Trends in Pediatric Donor Heart Discard Rates and the Potential Use of Unallocated Hearts for Allogeneic Valve Transplantation

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Trends in Pediatric Donor Heart Discard Rates and the Potential Use of Unallocated Hearts for Allogeneic Valve Transplantation

UNOS database 1987-2022: 72,460 pediatric/young adult (≤25 years) heart donations after brain death

- Transplanted 41,065 (56.7%)
- Discarded 31,395 (43.3%)

Procurement of fresh valve allografts

~900 hearts/yr x 2 = ~1,800 valves/yr

Allogeneic valve transplantation

Valves from discarded hearts may be used to expand the donor pool for allogeneic valve transplantation
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Glossary of Abbreviations

OHT - orthotopic heart transplant
OPO - Organ Procurement Organizations
OPTN - Organ Procurement and Transplant Network
UNOS - United Network of Organ Sharing

Central Picture Legend
The ~900 pediatric hearts discarded annually may source allogeneic valve transplantation

Central Message
Unutilized pediatric and young adult deceased donor hearts are a feasible source of valves for allogeneic valve transplant to supplement conventional therapies.

Perspective Statement
A significant number of pediatric and young adult deceased donor hearts are discarded annually. Given the newfound interest in allogeneic valve transplant for young patients with unrepairable valve disease, we propose that valves from unutilized donor hearts may be used to expand the donor pool to address an important need in congenital cardiac surgery.
ABSTRACT

Objectives
Allogeneic valve transplantation is an emerging therapy which delivers a living valve from a donor heart. We reviewed the national discard rate of pediatric and young adult (≤25 years) donor grafts to estimate the number of hearts potentially available to source valve allotransplantation.

Methods
We queried the United Network for Organ Sharing database to identify pediatric and young adult heart donors from 1987-2022. Donor heart discard was defined as non-transplantation of the allograft.

Results
Of 72,460 pediatric/young adult heart donations, 41,065 (56.7%) were transplanted and 31,395 (43.3%) were unutilized. The average annual number of discarded hearts in era 1 (1987-2000), era 2 (2000-2010), and era 3 (2010-2022) was 791 (42.8%), 1,035 (46.3%), and 843 (41.2%), respectively. From 2017-2021, the average annual number of discards by age was: 39 (31.8%) neonates/infants, 78 (38.0%) toddlers, 41 (49.4%) young children, 240 (38.0%) adolescents, and 498 (40.1%) young adults. High-volume procurement regions had the greatest proportion of non-utilization, with the national average discard rate ranging from 39%-49%. The most frequently documented reasons for non-allocation were distribution to the heart valve industry (26.5%), presumably due to suboptimal graft function, poor organ function (22.7%), and logistical challenges (10.8%).
Conclusions

With ~900 pediatric/young adult donor hearts discarded annually, unutilized grafts represent a potential source of valves for allogeneic valve transplant to supplement current conduit and valve replacement surgery. The limited availability of neonatal and infant hearts, however, may limit this technique in the youngest patients, for whom cryopreserved homografts or xenografts will likely remain the primary valve substitute.

Keywords:
Allogeneic valve transplant; heart transplant; organ procurement; organ shortage; valve replacement
Pediatric patients with congenital heart disease and unrepairable valve malformations often require valve replacement. Unfortunately, outcomes following surgical valve replacement in neonates and infants remain dismal; the operative mortality for infants undergoing mitral valve replacement has been reported to be as high as 52% [1], with age < 2 years at the time of surgery being a risk factor for early death [2]. Similarly, the early mortality of aortic valve replacement with a homograft ranges from 5% to 13% in children, with a 10-year freedom from reoperation of 50% to 60% [3]. Currently, there is no ideal valve substitute, and each has its associated risks and benefits. Mechanical prostheses yield excellent hemodynamics and durability, though the major drawback is mandatory long-term anticoagulation. Furthermore, even the smallest sized mechanical valve is too large for neonates and infants. Cryopreserved xenograft and homograft valves do not require anticoagulation but are limited by accelerated structural degeneration and early valve failure. The fundamental problem with all current valve replacement options is the lack of somatic growth potential. As such, neonates, infants, and young children with valve disease will inevitably require serial reoperations within a short timeframe to exchange the prostheses for increasingly larger sizes until they reach adulthood. This presents a major problem in terms of cumulative morbidity and mortality, in addition to having an enormous psychosocial impact on patients and their families.

Transplantation of fresh valve allografts has been historically performed with good results, though this technique was eventually replaced by cryopreservation due to limited donor availability [4]. Given the need for a valve substitute with growth potential, allogeneic valve transplantation has recently been revisited with new enthusiasm and with the modification of adding immunosuppression and treating the overall process similarly to a standard orthotopic heart
transplant. Though still in development, this is a promising strategy to deliver a living valve with growth potential to pediatric patients with unrepairable valve disease. To date, two infants with truncus arteriosus have successfully undergone an allogeneic valve transplant at a single institution [5]. In this approach, a size-matched donor heart is procured in the standard fashion; the valve is excised, placed under cold ischemia, and implanted within the usual time constraints of a conventional orthotopic heart transplant. Since it is not cryopreserved or fixed, the valve is theoretically fully viable and capable of growing with the developing child, just as cardiac allografts demonstrate somatic growth after transplant. Nonetheless, important factors such as the safety, durability, and growth potential of fresh valve allografts remain largely unknown.

Previous studies report a 40% to 50% annual discard rate of pediatric cardiac allografts [6], therefore, a primary source of fresh valve allografts could theoretically be donor hearts deemed unsuitable for transplant. However, for allogenic valve transplantation to feasibly scale, we must first determine the potential number of valves that are available annually. We examined the annual discard rate of pediatric and young adult donor hearts in the United States to estimate the number of potentially usable valves for allogeneic valve transplants in current practice.

Methods

Study Design and Patient Population

We performed a retrospective, observational study using data from the United Network for Organ Sharing (UNOS) database. UNOS is the regulatory agency responsible for overseeing all solid organ transplantation in the United States. Data are maintained on the characteristics of donors, recipients, and follow-up of all transplanted patients. We queried the UNOS database for
all deceased pediatric and young adult solid organ donors (≤ 25 years at the time of organ donation) from October 1987 to October 2022. Donors consented for heart donation after brain death were included in the study; donation after cardiac death donors were excluded. We stratified donors by the following age groups to best understand the matched available donor pool for prospective patients: neonates/infants (0-12 months), toddlers (1-4 years), young children (5-10 years), adolescents (10-18 years), and young adults (19-25 years). We assessed differences in cardiac allograft utilization over time across multiple eras: era 1 (1987-2000), era 2 (2000-2010), and era 3 (2010-2022), with a particular focus on the previous 5 years. We also analyzed the geographic distribution of unused donor hearts within Organ Procurement and Transplant Network (OPTN) regions 1 to 11. The study was approved by the Institutional Review Board of Columbia University Irving Medical Center with a waiver of consent (IRB AAAR3476, approved 12/16/2022).

**Definitions**

- **Organ refusal** - indicates that a center has declined the organ for transplantation; however, the organ may still be accepted and utilized by another center.

- **Organ discard** - refers to a donor heart that is offered by an organ procurement organization (OPO) to a center, but is ultimately not transplanted. Organs may be discarded for any of the following reasons:

  A. Potential organ donors were not evaluated for organ donation or were evaluated without assessing the heart

  B. The donor heart was evaluated but the local center or OPO determined it unsuitable for donation and no offer was made

  C. The donor heart was accepted and procured, but not transplanted
D. The donor heart was offered, but not accepted by any center for procurement

### Statistical Analysis

All data were analyzed using STATA16 (StataCorp LLC, College Station, TX). Categorical variables are presented as proportions and continuous variable are expressed as mean ± standard deviation. Comparisons between two groups were performed using Fisher’s exact test for categorical variables and the Mann–Whitney U test for continuous variables.

### Results

#### Overall Cardiac Allograft Utilization/Discard Rates

Between 1987 and 2022, a total 72,460 pediatric and young adult donors underwent procurement of at least one solid organ. Among these donors, 41,065 (56.7%) hearts were allocated and successfully transplanted, while 30,972 (42.7%) were considered unsuitable for transplant before or at the time of procurement. A remaining 423 (0.6%) were discarded following recovery for various reasons, bringing the total number of unused pediatric and young adult hearts to 31,395 (43.3%). The overall proportions of discarded hearts since 1987, stratified by age group, are presented in Table 1. Since 1987, 32.7% of hearts from donors less than 1 year of age were not utilized. Notably, among toddler and young child donors, the proportion of discarded hearts exceeded those that were transplanted (toddler: 55.3% vs. 44.7%; young child: 61.7% vs. 38.3%). The proportions of discarded hearts from adolescents and young adults were 45.9% and 40.7%, respectively. Initial assessment of cardiac function revealed significantly decreased left ventricular ejection fraction (47.3% ± 17.2% vs. 61.9% ± 8.1%, p<0.001) and fractional shortening (27.2% ±
12.3% vs. 33.9% ± 9.7%, p<0.001) in hearts that were unused compared to those that were
accepted for transplantation. At the time of organ assessment, there was greater utilization of
inotropic support for donor hearts that were utilized compared to those that were discarded
(n=13,443 [32.4%] vs. n=9,087 [28.9%], p<0.001) (Table 1).

Cardiac Allograft Discard Rate by Era

In era 1 (1987-2000), era 2 (2000-2010), and era 3 (2010-2022), the average annual number
of unutilized hearts were 791 (42.8%), 1035 (46.3%), and 843 (41.2%), respectively (Figure 1A).
When we examined the pattern of unused hearts by donor age groups across eras (Table 2), the
adolescent and young adult groups had the highest absolute number of discards across all three
eras, though the proportion of discarded hearts was relatively low. Conversely, the toddler and
young child groups had the highest proportion of discarded donor hearts across all eras; however,
this number has been decreasing over time (toddlers: 66.5% > 63.6% > 43.3%; child: 68.9% >
62.6% > 49.7%). The proportion of discarded neonate/infant donor hearts has remained stable over
time (35.0%, 29.7%, 33.2%). The average annual number of discarded hearts in each donor age
group, stratified by era, is illustrated in Figure 1B.

To understand the contemporary cardiac allograft utilization practice, particularly after the
changes to the UNOS allocation system in 2016, we specifically focused on the number of
discarded donor hearts from 2017 to 2021 (Table 2). We excluded 2022, as data for the months of
October to December are incomplete in the UNOS registry. The overall proportion of unused donor
hearts has remained stable since 2017. However, there has been a steady increase in the non-
utilization rate of neonate/infant donor hearts over the recent years; after a low of 18.9% in 2018,
the discard rate increased to 29.1% in 2019 and by 2021, had reached 43.7%. Meanwhile, the
allograft non-utilization rate has remained fairly stable over recent years for all other age groups. From 2017 to 2021, the average annual number of discarded hearts in each donor age group was as follows: 39 (neonate/infant), 78 (toddler), 41 (young child), and 738 (adolescent and young adult) (Figure 1C).

Geographic Variation of Donor Heart Non-Utilization

Analysis of discard patterns by geographic location revealed large differences in the absolute number of discarded hearts across the 11 OPTN regions (Figure 2A). Since 1987, regions 3 and 5 have had the greatest number of discarded hearts, with a total of 5,256 (43.9%) and 4,536 (41.1%), respectively, while regions 1 (n=1,073 [46.8%]) and 9 (n=1,288 [45.4%]) have had the fewest in number. In general, the number of hearts discarded in each OPTN region has remained relatively stable across all three eras, with the exception of regions 2, 4, 6, 8 and 11, which have seen a steady increase. The only region with a decrease in donor heart non-utilization was region 7 (Figure 2B).

As expected, there was a direct correlation between OPTN heart procurement volume and the absolute number of discarded hearts; however, when evaluating the overall proportion of discarded allografts, there was little geographic variation with a national range of 39.3% to 49.0% (Figure 2C). Lastly, the average annual number of discarded hearts across OPTN regions between 2017 and 2021 is shown in Figure 2D. The discard trend in recent years seems to reflect that of the all-time discards, with regions 3 and 5 having the highest absolute number of discards and regions 1 and 9 having the lowest.

Reasons for Donor Heart Non-Utilization
Overall, the most commonly cited reason for discard of a donor heart was distribution to the heart valve industry (26.5%). Although the original reason for discard is unclear, these allografts were likely unallocated due to suboptimal function. Other common reasons for donor allograft discard across all donor age groups included poor organ function (22.7%), family beliefs/requests (4.5%), and donor history (3.5%). Less than 1% of hearts were discarded secondary to an anatomic abnormality, although specific details are unavailable. Logistical barriers - including time constraints, lack of a local procurement team, and inability to identify a suitable recipient - were cited as the rationale for discard of 10.8% of hearts across all donor age groups. Such transplant/procurement logistical issues were particularly apparent in the younger cohort, as 18.0% of neonate/infant, 18.0% of toddler, and 17.7% of young child donor hearts were unable to be allocated for this reason. Additional reasons for donor heart non-utilization are listed in Table 3.

Discussion

Though not yet an established therapy, allogeneic valve transplantation is a promising strategy to deliver a living valve from a deceased donor heart that grows with the child; however, the critical donor organ shortage remains a limiting factor [7]. Our analysis of the UNOS registry revealed a significant proportion of unused hearts across multiple age groups and geographical regions that has persisted over time. Between 2017 and 2021, the average number of discarded hearts per year was 920 (40.0%), 858 (38.7%), 882 (38.5%), 894 (39.0%), and 937 (38.9%), respectively. When stratified by donor age group, the average annual number of discarded donor hearts in the modern era was as follows: 39 (31.8%) neonate/infant, 78 (38.0%) toddler, 41 (49.4%) young child, 240 (38.0%) adolescent (10-18 years), and 498 (40.1%) young adult. We estimate
that this represents an adequate number of valve allografts to initially supplement conventional valve and conduit replacement surgeries in children, including repair of truncus arteriosus, tetralogy of Fallot with pulmonary atresia, or any other lesion requiring outflow tract reconstruction with a conduit (Figure 3). However, in neonates and infants with valve disease, for whom allogeneic valve transplant would provide the largest benefit, the small annual number of donor hearts from this age group limits the scalability of this therapy. As such, cryopreserved homografts or xenografts will likely remain the primary source of valve or conduit replacement in these cases. In adolescents and young adults – for whom there is the greatest availability of donor hearts – the growth potential of the allograft is less important and many other valve replacement options exist. Nonetheless, allogeneic valve transplant is a valid option, though the risks of immunosuppression should be weighed against factors such as anticoagulation, structural valve degeneration, and reoperation.

Our analysis is likely an underestimate of the number of potentially available valves, as we believe explanted hearts of recipients undergoing an orthotopic heart transplant may also be a source of fresh valve allografts. This practice was previously carried out in the 1980s to early 1990s, whereby valves were harvested from the native heart of transplant recipients or brain dead donors and stored in nutrient medium at 4 degrees Celsius on the order of hours to months before being transplanted [4,8,9]. The largest experience with these fresh homograft valves belongs to Yacoub and colleagues who reported the use of 224 aortic valves harvested from the explanted native hearts of transplant recipients from 1980 to 1993 [4]. The homografts were implanted using either the freehand (subcoronary) technique or as a freestanding root replacement. The original cardiac disease included ischemic heart disease, cardiomyopathy, and congenital heart disease. Though the authors do not provide echocardiographic data on the function of the explanted valves,
we presume that they were free from significant valvulopathy despite severe myocardial
dysfunction or other intracardiac abnormalities. Long-term durability was excellent, with actuarial
rates for freedom from degenerative valve failure of 94%±2% and 89%±3% at 5 and 10 years,
respectively. Furthermore, freedom from valve-related complications (i.e., reintervention,
degeneration, endocarditis, and thromboembolism) was 92%±2% and 80%±5% at 5 and 10 years,
respectively. Similarly acceptable outcomes were reported in smaller series [8,9]. Despite good
durability, such “homovital” valves fell out of favor with the introduction of modern
cryopreservation techniques which allow for prolonged storage and greater availability [10].
Nonetheless, the past success of this abandoned procedure validates the use of explanted native
hearts without valve pathology to source allogeneic valve transplants.

The primary reason for non-utilization was poor organ quality, which presumably refers to
ventricular dysfunction. In such cases, semilunar valve function was likely preserved, hence the
significant number distributed to the heart valve industry for cryopreservation. In general, specific
reasons for donor organ refusal and/or discard are poorly captured by network registry data. With
newfound interest in allogeneic valve transplantation and to inform future organ allocation
practices, we propose that all donor hearts deemed non-transplantable should be evaluated for
procurement of fresh valves for allotransplantation using standardized assessment criteria, as for
commercially prepared valves. A major drawback, however, would be the tradeoff between fresh
valves and cryopreserved homografts, which currently have limited availability in certain sizes.

Other common reasons for non-utilization of donor hearts were transplant or procurement
logistical barriers, such as timing constraints, unavailability of a procurement team, or lack of a
suitable recipient. Such issues are particularly pertinent to heart transplantation due to the stringent
limitations on organ ischemic times. In contrast, procurement of isolated heart valves would be
considerably more flexible. Kwon and colleagues’ investigation of aortic valve allograft viability with prolonged cold storage at 4°C revealed preserved structural integrity, no increased level of apoptosis, and unchanged cellular metabolic activity for up to 48 hours, unlike hearts, which demonstrate cell death and myocardial necrosis after 6 hours of cold ischemia [11]. The longer permissible window of cold ischemia has multiple clinical implications. First, it may allow for an extended travel radius for donor harvests and organ sharing between OPTN regions to alleviate disparities in usage. Second, this may have a substantial economic and environmental impact, as entire procurement teams would not need to travel to and from the donor hospital in a private aircraft or vehicle. Instead, existing local procurement teams could harvest the valve and deliver it to the recipient hospital by commercial courier services, as is routinely done for kidney transplants.

There are several important limitations to this study. The retrospective nature of the study, compounded by analysis of a large database, limits the completeness and granularity of clinical data. As such, we were unable to determine the presence or severity of valve pathology or other clinical factors that may contraindicate valve harvest for allogeneic valve transplant in many donors. Additionally, we do not yet know the number of pediatric valve replacement surgeries performed annually to determine the exact “supply and demand” relationship.

Our study demonstrates that the annual number of discarded donor hearts represents a feasible source of valves for allogeneic valve transplant to become a valve replacement option nationwide. To further expand the donor pool, we propose the following: i) donor hearts turned down for transplant should be systematically evaluated for isolated valve donation and ii) explanted native hearts of heart transplant recipients may be another potential source of valve allografts. This redirects well-functioning valves to meet an important clinical need in congenital cardiac surgery.
References


**Tables and Figures**

**Table 1.** The overall proportion of transplanted and unused donor hearts from 1987-2022, stratified by donor age group (top panel). Estimates of left ventricular function and incidence of inotropic support at the time of organ allocation are also displayed for both transplanted and discarded hearts (bottom panel).

\[ LVEF = \text{left ventricular ejection fraction} \]

**Table 2.** The average annual number of discarded hearts per era, stratified by donor age group (top panel). The contemporary average annual number of discarded hearts from 2017 to 2021 is also displayed (lower panel).

**Table 3.** Documented reasons for non-utilization of donor hearts at the time of organ allocation or procurement.

**Figure 1.** The frequency and distribution of discarded donor hearts by era. A) The total number of discarded donor hearts across the three eras. The green line represents the average annual number of discarded hearts within each era; B) The proportion of discarded donor hearts by donor age group, stratified by era; C) The average annual number of unused hearts from 2017-2021.

**Figure 2.** Geographic variation in pediatric donor heart non-utilization. A) Absolute number of discarded donor hearts across the 11 OPTN regions; B) Absolute number of discarded donor heart
across the OPTN regions, stratified by era; C) Proportion of discarded donor hearts across the OPTN regions from 1987 to 2022; D) Average annual number of discarded donor hearts across the OPTN regions from 2017 to 2021.

Figure 3. Graphical abstract: Trends in pediatric donor discard rates and the potential use of unallocated hearts for allogeneic valve transplantation.
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<td>Fractional shortening, %</td>
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<td>27.2 ± 12.3*</td>
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<td>Inotropic support, n (%)</td>
<td>13,443 (32.4%)</td>
<td>9,087 (28.9%)*</td>
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*p<0.001 when compared to transplanted cohort
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<td>Total</td>
<td>31,395 (100%)</td>
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<td>4,059 (100%)</td>
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<td>Poor organ function</td>
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<td>169 (13.7%)</td>
<td>801 (19.7%)</td>
<td>388 (16.9%)</td>
<td>5,761 (24.2%)</td>
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<td>466 (11.5%)</td>
<td>258 (11.2%)</td>
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<td>154 (3.8%)</td>
<td>89 (16.9%)</td>
<td>1,095 (4.6%)</td>
<td></td>
</tr>
<tr>
<td>Organ refused by all programs</td>
<td>1,206 (3.8%)</td>
<td>59 (4.8%)</td>
<td>216 (5.3%)</td>
<td>130 (11.2%)</td>
<td>842 (3.5%)</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>1,114 (3.6%)</td>
<td>29 (2.3%)</td>
<td>85 (2.1%)</td>
<td>47 (2.1%)</td>
<td>953 (4.0%)</td>
<td></td>
</tr>
<tr>
<td>Donor history</td>
<td>1,094 (3.5%)</td>
<td>40 (3.2%)</td>
<td>100 (2.5%)</td>
<td>61 (3.7%)</td>
<td>893 (3.8%)</td>
<td></td>
</tr>
<tr>
<td>Prior cardiac disease</td>
<td>947 (3.0%)</td>
<td>25 (2.0%)</td>
<td>90 (2.2%)</td>
<td>40 (1.7%)</td>
<td>792 (3.3%)</td>
<td></td>
</tr>
<tr>
<td>Unstable hemodynamics</td>
<td>900 (2.9%)</td>
<td>16 (1.3%)</td>
<td>77 (1.9%)</td>
<td>39 (1.7%)</td>
<td>768 (3.2%)</td>
<td></td>
</tr>
<tr>
<td>Discarded after evaluation</td>
<td>744 (2.4%)</td>
<td>24 (1.9%)</td>
<td>44 (1.1%)</td>
<td>19 (0.8%)</td>
<td>657 (2.8%)</td>
<td></td>
</tr>
<tr>
<td>Non-beating donor</td>
<td>720 (2.3%)</td>
<td>30 (2.4%)</td>
<td>48 (1.2%)</td>
<td>13 (0.6%)</td>
<td>482 (2.1%)</td>
<td></td>
</tr>
<tr>
<td>Time constraints</td>
<td>463 (1.5%)</td>
<td>24 (1.9%)</td>
<td>43 (1.1%)</td>
<td>15 (0.7%)</td>
<td>381 (1.6%)</td>
<td></td>
</tr>
<tr>
<td>Medical Examiner restriction</td>
<td>454 (1.5%)</td>
<td>51 (4.1%)</td>
<td>87 (2.1%)</td>
<td>18 (0.8%)</td>
<td>298 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>Infection/serology positive</td>
<td>410 (1.3%)</td>
<td>8 (0.7%)</td>
<td>14 (0.3%)</td>
<td>14 (0.6%)</td>
<td>374 (1.6%)</td>
<td></td>
</tr>
<tr>
<td>Anatomic abnormality</td>
<td>182 (0.6%)</td>
<td>13 (1.1%)</td>
<td>14 (0.3%)</td>
<td>11 (0.5%)</td>
<td>144 (0.6%)</td>
<td></td>
</tr>
<tr>
<td>Trauma to heart</td>
<td>164 (0.5%)</td>
<td>1 (0.08%)</td>
<td>3 (0.1%)</td>
<td>12 (0.5%)</td>
<td>148 (0.6%)</td>
<td></td>
</tr>
<tr>
<td>Vascular damage</td>
<td>64 (0.2%)</td>
<td>3 (0.2%)</td>
<td>7 (0.17%)</td>
<td>2 (0.1%)</td>
<td>52 (0.2%)</td>
<td></td>
</tr>
<tr>
<td>Donor age</td>
<td>50 (0.2%)</td>
<td>26 (2.1%)</td>
<td>15 (0.4%)</td>
<td>1 (0.04%)</td>
<td>8 (0.03%)</td>
<td></td>
</tr>
<tr>
<td>Prior cardiac surgery</td>
<td>29 (0.1%)</td>
<td>5 (0.4%)</td>
<td>6 (0.2%)</td>
<td>3 (0.1%)</td>
<td>15 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>PO2 &lt; 200 on challenge</td>
<td>4 (0.01%)</td>
<td>1 (0.08%)</td>
<td>0 (0.00%)</td>
<td>0 (0.00%)</td>
<td>3 (0.01%)</td>
<td></td>
</tr>
<tr>
<td>Biopsy findings</td>
<td>4 (0.01%)</td>
<td>1 (0.08%)</td>
<td>1 (0.02%)</td>
<td>0 (0.00%)</td>
<td>2 (0.01%)</td>
<td></td>
</tr>
<tr>
<td>Donor ABO</td>
<td>2 (0.01%)</td>
<td>1 (0.08%)</td>
<td>1 (0.02%)</td>
<td>0 (0.00%)</td>
<td>0 (0.00%)</td>
<td></td>
</tr>
<tr>
<td>Surgical damage</td>
<td>23 (0.07%)</td>
<td>0 (0.00%)</td>
<td>0 (0.00%)</td>
<td>1 (0.04%)</td>
<td>22 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>No local recovery team</td>
<td>19 (0.06%)</td>
<td>1 (0.08%)</td>
<td>3 (0.1%)</td>
<td>3 (0.1%)</td>
<td>12 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4,428 (14.1%)</td>
<td>191 (15.4%)</td>
<td>503 (12.4%)</td>
<td>273 (11.8%)</td>
<td>3,461 (14.5%)</td>
<td></td>
</tr>
</tbody>
</table>
Trends in Pediatric Donor Heart Discard Rates and the Potential Use of Unallocated Hearts for Allogeneic Valve Transplantation

UNOS database 1987-2022: 72,460 pediatric/young adult (≤25 years) heart donations after brain death

Procurement of fresh valve allografts

-900 hearts/yr x 2 = ~1,800 valves/yr

Valves from discarded hearts may be used to expand the donor pool for allogeneic valve transplantation
Average Annual Unused Hearts 2017-2021

Neonate / Infant 39
Toddler 78
Child 41
Teen+ 738

~900 hearts/year x 2 = ~1,800 valves/year