Long-term survival after heart transplantation for cardiac sarcoidosis

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Abstract

Background: Cardiac sarcoidosis is an increasingly common indication for a heart transplant, but there is a paucity of knowledge with regard to long-term outcomes following transplant.

Methods: We utilized the Organ Procurement and Transplantation Network database to retrospectively analyze adult patients undergoing first-time, single-organ heart transplant between January 1999 and March 2020.

Results: Of the 41,447 patients that underwent heart transplant during the study period, 289 (0.7%) were transplanted for a primary diagnosis of restrictive cardiomyopathy due to cardiac sarcoidosis (RCM-Sarcoidosis). RCM-Sarcoidosis was associated with 33% reduced risk of mortality over 10 years compared to non-RCM indications in a multivariable Cox proportional hazards model ($p = .03$). Ten-year survival functions were improved among RCM-Sarcoidosis compared to this reference group (73.4% [64.2%–80.6%] vs. 59.5% [58.8%–60.1%], $p = .002$). Among patients transplanted after 1999 who had at least 10 years of follow-up ($n = 19,489$), median survival of RCM-Sarcoidosis patients was 11.9 [8.3–14.6] years while that of non-RCM patients was 9.9 [4.0–13.1] years. RCM-Sarcoidosis was not associated with an increased risk of secondary outcomes such as graft failure, rejection, or infection. The incidence of retransplant was comparable between RCM-Sarcoidosis and non-RCM patients (1.38% vs. 1.50%, $p = .93$).

Conclusions: These data suggest that long-term outcomes following transplant for cardiac sarcoidosis are favorable compared to heart transplant for other indications.

KEYWORDS

transplant, cardiovascular research

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1 | INTRODUCTION

Cardiac manifestations of sarcoidosis are the second-most common cause of death among patients with sarcoidosis in the Western hemisphere.1–5 Between 25% and 50% of all sarcoidosis-related deaths are attributable to heart failure, and cardiac complications are estimated to occur in as many as 25%–27% of systemic sarcoidosis patients in postmortem analyses.2–6,7 These complications range from silent myocardial granulomas to sudden cardiac death and can be grouped into conduction abnormalities, arrhythmias, and heart failure.1

The incidence of cardiac sarcoidosis and sarcoidosis-related mortality are steadily increasing in the United States, with the greatest rise in the highest incidence of systemic disease.8

The Organ Procurement and Transplantation Network (OPTN) database | 2

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The Organ Procurement and Transplantation Network (OPTN) database

The Organ Procurement and Transplantation Network (OPTN) database was queried for adult (≥18 years) patients receiving a first-time heart transplant between January 1, 1999, and March 20, 2020. This period was selected to provide 20 years of follow-up data from the earliest transplants and to include only those patients receiving modern immunosuppression regimens. Patients were excluded from analysis if they had multiple organs transplanted, any previous transplant, heterotopic heart transplants, or no clinical follow-up. Variables were excluded from analysis if missing data was >20%, with exception of up to 25% for clinically relevant variables. Institutional review board approval was obtained for analysis of the UNOS database in a prognostic study of survival following heart transplant, with no requirement to obtain informed consent.

Patients were sorted into three groups based on the primary indication for transplant: restrictive cardiomyopathy due to cardiac sarcoidosis (RCM-Sarcoidosis), restrictive cardiomyopathy due to other causes (RCM-Other), and non-RCM. Linear regression was used to determine if the number of transplants for cardiac sarcoidosis increased over the study period. Logistic regression was used to determine if the proportion of transplant patients with cardiac sarcoidosis increased over the same period. Pearson’s χ2 and Fisher’s exact test were used to measure differences in categorical demographic and baseline clinical characteristics across groups and between RCM-Sarcoidosis and non-RCM groups. Differences in continuous variables with normal distribution were assessed using analysis of variance while those with nonnormal distribution were assessed with the Kruskal–Wallis H test.

2.2 | Survival analysis

Log-rank tests and univariate Cox Proportional Hazards regression models were used to assess the associations of clinically relevant categorical and continuous variables, respectively, with posttransplant 10-year survival. All variables with p ≤ .2, and one with p > .2 (recipient gender) were included in a multivariable Cox model. Patients were censored at the time of retransplant, if applicable, or at the time of the last contact if lost to follow-up. The proportionality of hazards assumption was satisfied in our multivariable Cox model.

Kaplan–Meier survival functions were calculated for RCM-Sarcoidosis, RCM-Other, and non-RCM groups and graphed both with and without adjustment for transplant year, recipient age, and organ ischemic time. The log-rank test for equality was used to measure the differences across survival functions and between RCM-Sarcoidosis and non-RCM indications at 1, 5, and 10 years. Logistic regression was used to assess the incidence of secondary outcomes in each group, including coronary artery disease, stroke, pacemaker requirement, acute rejection, treatment for rejection, hospitalization for rejection, hospitalization for infection, graft failure, and retransplantation. The incidence of the most common causes of death in each group were compared using Fisher’s exact test.

Statistical analyses were performed using Stata 15/SE19 with a 0.05 level of statistical significance.

3 | RESULTS

3.1 | Demographics

A total of 41,447 adult patients received a first-time, heart-only transplant between January 1, 1999, and March 20, 2020, and met...
the inclusion criteria. These included 289 (0.7%) with a primary indication of RCM-Sarcoidosis, 887 (2.1%) with a primary indication of RCM-Other, and 40,271 (97.2%) undergoing transplant for non-RCM indications (Figure 1). The number of transplants performed for RCM-Sarcoidosis increased over the study period, with two performed in 1999 and 47 performed in 2019 (p < .001) (Figure 2A). The proportion of transplants for RCM-Sarcoidosis compared to those for all other indications also increased over the study period, from 0.11% in 1999 to 1.74% in 2019 (p < .001) (Figure 2B).

Compared to patients transplanted for non-RCM indications, RCM-Sarcoidosis patients were more likely to be female (37% vs. 25%, p < .001), black (27% vs. 19%, p = .002), younger (54 [47–60] vs. 56 [46–62], p = .035), and chronically using steroids (43% vs. 8%, p < .001) (Table 1). RCM-Sarcoidosis and non-RCM patients were assigned similar initial transplant statuses (1A, 1B, 2) and experienced changes in transplant status with a similar frequency (53% vs. 50%, p = .25). At the time of transplant, relatively fewer RCM-Sarcoidosis patients were classified as adult transplant status 2 (7% vs. 12%, p = .01) and more were classified as either 1A or 1B (93% vs. 88%, p = .005).

Compared to non-RCM patients, RCM-Sarcoidosis patients spent fewer days on the waitlist (70 [47–60] vs. 90 [25–261], p = .031) and were less likely to have diabetes (17% vs. 26%, p < .001), prior cardiac surgery (21% vs. 39%, p < .001), or a history of tobacco use (28% vs. 48%, p < .001) (Table 2). Overall, RCM-Sarcoidosis patients were less often on life support (including ECMO, ventricular assist devices, intra-aortic balloon pumps, IV inotropes, ventilator, or inhaled nitric oxide) at transplant (70% vs. 75%, p = .039), but they were more likely to be on ECMO at the time of transplant (2.4% vs. 0.8%, p < .001). All hemodynamic measurements were lower among RCM-Sarcoidosis patients compared to non-RCM: pulmonary artery systolic pressure (34.2 ± 12.4 vs. 41.0 ± 14.1 mmHg, p < .001), diastolic pressure (16.8 ± 7.2 vs. 19.6 ± 8.6 mmHg, p < .001), mean pressure (23.6 ± 8.9 vs. 27.7 ± 10.1, p < .001, and pulmonary capillary wedge pressure (15.6 ± 7.8 vs. 18.3 ± 8.8, p < .001).

### 3.2 Survival analysis

Twenty-eight variables were associated with 10-year survival in the univariate model, and all were subsequently included in the multivariable model (Table 3). When adjusting for all other variables, RCM-Sarcoidosis was associated with reduced risk of mortality (HR = 0.67 [0.46–0.97], p = .029) and RCM-Other was associated with increased risk (HR = 1.32 [1.14–1.53], p < .001) compared to non-RCM indications. In the same multivariable model, eleven baseline recipient characteristics were associated with the risk of mortality at 10 years. These included age (HR = 1.003, p = .001), transplant year (HR = 0.97, p < .001), black race (HR = 1.29, p < .001), BMI (HR = 1.01, p < .001), days on waiting list (HR = 1.0001, p = .039), prior cardiac surgery (HR = 1.20, p < .001), diabetes (HR = 1.26, p < .001), diaylsis at any time before transplant (HR = 1.67, p < .001), serum creatinine at transplant (HR = 1.09, p < .001), hospitalization at the time of transplant (HR = 1.13, p < .001), and ECMO use before transplant (HR = 2.17, p < .001). Several donor characteristics were also associated with mortality risk, including donor age (HR = 1.01, p < .001), gender matching of the recipient and donor (HR = 0.92, p = .001), organ ischemic time (HR = 1.07, p < .001), donor history of cancer (HR = 1.17, p = .043), and donor history of tobacco use (HR = 1.10, p = .001).

Kaplan–Meier survival estimates of RCM-Sarcoidosis patients were comparable to those of non-RCM patients at 1 year (91.6% [85.6%–94.4%] vs. 89.7% [89.4%–90.0%], p = .306) and superior at 5 years (87.3% [81.6%–91.7%] vs. 80.3% [78.3%–82.1%], p = .001).
**FIGURE 2** Number of transplants for cardiac sarcoidosis and percentage of all transplants for this indication. Between 1999 and 2019, (A) the absolute number of heart transplants for cardiac sarcoidosis increased ($p < .001$) and (B) the percent of all annual transplants performed for cardiac sarcoidosis increased ($p < .001$).

**TABLE 1** Transplant recipient demographics and transplant status data, by primary indication

|                      | Non-RCM ($N = 40,271$) | RCM-Sarcoidosis ($N = 289$) | RCM-Other ($N = 887$) | $p$ Across groups | $p$ RCM-Sarcoidosis versus non-RCM |
|----------------------|-------------------------|-----------------------------|-----------------------|-------------------|----------------------------------|
| **Age**              | 56 (46–62)              | 54 (47–60)                  | 57 (46–65)           | <.001             | .04                              |
| **Male gender**      | 30,225 (75%)            | 182 (63%)                   | 557 (63%)            | <.001             | <.001                            |
| **Race/Ethnicity**   |                         |                             |                      |                   |                                  |
| White                | 27,955 (69%)            | 192 (66%)                   | 617 (70%)            |                   |                                  |
| Black                | 7600 (19%)              | 79 (27%)                    | 181 (20%)            | .01               | <.001                            |
| Hispanic             | 3104 (8%)               | 10 (3%)                     | 58 (7%)              | .03               | .02                              |
| Asian                | 1170 (3%)               | 5 (2%)                      | 26 (3%)              | .57               | .29                              |
| Amer. Indian/Alaskan Native | 124 (~0%)             | 1 (~0%)                     | 0 (~0%)              | .25               | .87                              |
| Pacific Islander     | 113 (~0%)               | 0 (0%)                      | 4 (~0%)              | .44               | .38                              |
| Multiracial          | 205 (1%)                | 2 (1%)                      | 1 (~0%)              | .22               | .68                              |
| **Initial transplant status** |                 |                             |                      |                   |                                  |
| 1A                   | 9700 (25%)              | 70 (25%)                    | 180 (21%)            | .03               | .96                              |
| 1B                   | 15,478 (39%)            | 99 (35%)                    | 306 (35%)            | .02               | .15                              |
| 2                    | 14,127 (36%)            | 116 (41%)                   | 391 (45%)            | <.001             | .07                              |
| **Ending transplant status** |                |                             |                      |                   |                                  |
| 1A                   | 21,574 (54%)            | 162 (56%)                   | 479 (54%)            | .68               | .40                              |
| 1B                   | 13,734 (34%)            | 107 (37%)                   | 293 (33%)            | .46               | .30                              |
| 2                    | 4,900 (12%)             | 20 (7%)                     | 115 (13%)            | .02               | .01                              |
| Change in status     | 19,952 (50%)            | 153 (53%)                   | 469 (53%)            | .08               | .25                              |

Note: Categorical variables are presented as $n$ (% of column group) and age is presented as median (interquartile range). Bold font signifies statistical significance of $p$-values.
years (87.7% [82.6%–91.4%] versus 77.2% [76.8%–77.7%], p = .004) and 10 years (73.4% [64.2%–80.6%] vs. 59.5% [58.8%–60.1%], p = .002) (Table 4). In contrast, the survival functions of RCM-Other patients were worse than those of non-RCM patients at each time point (p = .001). Adjustment for transplant year, recipient age, and organ ischemic time in Kaplan-Meier graphs enhanced the survival advantage of RCM-Sarcoidosis patients compared to non-RCM patients (p = .002) (Figure 3).

3.3 | Secondary outcomes

The incidence of retransplantation was comparable across RCM-Sarcoidosis, non-RCM, and RCM-Other groups (1.4% vs. 1.5% vs. 1.4%, p = .93). Loss to follow-up was less common among RCM-Sarcoidosis patients compared to non-RCM and RCM-Other patients (0.4% vs. 3.7% and 2.5%, p = .003).

In multivariable logistic regression, RCM-Sarcoidosis was not associated with any morbidity outcomes, including coronary artery disease, stroke, pacemaker requirement, acute rejection, treatment or hospitalization for rejection, hospitalization for infection, graft failure, or retransplantation (Table 5).

3.4 | Causes of death

When comparing primary causes of death across groups, an increased number of RCM-Sarcoidosis patients died from fungal Aspergillus infection (4.3% vs. 0.9%, p = .011) or "other pulmonary causes" (4.3% vs. 1.1%, p = .028) compared to non-RCM and RCM-Other patients. The "other pulmonary causes variable" in UNOS includes various pathologies such as pneumonia, chronic obstructive pulmonary disease, and restrictive lung disease that are not as common as respiratory pathologies designated with their own variable, none of which were more common among RCM-Sarcoidosis patients (including pulmonary embolism, respiratory failure, and acute respiratory distress disease). Fewer RCM-Sarcoidosis patients died as a result of multiple organ failure (4.3% compared to 8.1% for non-RCM indications, p = .02).
### TABLE 3  Multivariable Cox regression for 10-year survival

|                              | Hazard Ratio | 95% confidence interval | p     |
|------------------------------|--------------|-------------------------|-------|
| **Recipient demographics**   |              |                         |       |
| Female gender                | 1.04         | 0.99-1.10               | .107  |
| Age                          | 1.003        | 1.00-1.01               | .001  |
| Transplant year              | 0.97         | 0.97-0.98               | <.001 |
| **Race/Ethnicity (White as reference)** |          |                         |       |
| Black                        | 1.29         | 1.22-1.36               | <.001 |
| Hispanic                     | 1.04         | 0.96-1.13               | .332  |
| Asian                        | 0.88         | 0.75-1.02               | .080  |
| Amer. Indian/Alaskan Native  | 0.89         | 0.60-1.31               | .550  |
| Pacific Islander             | 1.20         | 0.82-1.76               | .338  |
| Multiracial                  | 1.24         | 0.93-1.65               | .137  |
| **Other recipient characteristics** |          |                         |       |
| Body mass index              | 1.01         | 1.01-1.02               | <.001 |
| Days on waitlist             | 1.0001       | 1.00-1.01               | .039  |
| Prior cardiac surgery        | 1.20         | 1.15-1.26               | <.001 |
| Prior malignancy             | 1.07         | 0.98-1.16               | .123  |
| Prior stroke                 | 1.05         | 0.95-1.16               | .319  |
| Diabetes                     | 1.26         | 1.20-1.32               | <.001 |
| Dialysis before transplant   | 1.67         | 1.50-1.87               | <.001 |
| Chronic steroid use          | 1.04         | 0.96-1.13               | .313  |
| Serum creatinine at Tx       | 1.09         | 1.07-1.11               | <.001 |
| Pulmonary artery (systolic)  | 0.999        | 0.99-1.00               | .970  |
| Pulmonary artery (diastolic) | 1.002        | 1.00-1.01               | .368  |
| Hospitalization at Tx        | 1.13         | 1.08-1.19               | <.001 |
| Life support on Tx<sup>a</sup> | 1.02         | 0.97-1.08               | .469  |
| ECMO use at Tx               | 2.17         | 1.68-2.79               | <.001 |
| **Indication for transplant (non-RCM reference)** |          |                         |       |
| RCM-Sarcoidosis              | 0.67         | 0.47-0.96               | .029  |
| RCM-Other                    | 1.32         | 1.14-1.53               | <.001 |
| **Donor characteristics**    |              |                         |       |
| Donor age                    | 1.01         | 1.01-1.01               | <.001 |
| Gender match                 | 0.92         | 0.87-0.96               | .001  |
| HLA mismatch level           | 1.02         | 1.00-1.04               | .084  |
| Organ ischemic time          | 1.07         | 1.05-1.09               | <.001 |
| Donor history of hypertension| 0.99         | 0.94-1.07               | .966  |
| Donor history of cancer      | 1.17         | 1.01-1.36               | .043  |
| Donor history of diabetes    | 1.04         | 0.91-1.18               | .561  |
| Donor history of cigarette use | 1.10         | 1.04-1.16               | .001  |
| Donor history of MI          | 1.17         | 0.93-1.47               | .178  |

Note: All variables from univariate Cox regression with p < .2 were included. Bold font signifies statistical significance of p-values.

Abbreviations: MI, myocardial infarction; Tx, transplant.

<sup>a</sup>Forms of life support include ECMO, ventricular assist devices, intra-aortic balloon pumps, IV inotropes, ventilator, or inhaled nitric oxide.
In our analysis of 289 cardiac sarcoidosis patients across 20 years of UNOS data, we found that their 10-year survival following transplant was improved compared to that of all other patients. The incidence of cardiac sarcoidosis and the number of transplants for this indication are both on the rise—in our data set, more than half of all cardiac sarcoidosis transplants took place in the most recent 5 years of complete data. These developments, coupled with an unchanging supply of donor hearts, necessitate a study of long-term survival outcomes in this population, both to inform organ allocation and clinical decision-making. We found that survival among RCM-Sarcoidosis patients was comparable to that of non-RCM patients at 1 year and superior at 5 years, in agreement with prior studies that have shown at least comparable survival at up to 6 years.\(^1\)\(^2\)\(^,\)\(^1\)\(^7\)\(^,\)\(^1\)\(^8\) We have further shown that cardiac sarcoid patients experience significantly improved survival over a longer, 10-year period.

Furthermore, we found that transplant for cardiac sarcoidosis is more common among black and female patients, who also experience the highest incidence of the systemic disease.\(^1\)\(^0\)\(^,\)\(^1\)\(^1\) There is a growing awareness of racial disparities in heart transplant outcomes, and our study further demonstrates an increased risk of 10-year mortality among black cardiac sarcoidosis patients.\(^2\)\(^0\) In our study, most clinical features of RCM-Sarcoidosis patients are favorable compared to those of non-RCM patients; for example, they are younger, less likely to have diabetes, and less likely to have undergone prior cardiac surgery. Despite fewer comorbidities, however, their decompensation during heart failure may be more rapid: RCM-Sarcoidosis spent fewer days on the waitlist, were more likely to require ECMO, and were more likely to have an adult transplant status of 1A or 1B at time of surgery. These events may be more common and more serious following the OPTN’s updated heart allocation policy, which assigns patients with hypertrophic and restrictive cardiomyopathy to...

### TABLE 4  Kaplan–Meier survival estimates by group and log-rank test results

|          | 1 year SF (%) | 95% CI (%) | \(p\) | 5 years SF (%) | 95% CI (%) | \(p\) | 10 years SF (%) | 95% CI (%) | \(p\) |
|----------|---------------|------------|------|---------------|------------|------|----------------|-------------|------|
| Non-RCM  | 89.7          | 89.4–90.0  |      | 77.2          | 76.8–77.7  |      | 59.5           | 58.8–60.1   |      |
| RCM-Sarco | 91.6          | 87.6–94.4  | .306 | 87.7          | 82.6–91.4  | .004 | 73.4           | 64.2–80.6   | .002 |
| RCM-Other | 86.3          | 83.8–88.5  | .002 | 72.0          | 68.5–75.2  | .003 | 53.9           | 48.9–58.75  | .001 |

Note: Bold font signifies statistical significance of \(p\)-values.

### FIGURE 3  Kaplan–Meier curves representing the survival functions of each group without adjustment (A) and with adjustment for age, ischemic time, and transplant year (B). \(p\)-values represent significant differences between either RCM-Sarco or RCM-Other compared to non-RCM indications at 10 years. RCM, restrictive cardiomyopathy

### TABLE 5  Risk of secondary outcomes of RCM-Sarco patients, with non-RCM indications as the reference

| Outcome                        | Odds ratio | 95% CI         | \(p\) |
|--------------------------------|------------|----------------|------|
| Ten-year survival              | 1.73       | 1.10–2.73      | .02  |
| Coronary artery disease        | 0.69       | 0.41–1.14      | .15  |
| Stroke                         | 1.11       | 0.49–2.52      | .81  |
| Pacemaker requirement          | 0.76       | 0.31–1.86      | .55  |
| Acute rejection episode        | 0.95       | 0.66–1.35      | .76  |
| Hospitalized for rejection     | 0.88       | 0.33–2.37      | .81  |
| Hospitalized for infection     | 1.03       | 0.48–2.18      | .94  |
| Graft failure                  | 1.09       | 0.65–1.84      | .74  |
| Retransplant                   | 1.20       | 0.38–3.83      | .76  |

Note: Bold font signifies statistical significance of \(p\)-values.

### 4  CONCLUSIONS

In our analysis of 289 cardiac sarcoidosis patients across 20 years of UNOS data, we found that their 10-year survival following transplant was improved compared to that of all other patients. The incidence of cardiac sarcoidosis and the number of transplants for this indication are both on the rise—in our data set, more than half of all cardiac sarcoidosis transplants took place in the most recent 5 years of complete data. These developments, coupled with an unchanging supply of donor hearts, necessitate a study of long-term survival outcomes in this population, both to inform organ allocation and clinical decision-making. We found that survival among RCM-Sarco patients was comparable to that of non-RCM patients at 1 year and superior at 5 years, in agreement with prior studies that have shown at least comparable survival at up to 6 years.\(^1\)\(^2\)\(^,\)\(^1\)\(^7\)\(^,\)\(^1\)\(^8\) We have further shown that cardiac sarcoid patients experience significantly improved survival over a longer, 10-year period.

Furthermore, we found that transplant for cardiac sarcoidosis is more common among black and female patients, who also experience the highest incidence of the systemic disease.\(^1\)\(^0\)\(^,\)\(^1\)\(^1\) There is a growing awareness of racial disparities in heart transplant outcomes, and our study further demonstrates an increased risk of 10-year mortality among black cardiac sarcoidosis patients.\(^2\)\(^0\) In our study, most clinical features of RCM-Sarco patients are favorable compared to those of non-RCM patients; for example, they are younger, less likely to have diabetes, and less likely to have undergone prior cardiac surgery. Despite fewer comorbidities, however, their decompensation during heart failure may be more rapid: RCM-Sarco spent fewer days on the waitlist, were more likely to require ECMO, and were more likely to have an adult transplant status of 1A or 1B at time of surgery. These events may be more common and more serious following the OPTN’s updated heart allocation policy, which assigns patients with hypertrophic and restrictive cardiomyopathy to...
waitlist status 4. Due to their poor candidacy for mechanical circulatory support, which now prioritizes patients for transplant, changes in status may also be rarer for cardiac sarcoidosis patients. Given these data, it is possible that cardiac sarcoidosis may now be experiencing longer waitlist times, reduced opportunities for transplant, and higher waitlist mortality. However, analysis of 1-year survival among non-RCM and RCM-Sarcoidosis patients receiving transplant after October 2018 indicated no differences in 1 year survival thus far. Sixty-five (22.5%) of RCM-Sarcoidosis patients were transplanted since the allocation policy change.

Despite the risk of lung disease and resultant pulmonary fibrosis in these patients, RCM-Sarcoidosis patients had lower pulmonary artery pressure than other patients (median values 34.2/16.8 mmHg vs. 41.0/19.6 mmHg). Coupled with recent findings of favorable long-term, posttransplant pulmonary artery hemodynamics, these data suggest that pulmonary artery pressure is acceptable both before and after transplant in this patient subset. Given that steroids are often utilized in the treatment of sarcoidosis, we unsurprisingly found that a higher proportion of sarcoïd heart transplant patients used chronic steroids compared to all others. However, chronic steroid use before transplant was not associated with adverse outcomes post-transplant. RCM-Sarcoidosis patients were more likely to require ECMO at the time of transplant, and in the entire cohort of heart transplant patients, ECMO use was associated with an increased risk of posttransplant mortality. Despite this, RCM-Sarcoidosis was associated with a 33% reduced risk of 10-year mortality compared to non-RCM patients in our adjusted model, likely due to the small number of patients utilizing ECMO in this group.

This is the largest database study of cardiac sarcoidosis patients undergoing heart transplant to date, but there were several limitations. The high proportion of RCM-Sarcoidosis patients who were transplanted in the most recent 5 years of OPTN data limits the power of the long-term follow-up—of 289 RCM-Sarcoidosis patients, 117 (40.5%) had follow-up through 5 years and 45 (15.6%) had follow-up through 10 years. Sarcoïd patients transplanted more than a decade ago, however, had excellent long-term survival, alleviating concerns that more recently transplanted patients may not be representative of the larger cohort. The greatest limitation of this study is that it only includes those carefully selected cardiac sarcoidosis patients who were selected for transplant and so documented in UNOS. Therefore, our findings cannot indicate that outcomes would be as favorable for each cardiac sarcoidosis patient experiencing heart failure. Other limitations include those inherent to any retrospective study of a large, national database.

This study has shown that survival following transplant for cardiac sarcoidosis is not only acceptable but also superior compared to that of patients undergoing transplant for all other indications. In addition, concerns of sarcoïd recurrence, which is both rare and usually experienced without mortality, and of right heart dysfunction due to pulmonary disease, have been mitigated by recent literature. In light of our study's findings and other recent data, cardiac sarcoidosis should be considered a viable indication for transplant in selected patients with the expectation of excellent long-term survival and morbidity.

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CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

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