Profile of Effective Donors for Heart Transplantation: Experience of a Brazilian Center

Wágner do Nascimento Carvalho[a,*], Karla Cordeiro Gonçalves[b], Anna Letícia Miranda[a], Gustavo dos Santos Alves Maria[a], Salete Maria de Fátima Silqueira[c], and Maria da Consolação Vieira Moreira[a,b]

[a]Faculdade de Medicina da Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil; [b]Hospital das Clínicas da Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil; and [c]Escola de Enfermagem da Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil

ABSTRACT

Background. Brazil's transplant network is a consolidated, worldwide-recognized program, with about 96% of heart transplantations (HTs) financed by its Unified Health System. It is known that the number of HTs has risen in the past few years, but it still does not meet the demand. This study aims to characterize the profile of the heart donors of a Brazilian center and ascertain the factors contributing to the increase in number of HTs.

Materials and methods. This is a cross-sectional and analytical study, developed between 2012 and 2018 at a Brazilian transplant center.

Results. There were 210 donations for HT in this period. The median age of donors in years (range) was 33 (24–40), and the donors were 15.5 years younger than the recipients (P value $< .001$). One hundred forty-two donors (67.6%) were male, 98 (46.7%) were mullato, and 115 (54.8%) had cranioencephalic trauma as the cause of brain death. The distance from the transplant center to the organ procurement area was short in 183 (87.1%) cases, enabling a allograft ischemic time with a median of 125 minutes. There was a relevant association between donor age and cause of brain death ($P < .001$), sex and cause of brain death ($P < .001$), and organ procurement area and allograft ischemic time ($P < .001$). Hospitals that provide urgent and emergency care served as sources for a larger number of organ donations.

Conclusions. This study concluded that the profile of most donors for HT include young adult mullato men who were victims of cranioencephalic trauma. In addition, these donors had few comorbidities and a median age of 33 years.

HEART transplantation (HT) is an effective therapeutic possibility for patients with advanced and refractory heart failure, without other alternatives for clinical or surgical treatment, and with a low life expectancy in one year. The scarcity of organs is an important limiting factor for patients in need of a HT [1–4].

In the evaluation for a HT, risks and benefits must be taken into consideration. The organ allocation process is based on ethical questions, which must take into consideration the survival possibilities and the reality of the scarcity of organs [5].

The Brazilian transplant program is consolidated and has a specific legislation and fair regulation. It is considered the largest public transplant system of the world, with about 96% of the HTs financed by the Unified Health System. In 2016, a list of 30 countries that performed transplants

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*Address correspondence to Wágner do Nascimento Carvalho, Sítio Sao José, Zona Rural, Córrego Sucanga, Caputira – Minas Gerais, Brazil 36.925-000. E-mail: wagnernasccarvalho@gmail.com

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placed Brazil only behind the United States in absolute number of liver and kidney transplantations [6].

However, Brazil faces logistical challenges, geographic barriers, and financial issues of the Unified Health System in the guarantee of a broader coverage of the transplant program in areas with a lower level of economic development [7].

Statistics from the Brazilian Society of Organ Transplantation show that, despite the increase in the number of HTs in Brazil, which grew from 161 in 2007 to 380 in 2017, the country does not meet the demand due to scarcity of organs and a large number of familial refusal (42%) [6]. In their 2017 report, the Brazilian Society of Organ Transplantation estimated that the number of people in need of a HT in the country was 1649, but only 380 transplantations were accomplished [6].

The recipient of a HT must have immunologic and morphologic compatibility with the donor. In addition, the ideal donor must have an adequate structural and functional formation of the heart, be absent of important comorbidities and, for most transplant centers, not be older than 55 years of age [1].

This study aims to characterize the profile of an effective donor for HTs in a reference center of the Brazilian transplant network.

MATERIALS AND METHODS

This is a cross-sectional, analytical, descriptive study with a quantitative approach, that was approved by the Ethics Committee of the Federal University of Minas Gerais (registration number:. 68546717.1.0000.5149).

The transplant center in which this study was conducted assists patients from medium to high complexity. It is considered a reference for the state, which has an approximated population of 21,040,662 habitants distributed in 853 cities. This center began its HT activities in 2006, and, by 2018, over 307 procedures had been performed, including retransplantations. The center is also responsible for about 70% of all HTs performed in the state, currently occupying the second position in absolute number of HTs in the country [8].

The data for this study were obtained from patients records and organ donation forms, standardized from the National Transplantation System. This system uses an electronic software system since 2011, when all organ donors started having a clinical computerized record. It contains information such as sex, age, ethnicity, blood type, height, weight, comorbidities, previous infections, cause of brain death, and city and hospital of organ procurement [9].

The population of the study consisted of data from the effective donors and some data from the recipients, such as age, sex, blood type, allograft ischemic time, and anthropometric measurements, referent to the period between 2012 and 2018.

In the data analysis, the categorical variables were analyzed by absolute and relative frequency. The Shapiro-Wilk test did not take into account continuous variables as with normal distribution, so the median, first, and third quartiles were used to represent these data. The Mann-Whitney test was used to compare the median of continuous variables between two groups. The Kruskall-Wallis test was used to compare the medians between three groups. The Pearson χ^2 test was used to verify the association hypothesis that compared two categorical variables. The analyses were made using .05 as a significance level. SPSS version 18.0 (IBM, Armonk, New York, United States) was used for the data analysis.

RESULTS

From 2012 to 2018, 210 donations for HT were received at the studied center. The median age (range) of the donors was 33 (24–40) years and the recipients' median age was 48.5 (39–57) years. The donors were 15.5 years younger than the recipients (P value $< .001$). There was a correspondence between the sex of the donor and of the recipient in 119 (56.7%) of the cases for HT. One hundred forty-two (67.6%) donors were male, ranging from 31 to 40 years of age in both sexes. Ninety-eight (67.6%) donors were mullato, 115 (54.8%) had type O blood, 115 (54.8%) were victims of cranioencephalic trauma (CET), and 183 (87.1%) organ procurements were accomplished over a short distance (the criteria for this categorization was a distance less than 100 km between the organ procurement area and the transplant center) noted in Tables 1 and 2.

The analysis of the anthropometric data revealed that the recipients had a median weight (range) of 70 (66–80) kilograms, a median height of 1.70 (1.65–1.75) meters, and a median body mass index of 24.5 (22.9–26.7) kilograms per square meter. All transplantations were performed taking into consideration morphologic compatibility, blood type, and, when indicated, virtual cross-match compatibility.

The hospitals that were specialized in urgent and emergency care had a larger number of donations; in this study, those hospitals were identified with alphabet letters to preserve the patient confidentiality. General hospitals presented fewer organ donations, which placed almost all of them in the "other" category due to a number of one to five donations (Table 1).

There was an association between age and cause of death (P value $< .001$; Fig 1). In the Kruskal-Wallis test, the P value was $< .017$. The comparison between groups resulted as follows: CET and stroke (P value $< .001$); CET and other causes (P value $= .037$); stroke and other causes (P value $= .287$). Association between sex and cause of death was also statistically significant (P value $< .001$), presenting an association between male sex and CET (P value $< .001$) and between female sex and stroke (P value $< .001$). There was no association between ethnicity and cause of death (Table 2).

The allograft ischemic time for organ procurements over a short distance was 125 (109–145) minutes. For procurements over a long distance, this time was increased to 220 (200–245) minutes. Short-distance organ procurement was related to a shorter allograft ischemic time (P value $< .001$).

DISCUSSION

According to the Registry of the International Society of Heart and Lung Transplantation from 2017, the mean age

Table 1. Social and Clinical Characteristics of Donors for Heart Transplantation

Variables	n	%
Sex		
Male	142	67.6
Female	68	32.4
Ethnicity		
Mullato	98	46.7
White	75	35.7
Black	26	12.4
Ignored	11	5.2
Blood type		
O	115	54.8
A	68	32.4
B	21	10
AB	6	2.8
Presence of infection		
Yes	103	49
No	107	51
Locus of infection		
Pulmonary	75	72.8
Undetermined	12	11.6
Urinary tract	6	5.8
Bacterial meningitis	4	4
Others	6	5.8
Comorbidities and life habits		
Alcoholism	57	27.1
Inhaled drug use	17	8.1
Obesity	14	6.7
Systemic arterial hypertension	5	2.4
Diabetes mellitus	2	1
Others	5	2.4
Causes of brain death		
Cranioencephalic trauma	115	54.8
Stroke	69	32.8
Others	26	12.4
Distant procurement location		
No	183	87.1
Yes	27	12.9
Procurement hospital type		
A	102	48.6
B	23	11
C	12	5.7
D	9	4.3
E	7	3.3
Others	57	27.1

Hospitals that specialized in urgent and emergency care are identified by letter to maintain privacy.

of the donors was 35 (17–58) years and the mean age of the recipients was 55 (25–68) years. Compared to these data, both the donors and recipients from the study center were younger. The donors were about 2 years younger and the recipients were about 6.5 years younger [10].

The results of this study also differed from those obtained by Rodriges et al [11], which characterized the profile of 305 organ donors from a hospital in Sao Paulo city, Brazil, from 2006 to 2010. In that study, the donors where on average 41 years old, the majority of them were male (55%), white (72%), and the main cause of brain death was stroke (55%),

Table 2. Analysis of Associations Between Demographic Variables by Cause of Death for the Donors of Hearts for Transplantation

Variable	CET (n = 115)	Stroke (n = 69)	Others (n = 26)	*P* Value
Age	29 (21–36)	38 (31–44)	35 (29–41.7)	<.001*
Sex				
Male	100 (70.4)	30 (21.1)	12 (8.5)	<.001*
Female	15 (22)	39 (57.4)	14 (20.6)	<.001*
Ethnicity				
Mullato	50 (51)	35 (35.7)	13 (13.3)	.869
White	41 (54.7)	24 (32)	10 (13.3)	.858
Black	16 (61.5)	8 (30.8)	2 (7.7)	.570

Values are noted as median (percentile 25-percentile 75) or frequency (%).
Abbreviation: CET, cranioencephalic trauma.
*$P < .05$.

immediately followed by CET (35%). Comorbidities were also infrequent, in particular, being overweight (31%), having systemic arterial hypertension (27%), and having a diagnosis of diabetes mellitus (4.3%).

The compatibility between donor and recipient sexes is a much-debated topic and still focus of controversy. Some studies have noted decreased survival when this criterion was not applied. Sex incompatibility was also associated, altogether with other factors, with a larger number of rejection episodes in the posttransplantation setting [12,13].

A study performed in a university hospital in Sao Paulo city, from 2005 to 2007, with data from 187 donors for transplants, also presented results that diverged from those of this study. The donors were mainly female (51.9%), between 41 and 60 years old, and victims of stroke (53.4%). However, only 35 were donors for HT and they were not separately analyzed, which could explain the differences [14].

In this study, the majority of donors were male (67.6%) and have not had a significant history of comorbidities; however, habits, such as ethanol consumption and inhaled drug use, were more frequent. Data from the International

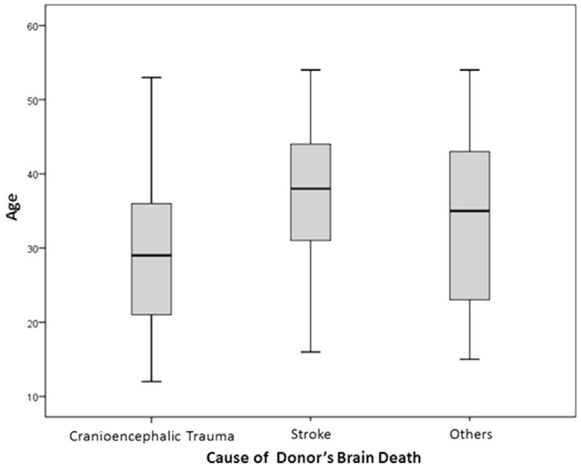

Fig 1. Distribution of donors for heart transplantation by age and cause of brain death.

Society of Heart and Lung Transplantation show donors to be predominantly male (68% to 69%), with a mean age that has increased from 31 years in 1992 to 35 years at the time of this study. Donor weight was approximately79.4 kg, the height 1.75 m, and body mass index 25.6 kg/m^2. Comorbidities were rare, but systemic arterial hypertension was found in 14% of the donors and diabetes mellitus in 3%. The main causes of death were CET (45%) and stroke (24%) [15].

The results of this study also corroborate partially with the study of Paz et al [16], which characterized the clinical and epidemiologic aspects from 308 donors of multiple organs and tissues. According to these authors, the donors of the study were mainly male (65.9%) with a mean age of 39.2 years old. The main causes of brain death were CET (27.9%) and stroke (23.4%), and only 16% of the donations were destined to HT.

Similar data were also found in the study of Aguiar et al [17], which evaluated the profile from 38 donors of multiple organs from 2004 to 2008. The donors were predominantly male (66.3%), 18 to 40 years of age (50.55%), mullato (47%), with type O blood (48%), and victims of CET (52%). Around 34% of the donated organs were destined for HT.

In this study, organ procurement occurred over a short distance in 87.1% of cases, providing less allograft ischemic time in comparison with long-distance organ procurement. The allograft ischemic time is influenced by logistic and geographic factors. According to data from International Society of Heart and Lung Transplantation, a allograft ischemic time smaller than 240 minutes is associated to a greater survival rate. In a allograft ischemic time shorter than 120 minutes, the survival rate is similar to cases in which the allograft ischemic time is between 120 and 240 minutes [10].

In this study, donors for HT were younger. As in any other previously published study, donors from the male sex were predominant [10,11,15–17]. As in some other previous studies, CET was the main cause of brain death [12,14,15–17].

It is hoped that the data obtained in this study may contribute to an improvement in the organ donation process. We also believe that these results may enable discussions of public health changes that aim at better assistance to both donors and recipients in HT, as well as an increase in the possibilities of donations for transplants.

The limitations of this study were (1) relying on retrospective analysis based on data from patients records and (2) not having access to donors' full patients records, only to their organ donation form. If it had been possible to access the donor's patient records, we might have done a more robust analysis. Prospective analyses are recommended, intending to have a deeper comprehension of logistics processes in the donation and procurement of organs.

CONCLUSIONS

The profile of the effective donors for HT in the studied center was of young adults, with a median age of 33 years, mainly male, and victims of CET. Comorbidities were infrequent, but habits such as alcoholism were frequent. Organ procurements were performed, in a great majority, over a short distance, which resulted in a shorter allograft ischemic time.

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