others, like the Mexican Legislation about DCD, and the unknown area represents latent capacities or unrecognized patterns that may emerge under new conditions. As its name suggests, in this area we found the things that are unknown to you and by everyone else (what is the best technique for DCD heart procurement?).

In this sense, the model parallels adaptive biological systems, where transparency, feedback, and environmental interaction govern functional coherence *(Fig. 1)*.

Philosophically, the Johari Window evokes the notion of relational epistemology -the idea that knowledge of oneself is neither static nor solitary, but co-constructed through interaction. It highlights the inherent asymmetry between how we see ourselves and how we are seen, and it underscores the humility required to navigate that gap. The model suggests that self-understanding is not merely introspective but contingent upon the willingness to engage with others, to tolerate vulnerability, and to accept that parts of the self-remain undiscovered until circumstances reveal them.

In this dual scientific-philosophical framing, the Johari Window becomes more than a communication tool; it becomes a reminder that human insight is iterative, relational, and perpetually incomplete. It affirms that growth (whether personal, organizational, or clinical) emerges from the interplay between what we reveal, what we learn, and what we have yet to uncover.

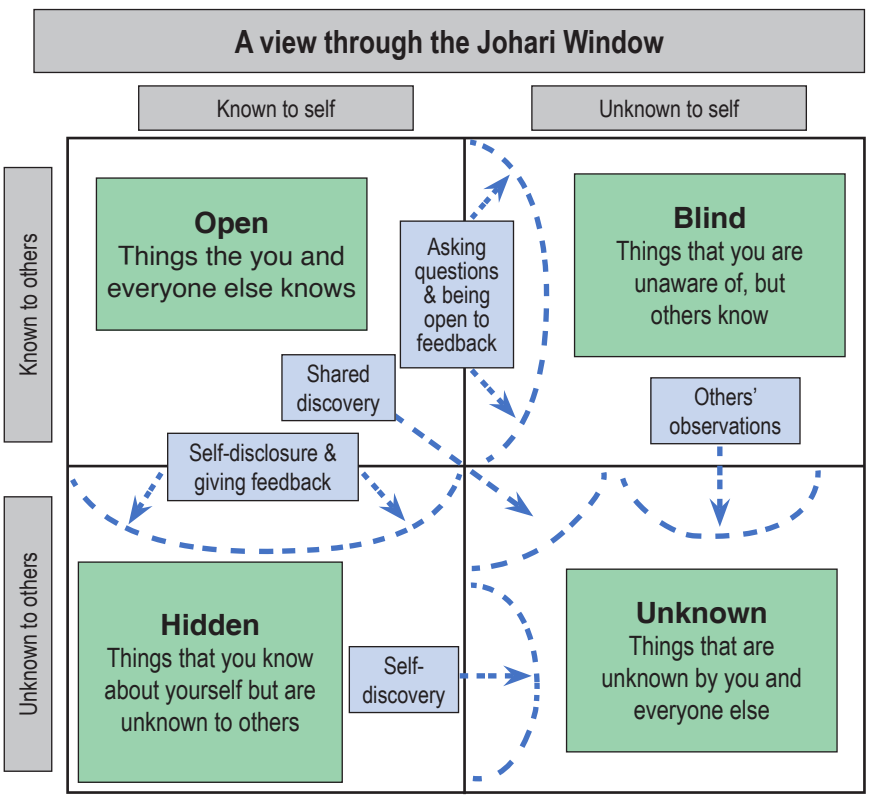

Figure 1:

The Johari Window. A four-quadrant framework illustrating the interaction between self-knowledge and external perception. The model comprises the open (known to self and others), hidden (known to self only), blind (known to others only), and unknown (known to neither) areas, highlighting how feedback and disclosure shape the evolution of personal insight.

The dynamic and essential logistics required for progress in the field of transplantation and, in truth, in nearly every area of science and art.

Let us now examine the different techniques employed in DCD heart procurement:

Direct Procurement and Perfusion (DPP)

Procedure: after circulatory death is confirmed and a standoff period is observed, the donor heart is rapidly procured and immediately placed on an *ex situ* normothermic perfusion platform, such as the OCS, for reanimation and functional assessment. This process typically involves draining 1.2–1.5 liters of donor blood to prime the perfusion system before aortic cross-clamping and heart explantation. The heart is then transported to the recipient center on the perfusion device *(Fig. 2)*, allowing for continued assessment and preservation during transport.[14,15]

Advantages and limitations: allow for *ex situ* functional assessment of the heart.

Can be resource-intensive, costly, and operationally complex due to the need for specialized equipment and trained personnel[16] and may delay abdominal organ perfusion, potentially increasing warm ischemia time for other organs.[17]

Thoracoabdominal Normothermic Regional Perfusion (TA-NRP)

Procedure: after circulatory death is declared, Extracorporeal Membrane Oxygenation (ECMO) is established via central aortic and right atrial cannulation. The cranial branches of the aortic arch are clamped to prevent cerebral reperfusion, and circulation is restored to the thoracoabdominal organs. The heart is reanimated *in situ*, and its function is assessed under physiological conditions using transesophageal echocardiography and pulmonary artery catheterization before procurement *(Fig. 3)*. The heart is then preserved, usually using cold storage for transport.[15,18]

Advantages and Limitations: enables *in situ* functional assessment of the heart in a loaded state, which may improve graft selection and outcomes.[18,19]

Allows for more rapid reperfusion of all transplantable organs, potentially reducing warm ischemic injury to abdominal organs.[17] Less costly than *ex situ* perfusion, but has raised ethical and legal concerns regarding the dead donor rule and restoration of circulation after death.[14,19]

A modification that could significantly expand its use in developing countries is the substitution of conventional Cardiopulmonary Bypass (CPB) for ECMO, as this would dramatically reduce procedure-related costs, and current knowledge and experience with CPB are far more widespread and disseminated than those concerning ECMO.

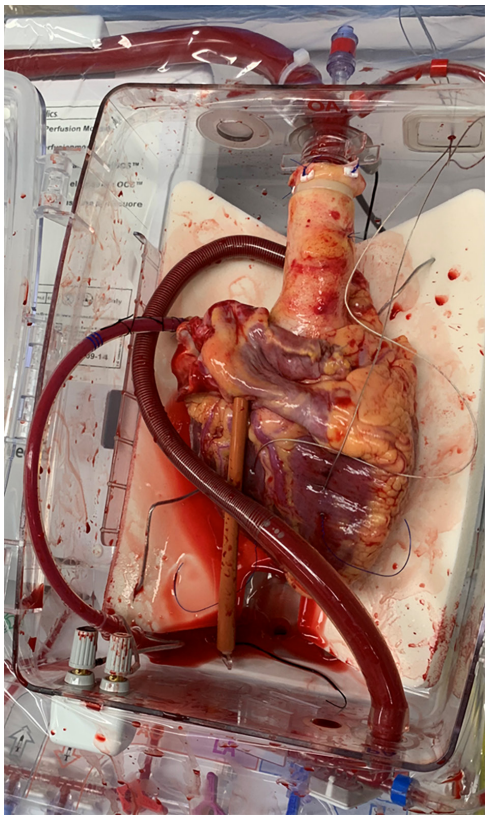

Figure 2: Heart in organ care system after direct procurement and perfusion.

Rapid Recovery with Extended Ultra-Oxygenation Preservation (REUP) [BLIND AREA]

Entering the subject directly, this technique represents the cornerstone for achieving the objective described in the title of the manuscript.

Though nascent and unconventional, this approach underscores global potentialities, a promise tempered by systemic hurdles: entrenched donation cultures, socioeconomic disparities, and policy constraints variably stifle DCD expansion worldwide.

The REUP technique importantly highlights the issue of cardiac reanimation. Discard rates using *ex situ* perfusion are 8-10%, as visual assessment of cardiac reanimation in an unloaded state and lactate levels may not necessarily correlate with allograft performance, and the fact that the associated mortality of DCD remains comparable to that of DBD loses impact.[20] *In situ* cardiac reanimation with TA-NRP provides a more physiologic assessment, and discard rates are much lower at around 1-3%.[18]

With REUP, cardiac reanimation may be unnecessary and contribute to added costs. REUP uses Del Nido as

a preservation solution based on ensuring an excellent diastolic arrest and avoiding additional myocardial energy depletion with cardiac reanimation. This additionally eliminates the ethical issue of cardiac reanimation in the donor, which is problematic for NRP. Furthermore, the REUP technique is simple to set up with a small team (one perfusionist), requires little time and setup (30 min), and is much less costly (less than $2K for disposables) than these other techniques.[21]

This novel, reanimation-less rapid recovery technique using extended oxygenated preservation and cold storage, designed to avoid the need for *ex situ* perfusion systems or TA-NRP, is a technique developed for the recovery and preservation of cardiac allografts from DCD donors. This method is characterized by the rapid, ultra-oxygenated recovery of DCD hearts for transplantation, notably without the need for pre-implant reanimation, which distinguishes it from traditional approaches such as *ex situ* perfusion or TA-NRP.[22]

Key features and application of REUP

Reanimation-less recovery: unlike conventional methods that require reanimating the heart before implantation to assess graft viability, REUP enables transplantation without this step; you don't need the use of ECMO, CPB, or TEE, simplifying the process and reducing associated costs.[16]

REUP advantages: by providing ultra-oxygenation and eliminating the need for reanimation, REUP may reduce the risk of organ damage and expand the applicability of DCD heart transplantation, especially in settings with mandatory prolonged "no touch" periods.[21]

Extended ultra-oxygenation: the technique involves providing ultra-oxygenated conditions during the rapid recovery phase, which is intended to preserve organ viability even after prolonged periods of circulatory arrest.

Before withdrawal of life-sustaining care, a modified NRP flush circuit with reservoir was constructed *(Fig.4)*. The components of the preservation solution included two units of packed red blood cells, two liters of del Nido cardioplegia solution, heparin (30,000 U), mannitol (3,125 mg), solumedrol (125 mg), N-acetyl-L-cysteine (30 g), and levothyroxine (50 mg). The addition of valproic acid, as well as oxygenation of the perfusate, has helped contribute to the favorable outcomes of the REUP technique. Valproic acid has been shown to promote cardioprotection. After mixing the components, the circuit was started at two liters per minute, and the perfusate was oxygenated. However, a perfusate temperature of 10-12 °C was targeted. A pH of 7.5 and a partial pressure of oxygen of 500 mmHg were targeted. Arterial blood gases were analyzed serially until temperature-correct values were achieved.[21]

The premise for the technique is that the slow delivery of an oxygenated preservation solution with additional cardioprotective additives may help resuscitate the heart and reverse the myocardial energy debt incurred during circulatory death.

There is an interesting theory with respect to the concept of reanimation, independently of the protocol (DPP-OCS,

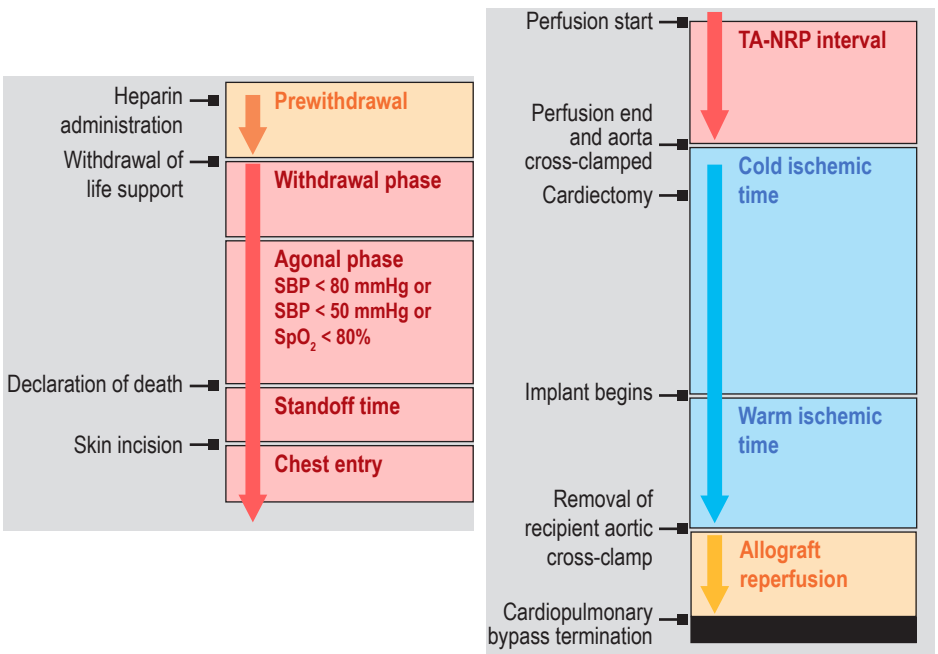

Figure 3:

Algorithm for Toracoabdominal-Normothermic Regional Perfusion (TA-NRP).

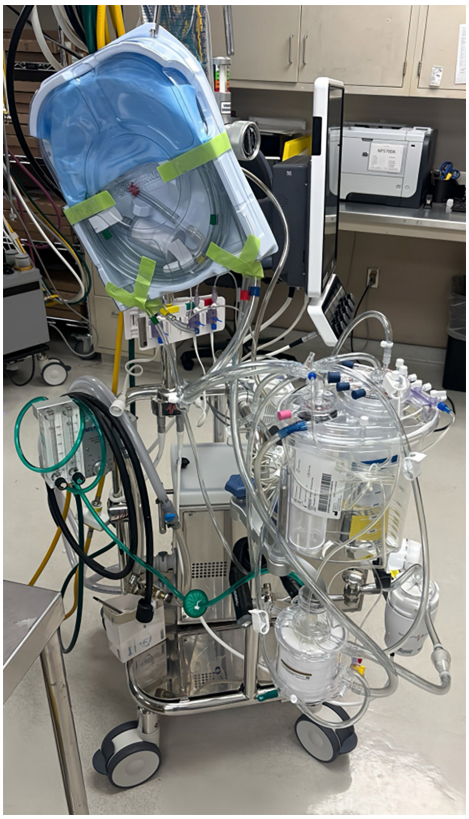

Figure 4: Modified normothermic regional perfusion flush circuit with reservoir.

TA-NRP), there may be a deleterious impact introduced by the additional arrest of the DCD donor heart that is necessarily introduced by reanimation techniques. Namely, that the "second hit" of cardiac arrest imposed on the donor heart following reanimation creates additional insult and non-physiologic consequence to the allograft that may impact its function after implantation.[21,22]

Following the protocol for DCD, when the right time was, A sternotomy was performed, the left and right sides were vented, and an ascending cross clamp was placed. A bifurcated ascending root vent was used to administer the perfusate with an aortic root pressure of 80 mmHg and a flow rate of 200 ml/minute. The donor cardiectomy is performed in standard fashion, and the heart is placed in the 10 ºC cooler.

The premise for this technique is that the slow delivery (aortic root pressure of 80 mmHg) of an oxygenated preservation solution may help resuscitate the heart and reverse the myocardial energy debt incurred during circulatory death, and hypothesized that the use of 10 ºC preservation would allow successful transplantation of REUP allografts even in the setting of prolonged ischemia time.[22]

In the last several years, cardiac allografts from DCD donors have been used in adult heart transplantation with excellent early and midterm outcomes comparable to those from donation after brain death. TA-NRP and DPP with commercial *ex situ* platforms have shown success in countries with short asystolic "no-touch" periods (five minutes or less), including the United States, England, and Australia. However, countries such as Italy have some of the longest known periods, requiring up to 20 minutes of asystole prior to final declaration of death. These prolonged periods of circulatory arrest have been considered major barriers to the uptake of DCD adult heart transplant in these settings. Early studies demonstrated a 10% 30-day mortality rate and a 25% severe PGD rate, and larger follow-up studies showed similar results. Compared to the United States, where "no-touch" periods are typically less than five minutes, the rates of mortality and severe PGD remain significantly higher.[22]

Williams et al. reported the longest total ischemic time in literature involving the rapid recovery of a DCD cardiac allograft (eight hours) with static cold storage using the REUP technique with optimal results. Also, the same group described recovery of a 32-year-old donor cardiac allograft with a prolonged "no touch" period of circulatory arrest. Despite 37 minutes of circulatory arrest before donor heart preservation, the recipient underwent successful heart transplantation with normal biventricular function and excellent outcomes postoperatively.[21] This case challenges the concerns regarding the REUP technique in prolonged "no-touch" periods.

Just recently, Williams et al. reported the first series of DCD hearts using REUP. In this case series of 24 adult patients who underwent heart transplant with REUP-recovered DCD cardiac allografts, 38% were older than 40 years. The mean time from initial declaration of donor death to flush was nine minutes. 60% had a total ischemic time longer than four hours, including one that was eight hours. Among recipients, 30-day survival was 96%. Only one patient (4%) had severe primary graft dysfunction, and one other patient (4%) had secondary graft dysfunction. On initial endomyocardial biopsy, one patient (4%) had acute cellular rejection grade 2R; no cases of antibody-mediated rejection were observed, highlighting the safety, feasibility, and efficacy of this novel DCD recovery technique.[22]

The 30-day survival of 96% remains similar to TA-NRP and DPP of 96 and 97%, respectively. Several studies have highlighted a lower rate of biopsy-proven acute cellular rejection grade 2R with TA-NRP compared with a DPP (15 vs 35%) over the first year. The present study also observed low rates of clinically significant acute cellular rejection grade 2R at 4%; although this is low and promising, additional data out to one year are needed.

REUP does not prevent the recovery of any other organ, or use of abdominal NRP, the data in this study reflect similar

abdominal organ and lung utilization rates, compared with the literature.[22]

At present, it exists a big deal of controversy internationally regarding the costs of *ex situ* perfusion systems and ethical concerns with TA-NRP. As such, this manuscript highlights how the REUP technique has potential for broad application to allow more patients access to DCD heart transplantation, and will be appealing to programs with long travel times, limited resources (financial and technologic) without cardiac reanimation, with ethical issues that create legislative barriers to advancing the fundamental goal of better balancing the demands of the waiting list with the donor pool available in response. Undoubtedly, REUP is a highly promising technique (particularly in Mexico and other developing countries) for achieving the balance previously mentioned, and it carries substantial potential for worldwide implications for DCD hearts, even in the setting of prolonged pulseless electrical activity and agonal warm ischemic time, geographic distance, and extremely high ischemic times. Although REUP-recovered DCD hearts from younger donors (aged 16-30 years) with shorter ischemic times (< 4 hours) have demonstrated favorable early outcomes, the last report highlights that REUP is safe, feasible, and effective for the recovery of older donor cardiac allografts, for use in high-risk recipients, and for allografts with prolonged ischemic time.

Notwithstanding the excellent early outcomes have been achieved using the REUP technique, additional studies are required to further validate its use. This includes evaluation of long-term patient outcomes, and direct comparisons with TA-NRP and DPP will be needed. Just as further basic and translational science studies are required before widespread adoption, additional prospective trials will be required to evaluate REUP.

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