Donation after circulatory death heart transplantation in the United States: An early report of donor characteristics

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In the United States, heart transplantation continues to be constrained by a limited supply of donor organs. Over the past decade, we have seen a dramatic rise in the number of candidates listed for heart transplantation, with the number of transplants performed increasing, although at a lesser rate.1 A multitude of efforts are being undertaken to increase the size of the donor pool, including the transplantation of expanded-criteria donor hearts, the use of normothermic ex vivo perfusion techniques, as well as a renewed interest in transplanting hearts following donation after circulatory death (DCD). A previous analysis by our group estimated that DCD heart transplantation has the potential to increase the size of the donor pool by as much as 30%.2 Following pioneering efforts in the United Kingdom and Australia,3,4 the first adult DCD heart transplant was performed in the United States in December 2019. Since then, DCD heart-transplantation protocols have been adopted by an increasing number of programs around the United States. We aimed to examine the clinical and geographic characteristics of this new population of DCD heart donors in the first 15 months of DCD heart transplantation in the United States.

The United Network for Organ Sharing (UNOS) deceased donor dataset was queried for all heart transplants performed during the study period. Donors with missing DCD status were excluded (n = 1). Descriptive analysis of donor clinical and geographic characteristics was performed, stratified by donation after brain death (DBD) versus DCD status. Data are presented as median (interquartile range) for continuous variables and count (percentage) for categorical variables. Unadjusted comparisons were performed using the Wilcoxon rank sum test for continuous variables and the Pearson χ² test for categorical variables. All statistical analyses were performed using R, version 3.5.1 (R Foundation for Statistical Computing, Vienna, Austria). This study was deemed exempt by Duke University’s institutional review board (IRB# Pro00073879 approved May 24, 2016). Patient written consent for the publication of the study data was waived by the institutional review board due to the lack of patient identifiable information in the publicly available registry.

In total, 4347 US heart transplants performed during the study period were examined, with allografts from 4204 DBD donors (96.7%) and 143 DCD donors (3.3%). Donor characteristics stratified by DCD/DBD status are presented in Table 1. Compared with DBD donors, DCD donors were more likely male (90% vs 70%, P < .001), White (77% vs 60%, P = .001), and were more likely to have a history of diabetes (25% vs 16%, P = .003). DCD and DBD donors

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were of similar age (median 29 vs 30 years, $P = .53$) and had a similar distribution of cause of death. Compared with DBD donors, DCD heart donors were significantly less likely to be concomitant lung donors (14% vs 39%, $P < .001$) or liver donors (62% vs 89%, $P < .001$) but were similarly likely to have donated at least 1 kidney for transplant (96% vs 94%, $P = .54$).

The raw number of DCD hearts recovered in each UNOS region is presented in Figure 1, A (although the hearts were not necessarily implanted within that region). The greatest number of DCD heart recoveries were performed in UNOS regions 3 and 10 (both $n = 26$). The proportion of DCD hearts recovered compared with the total number of hearts recovered in each region is presented in Figure 1, B, with UNOS region 9 using DCD donors for the greatest proportion of heart recoveries (10.4%). Overall, the 143 DCD heart allografts were transplanted at 14 different US transplant centers.

In this analysis of the early US experience, we found that transplanted DCD heart donors are similar to contemporaneous DBD heart donors in terms of the majority of captured demographic and clinical characteristics. Significant differences were, however, observed in sex, race, and history of diabetes. These findings must be interpreted with caution, given the small number of DCD transplants performed thus far. Considering that most efforts to expand the heart transplant donor pool in recent decades have focused on capturing more “marginal donors” (ie, hepatitis C, high-risk donors, longer ischemic time, expanded criteria via warm perfusion, etc), the fact that the DCD pool closely mirrors the DBD pool is indeed quite encouraging. In the first 15 months of US DCD heart transplantation, we have

| Characteristic | DCD donor ($n = 143$) | DBD donor ($n = 4204$) | $P$ value |
|---------------|----------------------|------------------------|-----------|
| Male sex      | 129 (90.2%)          | 2936 (69.8%)           | $.001     |
| Donor age, y, median (IQR) | 29 (23-35) | 30 (22-38) | .53     |
| Donor BMI, kg/m², median (IQR) | 26.6 (24.0-30.9) | 26.2 (22.6-30.6) | .11     |
| Donor race/ethnicity | .001 |
| White          | 110 (76.9%)          | 2506 (59.6%)           |           |
| Black          | 17 (11.9%)           | 761 (18.1%)            |           |
| Hispanic       | 14 (9.8%)            | 793 (18.9%)            |           |
| Other          | 2 (1.4%)             | 144 (3.4%)             |           |
| Donor history | .003 |
| Cigarette use | 14 (9.8%)            | 432 (10.3%)            | .96       |
| Cocaine use   | 28 (19.6%)           | 941 (22.4%)            | .49       |
| Diabetes       | 36 (25.2%)           | 652 (15.5%)            | .003      |
| Hypertension   | 17 (11.9%)           | 544 (12.9%)            | .81       |
| Cancer         | 3 (2.1%)             | 38 (0.9%)              | .31       |
| Donor creatinine, mg/dL, median (IQR) | 0.8 (0.6-1.2) | 1.0 (0.7-1.5) | $.001     |
| Donor bilirubin, mg/dL, median (IQR) | 0.7 (0.4-1.0) | 0.7 (0.4-1.1) | .9        |
| LVEF, %, median (IQR) | 64 (60-68) | 60 (57-65) | .004     |
| Donor cause of death | .26 |
| Anoxia         | 65 (45.5%)           | 1927 (45.8%)           |           |
| Cerebrovascular/stroke | 9 (6.3%) | 490 (11.7%) |           |
| Head trauma    | 64 (44.8%)           | 1665 (39.6%)           |           |
| CNS tumor      | –                    | 13 (0.3%)              |           |
| Other          | 5 (3.5%)             | 109 (2.6%)             |           |
| ABO blood type | <.001 |
| A              | 26 (18.2%)           | 1465 (34.8%)           |           |
| B              | 5 (3.5%)             | 463 (11.0%)            |           |
| AB             | –                    | 74 (1.8%)              |           |
| O              | 112 (78.3%)          | 2202 (52.4%)           |           |
| Lung donor     | 20 (14.0%)           | 1621 (38.6%)           | <.001     |
| Kidney donor   | 137 (95.8%)          | 3961 (94.2%)           | .54       |
| Liver donor    | 88 (61.5%)           | 3728 (88.7%)           | <.001     |

DCD, Donation after circulatory death; DBD, donation after brain death; IQR, interquartile range; BMI, body mass index; LVEF, left ventricular ejection fraction; CNS, central nervous system.
seen a gradual increase in the adoption of this source of donor allografts among US transplant programs. Importantly, UNOS data do not allow us to distinguish between the methods of recovery used (ex vivo perfusion vs normothermic regional perfusion) nor about rates of acceptance of organ offers.

Heart transplantation has been severely impacted by the coronavirus disease 2019 (COVID-19) pandemic, which has likely slowed the use of the DCD heart donor pool. These data demonstrate that DCD heart recoveries are occurring in all UNOS regions, but to a varying degree. DCD hearts were just more than 3% of the used donor pool in 2020, a much smaller proportion than other solid organs due to the additional technical challenges of preserving DCD hearts. As recovery, perfusion and assessment techniques are refined, this proportion will increase. This will, of course, be driven by post-DCD transplant recipient outcomes and the forthcoming results of

FIGURE 1. Total number of DCD heart recoveries performed in 2020 by UNOS region (A) and proportion of total heart transplants performed using DCD donors (B). DCD, Donation after circulatory death.
the recently concluded Organ Care System (OCS) DCD Heart trial. Ultimately, DCD heart transplantation has the potential to greatly increase the size of the US donor pool; however, significant barriers related to technique refinement and cost reduction must first be addressed to facilitate its broader national adoption.

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