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Donation After Circulatory Death: Current Utilization in the United States

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There is a severe mismatch in the supply of donor organs for solid organ transplants and the number of patients with end-stage disease that could potentially benefit from them. Infants awaiting heart transplantation are particularly vulnerable, with the highest waitlist mortality rates of all pre-transplant groups, as high as 30% for patients with congenital heart disease.¹ The advances in mechanical support that have benefited other age groups, such as dependable and durable ventricular assist devices (VADs), are still not readily applicable to all infants. Thus, strategies to expand the infant donor pool are urgently needed.

One potential avenue for increasing available organs is to use hearts donated from children who died from circulatory death (DCD), expanding on the current practice of using hearts donated after brain death (DBD). If pursued, the use of DCD hearts is estimated to increase organ availability by nearly a third.² Indeed, the feasibility of DCD heart transplantation was demonstrated almost a decade ago, with the successful transplantation of DCD hearts in 3 infants in the highest waitlist mortality group (congenital disease, age, and blood group O) at Children's Hospital Colorado, results of which were published in 2008.³ With the recent advent of warm perfusion technology, colleagues in the UK and Australia have published cases of successful adult heart transplantation using DCD hearts.⁴ However, in the years since 2008, no subsequent cases of DCD heart transplants performed in the US have been reported in the literature.

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We sought to assess the degree of subsequent DCD heart transplantation and outcomes associated with these transplants. The United Network for Organ Sharing (UNOS) database, a comprehensive registry of all transplants in the US, was queried to ascertain the number of DCD heart transplants performed from 1987 through December 2014 in patients of all ages.

A total of five such cases (including the original 2008 case series) were identified, all in infants less than 1 year of age (see Table 1). Of the five patients, four transplants were undertaken by the original Colorado group, and one transplant was performed in Massachusetts. Two of the infants passed away within the first 4 months: one with primary graft failure after being transplanted from extracorporeal membrane oxygenation (ECMO) after congenital surgery and the other from an adenoviral infection. One patient developed acute rejection and passed away at 6 years post-transplant (also an ECMO survivor), while the remaining two children are alive and without rejection at approximately 8 years post-transplant. Taken together, the overall survival rate for this group is 40%; and notably, two of the three deaths were in ECMO survivors, a subgroup with already uniformly grim outcomes. Of those surviving to 1-year post transplant, there has been 67% survival at 8 years of follow-up.

While it is difficult to draw conclusions about outcomes from such a small number of cases, the observation that 2 of 5 patients have survived to 8 years post-transplant suggests that DCD may offer a viable opportunity for this high-risk group. Thus, given the demonstrated feasibility and reasonable outcomes for infants receiving hearts from DCD patients and the ongoing critical shortage of donor organs, a critical question remains as to why has there been no significant adoption of this approach.

There are multiple potential reasons for the lack of wide-spread acceptance of pediatric DCD heart transplantation. Hesitancy with uncharted guidelines for donor selection may be driven by perceived ethical and social barriers for DCD at individual sites and within the transplant community at large. In addition, hoped-for advances in infant VADs, stem cell therapies, and improvements in congenital heart surgery may lead the field to be more optimistic about survival outcomes for infants with heart disease without requiring transplantation. In the face of these reasons, there may be less incentive to change the status quo. However, as mentioned previously, advancement in mechanical, surgical or medical support for these patients has not matured as rapidly as anticipated, and heart transplantation remains the only viable option for many infants with advanced heart failure.

Certainly, the ethical questions surrounding DCD heart transplantation alone may appear daunting; indeed, the initial case series was accompanied by four separate articles regarding the ethics and history of DCD. Veatch noted that the definition of death includes “irreversible loss of heart function,” but the very fact of hearts being restarted in recipient bodies suggests that DCD hearts may not necessarily be considered organs from truly dead donors.⁵ In contrast, Truog and Miller argued that legal definitions of neurologic and cardiac death for the purposes of organ transplantation have shifted focus away from the true ethical questions of informed consent for organ donation, thereby unnecessarily limiting available donor organs (e.g., patients who do not meet full brain death criteria) or the quality of available organs (e.g., hearts from DCD clearly have ischemic time).⁶ Ongoing discussion of

these ethical questions by the medical and public communities is warranted and represents an important consideration in advancing the field of DCD transplantation.

It is also clear, however, that such ethical debates are not held in isolation. The public, in social, professional, and lay media, has a great deal of interaction with the medical community. Initial work with other organs procured after cardiac death has been met with concern in the lay and medical press, specifically with regard to the role medical systems have in providing simultaneous care for patients who need organs and those potentially eligible to be DCD donors. The Colorado case series was critiqued in relation to the time elapsed after asystole, and the recent adult DCD heart transplants have incited further debate. The interaction of social media and personal narratives with medicine has certainly changed practices for individuals and groups of patients.⁷ It is quite possible that the long shadow cast by negative media portrayals can impact the willingness of medical decision makers to engage in areas of ethical controversy, even on behalf of a vulnerable infant population.

While these data do not shed light on the reasons why DCD has not been widely adopted among pediatric heart transplant programs in the United States, it is revealing that nearly all programs have not performed even a single case. However, given that infants with advanced heart failure are faced with a high waitlist mortality, and that DCD heart transplantation can have viable long-term outcomes, further discussion into DCD heart transplantation seems warranted. DCD heart transplantation is an area in which pediatric cardiac practitioners and patient advocacy groups, strengthened by formal review by UNOS, could lead the discussion, setting an ethical, moral and medical framework.

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Characteristics and outcomes of heart transplants using organs from donors after circulatory death

Table 1

Date of Transplant	Transplant Recipient Age	Primary Diagnosis for Recipient	Days on Waitlist	Donor Cause of Death	Status	Cause of Death	Graft Life
2004	<6 months	Congenital Heart Disease	0	Anoxia	Deceased	Rejection	6.7 years
2007	<6 months	Congenital Heart Disease	57	Anoxia	Alive	--	>8 years
2007	<6 months	Congenital Heart Disease	6	Anoxia	Deceased	Primary Graft Failure	0.3 years
2007	<6 months	Dilated Cardiomyopathy	54	Anoxia	Alive	--	>8 years
2010	<6 months	Congenital Heart Disease	27	Anoxia	Deceased	Infection	0.3 years