

Special article

Spanish heart transplant registry. 35th official report of the Heart Failure Association of the Spanish Society of Cardiology

Francisco González-Vílchez,^{a,*} Luis Almenar-Bonet,^b Cristina Mitroi,^c María G. Crespo-Leiro,^{d,e,f,g} Amador López-Granados,^h María Valero,ⁱ Juan F. Delgado-Jiménez,^{j,k,l} Sonia Mirabet-Pérez,^m José M. Sobrino-Márquez,ⁿ and Elena García-Romero^o, on behalf of the Spanish Heart Transplant Teams[◇]

^aServicio de Cardiología, Hospital Universitario Marqués de Valdecilla, Santander, Cantabria, Spain

^bServicio de Cardiología, Hospital Universitario y Politécnico La Fe, Valencia, Spain

^cDepartamento de Cardiología, Hospital Universitario Puerta de Hierro-Majadahonda, Majadahonda, Madrid, Spain

^dServicio de Cardiología, Complejo Hospitalario Universitario A Coruña (CHUAC), A Coruña, Spain

^eDepartamento de Fisioterapia, Facultad Medicina y Ciencias Biomédicas, Universidade da Coruña (UDC), A Coruña, Spain

^fInstituto de Investigación Biomédica A Coruña (INIBIC), A Coruña, Spain

^gCentro de Investigación Biomédica en Red de Enfermedades Cardiovasculares (CIBERCV), Spain

^hServicio de Cardiología, Hospital Universitario Reina Sofía, Córdoba, Spain

ⁱServicio de Cardiología, Hospital General Universitario Gregorio Marañón, Madrid, Spain

^jServicio de Cardiología, Hospital Universitario 12 de Octubre, Madrid, Spain

^kInstituto de Investigación i+12, Madrid, Spain

^lDepartamento de Medicina, Universidad Complutense de Madrid, Madrid, Spain

^mServei de Cardiologia, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain

ⁿServicio de Cardiología, Hospital Universitario Virgen del Rocío, Sevilla, Spain

^oServei de Cardiologia, Hospital Universitari de Bellvitge, L'Hospitalet de Llobregat, Barcelona, Spain

Article history:

Received 11 May 2024

Accepted 27 May 2024

Keywords:

Heart transplant

Registry

Survival analysis

ABSTRACT

Introduction and objectives: Our aim was to describe the characteristics and outcomes of heart transplants in Spain.

Methods: We analyzed trends in recipient and donor characteristics, recipient-donor interaction, surgical procedures, immunosuppression, and outcomes of patients included in the Spanish heart transplant registry from 2014 to 2023. Changes in survival were analyzed using the Kaplan-Meier method.

Results: In 2023, 325 cardiac transplants were performed (4.5% more than in the previous year), with a total of 2987 procedures from 2014 to 2023. There was a trend toward performing more transplants in women (29.2%), with etiologies other than cardiomyopathy (32.6%), and with better pretransplant status (less hepatic [12.5%], renal [glomerular filtration rate, 81.5 mL/min/1.73 m²], and respiratory [8.7%] involvement). In 2023, the number of urgent transplants increased (44% of the total), especially those performed after circulatory support with extracorporeal membrane oxygenation (36% of total assistance), and transplants performed with donation after circulatory death (17.9%). Survival improved in the triennium from 2020 to 2022 compared with 2014 to 2016 (83.0% at 1 year from 2020-2022 vs 79.0% from 2014-2016).

Conclusions: The number of transplants performed in Spain showed an upward trend, with recipients with better clinical status and an increasing use of donation after circulatory death. Survival improved in the last triennium.

© 2024 Sociedad Española de Cardiología. Published by Elsevier España, S.L.U. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

Registro español de trasplante cardiaco. XXXV informe oficial de la Asociación de Insuficiencia Cardiaca de la Sociedad Española de Cardiología

RESUMEN

Introducción y objetivos: El objetivo es describir las características y los resultados del trasplante cardiaco en España.

Métodos: Se realizó un análisis de la evolución de las características de receptor, donante, interacción receptor-donante, inmunosupresión y resultados de los pacientes incluidos en el Registro español de

Palabras clave:

Trasplante de corazón

Registro

Análisis de supervivencia

* Corresponding author.

E-mail address: cargvf@gmail.com (F. González-Vílchez).

◇ The affiliations of the collaborators are listed in [Appendix 1](#).

<https://doi.org/10.1016/j.rec.2024.05.015>

1885-5857/© 2024 Sociedad Española de Cardiología. Published by Elsevier España, S.L.U. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

Please cite this article in press as: González-Vílchez F, et al. Spanish heart transplant registry. 35th official report of the Heart Failure Association of the Spanish Society of Cardiology. *Rev Esp Cardiol*. 2024. <https://doi.org/10.1016/j.rec.2024.05.015>

trasplante cardiaco en el periodo 2014-2023. La evolución de la supervivencia se analizó mediante el método de Kaplan-Meier.

Resultados: En 2023 se realizaron 325 trasplantes cardiacos (el 4,5% más que el año anterior), con un total de 2.987 procedimientos en el periodo 2014-2023. Se comprobó una tendencia a trasplantar a más mujeres (29,2%), con etiologías diferentes de las dilatadas habituales (32,6%) y con mejor estado antes del trasplante (menos afecciones hepática [12,5%], renal [filtrado glomerular, 81,5 ml/min/1,73 m²] y respiratoria [8,7%]). En 2023 se incrementó el número de trasplantes urgentes (el 44% del total), sobre todo los realizados tras asistencia circulatoria con oxigenador extracorpóreo de membrana (el 36% del total de asistencias) y los trasplantes con donación en asistolia (17,9%). La supervivencia mejoró en el trienio 2020-2022 respecto a 2014-2016 (el 83,0% al primer año en 2020-2022 frente al 79,0% en 2014-2016).

Conclusiones: El número de trasplantes en España muestra una tendencia al alza, en receptores en mejor estado clínico y con aumento de la donación en asistolia. La supervivencia mejoró en el último trienio.

© 2024 Sociedad Española de Cardiología. Publicado por Elsevier España, S.L.U. Se reservan todos los derechos, incluidos los de minería de texto y datos, entrenamiento de IA y tecnologías similares.

INTRODUCTION

In 2024, a milestone was reached in the history of heart transplantation in Spain, with the 40th anniversary of the first transplant. In addition, 2024 marks the 33rd anniversary of the publication of the first annual report of the Spanish heart transplant registry.¹ In the intervening years, there have been multiple changes in numerous fields. The latest advances now adopted are ABO-incompatible heart transplants and transplants using grafts from donation after circulatory death, alongside the more traditional donation after brain death. The present report includes information on the procedures performed in 2023 and updates the historic series, particularly focusing on mortality data. As customary, the main findings are concentrated on procedures performed in the last 10 years (2014-2023).

METHODS

Patients and procedures

The Spanish heart transplant registry is a voluntary registry of heart transplant procedures performed in Spain. Although voluntary, the registry encompasses all procedures conducted in all centers with transplant activity in Spain since 1984 (table 1). The registry includes variables related to the demographic and clinical characteristics of recipients, donors, surgical procedures, immunosuppression protocols, and posttransplant complications, including mortality and its causes. The registry has been continually active for more than 30 years. The main changes in its structure are related to, first, the adoption of electronic data submission, second, the addition or change of variable definition or coding, and, finally, the incorporation of centers initiating transplant activity. Structurally, the Spanish heart transplant registry consists of a management team including a medical director and an assessment committee that is in charge of evaluating and approving the suitability of the use of registry data for research purposes and of an external contract research organization that is responsible for database maintenance and statistical analysis, activities that also involve comparisons with other international registries.

The total numbers and types of transplant conducted in 2023 and in the entire series are summarized in table 2. In 2023, 325 transplants were performed; most (n = 311) were isolated heart transplants. There were 11 retransplants (3.4%) and 3 combined transplants (2 heart-kidney transplants and 1 heart-lung transplant). In terms of age, 10.2% of recipients (33 patients) were younger than 18 years and 28.9% (94 patients) were older

than 60 years. Since the beginning, the Spanish heart transplant registry has recorded 9998 procedures (figure 1). The present report updates the information with the introduction of data related to the transplants performed in 2023. In addition, we analyzed the changes over time in the characteristics and outcomes of the procedures in the previous decade (since 2014). To do so, the period was stratified into triennia (2014-2016, 2017-2019, and 2020-2022). Some variables were analyzed on an annual basis (urgent transplants, circulatory assist devices).

Statistical analysis

Continuous quantitative variables are presented as mean ± standard deviation, while categorical variables are expressed as percentages. The nonparametric Kendall tau test and the Wilcoxon test for trends were used to assess temporal trends in the categorical and quantitative variables, respectively.² Cumulative survival was estimated using the Kaplan-Meier method and differences between groups were determined using the log-rank test. Differences were considered statistically significant at a 2-tailed $P < .05$.

RESULTS

Recipient characteristics

In total, 325 transplants were performed in 2023, marking a 4.5% increase compared with the previous year (figure 1). The principal recipient characteristics in 2023 and from 2014 to 2023 are summarized in table 3. The main changes in the last decade include the relative increase in female recipients, who represented 30% of all recipients in 2023. Related to this tendency is the percentage decrease in ischemic etiology as the leading cause of the heart disease prompting the transplant and the increase in other etiologies that are perceptually more frequent in women than in men (hypertrophic cardiomyopathy, 12.6% in women vs 6.1% in men; restrictive cardiomyopathy, 8.4% vs 4.1%; and congenital heart disease, 11.1% vs 5.7%). As in the previous report,³ a trend was seen toward recipients with better clinical status. This was inferred from a significant trend for fewer recipients with elevated pretransplant bilirubin levels (as an indicator of better congestive status and lower ischemic kidney disease) and for the need for pretransplant intubation, which was required in less than 10% of patients in 2023. In addition, the previous tendency toward a decrease in urgent transplants was broken in 2023, with an uptick to 44% in 2023 (P for trend = .02) (figure 2). As in previous

Table 1

Programs participating in the Spanish heart transplant registry from 1984 to 2023 (by order of first transplant performed)

Program	Date of first transplant	Transplants, No.
1. Hospital de la Santa Creu i Sant Pau, Barcelona	May 8, 1984	634
2. Clínica Universidad de Navarra, Pamplona, Navarra	July 6, 1984	329
3. Clínica Puerta de Hierro-Majadahonda, Majadahonda, Madrid (adult and cardiopulmonary)	September 28, 1984	1012
4. Hospital Marqués de Valdecilla, Santander	December 17, 1984	790
5. Hospital Reina Sofía, Córdoba (adult and pediatric)	May 10, 1986	768
6. Hospital Universitario y Politécnico La Fe, Valencia (adult and pediatric, cardiopulmonary)	November 16, 1987	1015
7. Hospital Gregorio Marañón, Madrid (adult)	August 2, 1988	697
8. Fundación Jiménez Díaz, Madrid (1989-1994)	July 25, 1989	21
9. Hospital Gregorio Marañón, Madrid (pediatric)	July 6, 1990	227
10. Hospital Virgen del Rocío, Sevilla	January 6, 1991	568
11. Hospital 12 de Octubre, Madrid	January 15, 1991	692
12. Hospital Universitario de A Coruña, A Coruña (adult and pediatric)	April 5, 1991	927
13. Hospital Bellvitge, L'Hospitalet de Llobregat, Barcelona	November 24, 1991	558
14. Hospital La Paz, Madrid (pediatric)	May 16, 1994	107
15. Hospital Central de Asturias, Oviedo, Asturias	February 2, 1998	381
16. Hospital Clínic, Barcelona	May 13, 1998	445
17. Hospital Virgen de la Arrixaca, El Palmar, Murcia	July 27, 1999	230
18. Hospital Miguel Servet, Zaragoza	March 30, 2000	190
19. Hospital Clínico o Universitario, Valladolid	November 12, 2001	222
20. Hospital Vall d'Hebron, Barcelona (pediatric)	April 21, 2006	83
21. Hospital La Paz, Madrid (adult)	June 1, 2019	26
22. Hospital de Gran Canaria Dr. Negrín, Las Palmas de Gran Canaria	December 4, 2019	76

Table 2

Spanish heart transplant registry (1984-2023). Type of procedure

Procedure	2023	1984-2022
De novo heart transplant	311	9577
Heart retransplant alone	11	228
Combined heart retransplant	0	8*
Combined de novo heart transplant	3	186
Heart-lung	1	90
Heart-kidney	2	80
Heart-liver	0	16
Total	325	9998

* All kidney transplants.

years, there was widespread use of pretransplant circulatory support in 2023 (191 recipients [39.7%]). Since 2014, 1815 patients (38.5%) have undergone transplantation with previous circulatory support. However, the most relevant finding in 2023 was the relative increase in the pretransplant use of extracorporeal membrane oxygenation (from 23.2% in 2022 to 36.5% in 2023) at the expense of ventricular assist devices (from 75.0% in 2022 to 61.1% in 2023) (figure 3).

Donor and surgical procedure characteristics

Donor and surgical procedure characteristics are summarized in table 4. There was a significant trend toward a lower use of suboptimal donors, defined as those older than 45 years, which fell to 47.4% of all transplants in 2023 vs 54.3% from 2014 to 2016 (figure 4). The trend for transplants with a recipient-donor sex mismatch (male recipient-female donor) was also significant,

falling from 24.9% in the triennium from 2014 to 2016 to 15.4% in 2023.

The most significant data regarding the donation process, consolidated in 2023, concerned donation after circulatory death (asystole). The first such procedure was conducted in January 2020 in Hospital Universitario Puerta de Hierro-Majadahonda. By December 2023, a total of 110 such transplants had been performed in 14 programs, 98 in adult recipients and 12 in pediatric patients. In 2023, transplants with donation after circulatory death comprised almost 18% of all procedures and 24% of all transplants performed at centers with an active circulatory death donation program. In addition, in 2023, 3 ABO-incompatible transplants were performed, a technique restricted to pediatric recipients. Since the initiation of these programs in 2018, this technique has represented 13.4% of all procedures performed in accredited centers.

Regarding the remaining characteristics, the last decade showed a highly significant trend toward ensuring recipient-donor sex concordance to avoid the unfavorable matching of a female donor with a male recipient (15.4% of patients in 2023 vs 24.9% in the triennium from 2014 to 2016). Equally, the use of the bicaval technique increased to almost 84% of all procedures. Although the difference was not statistically significant, ischemia time showed a slight tendency toward a decrease, with an average of slightly longer than 3 hours in 2023.

Immunosuppression

Induction immunosuppression trends are summarized in table 5. Over the past decade, there have been no significant new developments. Except in rare situations, patients receive triple therapy consisting of tacrolimus, mycophenolate mofetil/mycophenolic acid, and steroids. Induction therapy, often involves the use of antibodies (82.5% of patients), generally basiliximab.

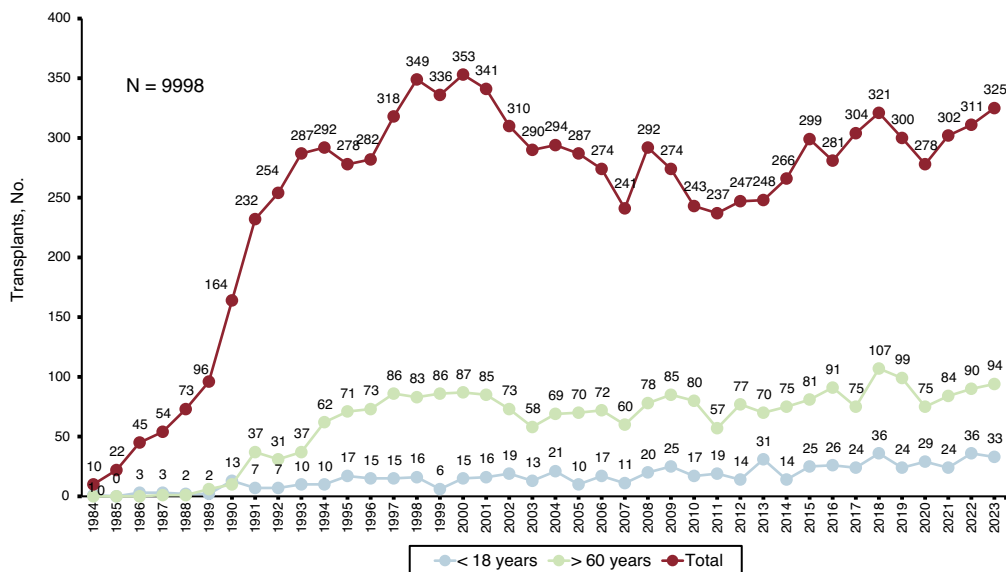


Figure 1. Annual number of transplants (1984-2023), total and by age group.

Table 3 Recipient characteristics in the Spanish heart transplant registry (2014-2023)

Characteristics	2014-2016 (n = 846)	2017-2019 (n = 925)	2020-2022 (n = 891)	P for trend	2023 (n = 325)
Age, y	49.7 ± 16.6	49.2 ± 17.7	48.7 ± 17.7	.45	49.0 ± 18.1
< 18 y, %	7.7	9.1	9.9	.26	10.2
> 60 y, %	29.2	30.4	28.0	.76	28.9
Male sex	75.4	71.8	70.3	.03	70.8
BMI	24.6 ± 4.4	24.8 ± 4.9	24.6 ± 4.9	.34	24.9 ± 9.4
Underlying etiology				.03	
Nonischemic dilated	36.5	36.5	33.5		39.7
Ischemic	37.0	31.7	32.3		27.7
Other	26.5	31.8	34.2		32.6
PVR, UW	2.2 ± 1.5	2.1 ± 1.3	2.1 ± 1.7	.001	1.9 ± 1.1
Glomerular filtration rate, mL/min/1.73 m²	79.3 ± 33.1	80.1 ± 34.5	80.8 ± 37.5	.88	81.5 ± 38.5
Bilirubin > 2 mg/dL	17.1	15.7	11.3	< .001	12.5
Insulin-dependent diabetes	22.7	20.0	20.5	.26	18.9
Moderate-severe COPD	11.8	10.5	9.3	.01	8.7
Previous infection	15.6	13.3	16.8	.45	18.8
Previous cardiac surgery	32.1	37.5	34.1	.39	31.2
Type of transplant				.60	
Isolated	96.6	96.7	96.2		95.7
Heart retransplant	1.9	1.5	2.2		3.4
Combined	1.9	1.6	1.9		0.9
Heart-lung	0.8	1.0	0.5		0.3
Heart-kidney	0.7	0.4	0.7		0.6
Heart-liver	0	0.2	0.3		0
Pretransplant mechanical ventilation	14.5	15.4	10.8	.02	9.1
Urgent transplant	46.3	43.0	38.1	.07	44.3
Pretransplant circulatory support				.12	
No	61.0	59.2	64.9		60.3
Balloon pump	11.0	1.9	1.3		0.9
ECMO	10.7	10.1	7.5		14.5
Ventricular support	17.3	28.9	26.4		24.3

BMI, body mass index; COPD, chronic obstructive pulmonary disease; ECMO, extracorporeal membrane oxygenator; PVR, pulmonary vascular resistance.

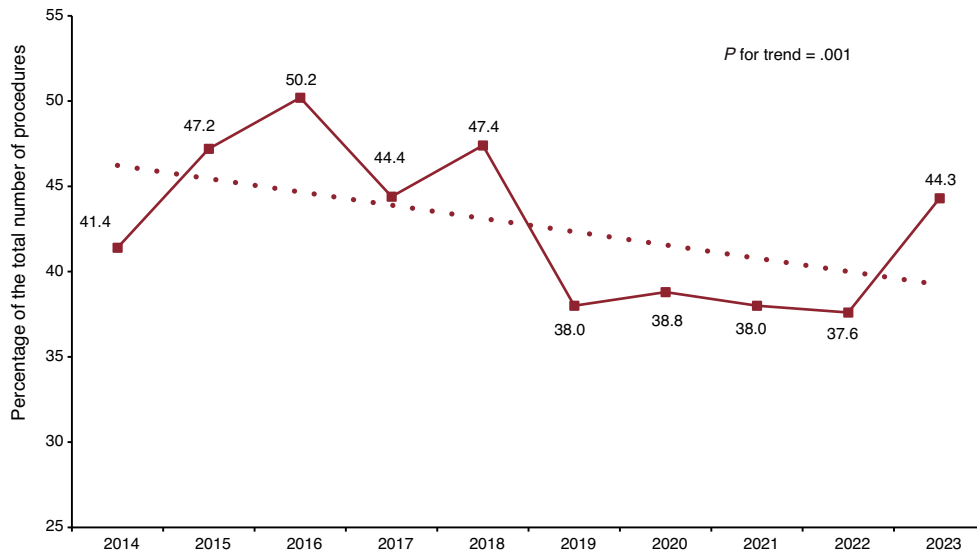


Figure 2. Annual percentage of urgent transplants vs the total number (2014-2023). The dotted line indicates the linear adjustment line of the temporal trend.

Survival

From 2014 to 2023, survival was 81.4% in the first post-transplant year and 74.0% at 5 years, which was significantly better than in the 1984 to 2013 period (figure 5A). In the pediatric population (recipients younger than 18 years at transplant), posttransplant survivals at 1 and 5 years were 83.6% and 80.4%, respectively, in the last decade.

The trend for improved survival in recent years was statistically significant (figure 5B). Survival in the first posttransplant year increased from 79.0% in the triennium from 2014 to 2016 to 83.0% from 2020 to 2022. Some of the univariable predictors of mortality are summarized in table 6. As already noted in the previous report,³ the main factors associated with mortality were related to

clinical characteristics or variables associated with the recipient's pretransplant clinical status.

Causes of death

The specific causes of death in the first 5 posttransplant years remained infection (25.8%) and primary graft failure (19.5%) (figure 6). As expected, primary graft failure was the leading cause of death in the first posttransplant month (37.8% of all deaths). Infection was by the far the leading cause of death after the first month and until the 1-year posttransplant point (44.5% of deaths), although the risk subsequently remained high (21% of deaths until the fifth posttransplant year). Acute rejection was a nonnegligible cause of death, particularly in the period between 1 and

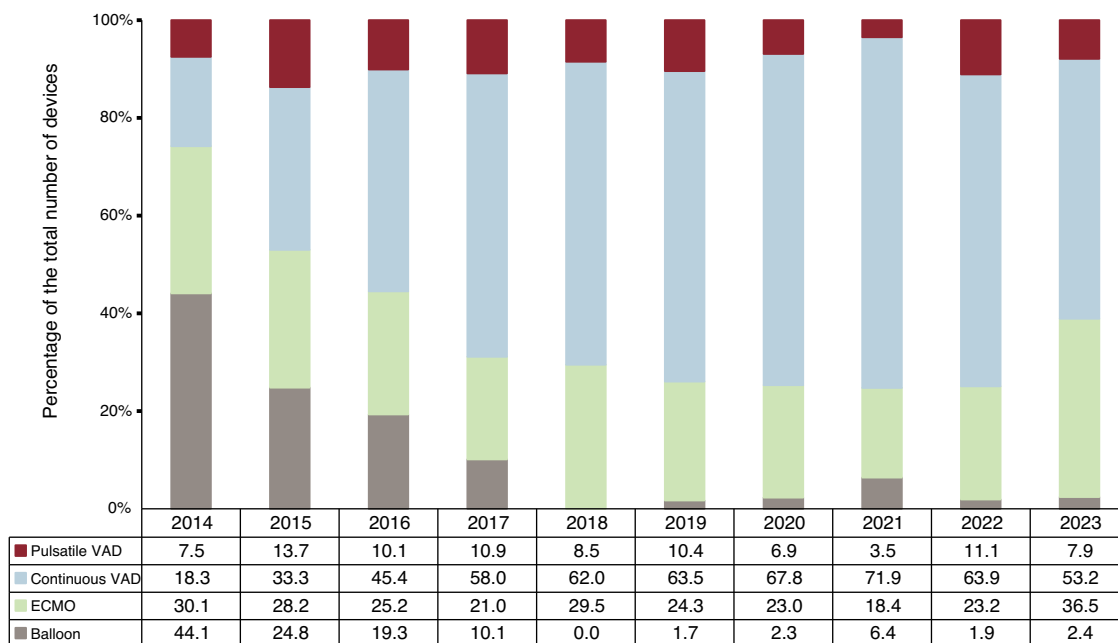


Figure 3. Distribution of the type of pretransplant circulatory support by year (2014-2023). ECMO, extracorporeal membrane oxygenation; VAD, ventricular assist device.

Table 4
Donor characteristics and procedure times in the Spanish heart transplant registry (2014-2023)

Characteristics	2014-2016 (n=846)	2017-2019 (n=925)	2020-2022 (n=891)	P for trend	2023 (n=325)
Age	43.4 ± 14.3	43.2 ± 15.4	41.6 ± 15.5	.07	41.1 ± 16.3
Age > 45 y	54.3	56.4	48.0	.02	47.4
Male sex, %	58.9	61.9	62.3	.14	70.5
Female donor-male recipient	24.9	21.4	17.6	< .001	15.4
Weight, kg	74.7 ± 17.9	74.5 ± 19.7	73.9 ± 19.7	.82	73.7 ± 21.0
Recipient/donor weight	0.93 ± 0.19	0.93 ± 0.20	0.93 ± 0.20	.91	0.93 ± 0.22
Recipient/donor weight < 1.2	6.9	8.3	7.9	.69	10.2
Recipient/donor weight < 0.8	21.9	23.8	24.0	.05	27.1
Cause of death				.80	
Trauma	23.3	19.7	22.8		23.1
Stroke	63.0	64.9	61.3		77.2
Other	13.7	15.5	15.9		22.8
Pretransplant cardiac arrest ^a	17.2	17.4	19.5	< .001	28.7
Predonation echocardiogram ^b				.58	
Not performed	1.3	1.7	0.1		0.5
Normal	96.5	95.7	97.7		98.2
Mild generalized dysfunction	2.5	2.6	2.1		1.4
Donation after circulatory death	0.0	0.0	5.8	< .001	17.9
Ischemia time, min	198.3 ± 71.8	196.8 ± 71.4	192.9 ± 72.6	.19	188.1 ± 72.2
≤ 120 min	16.1	17.7	18.2	.06	26.2
120-180 min	22.6	19.9	24.1		20.9
180-240 min	34.3	35.7	34.2		30.5
> 240 min	27.1	26.7	23.5		22.5
Bicaaval surgical technique	70.1	71.6	79.2	< .001	83.6

^a Of 2789 transplants.^b Of 2518 transplants.

Values are expressed as percentage or mean ± standard deviation.

5 posttransplant years (13% of deaths). Even so, in this period, the most frequent causes of death were graft vascular disease/sudden cardiac death (22.8%), infection (21%), and cancer (18.5%). Primary graft failure (14.6%) and particularly infection (25.0%) were also the most frequent causes of death in the first 5 posttransplant years in the pediatric population.

To assess changes in the main causes of death over time, we studied the same causes in the first posttransplant year to ensure a comparable follow-up among triennia. Acute rejection significantly decreased as a cause of death during the last decade. In contrast, primary graft failure and infection remained statistically stable in the same period (figure 7).

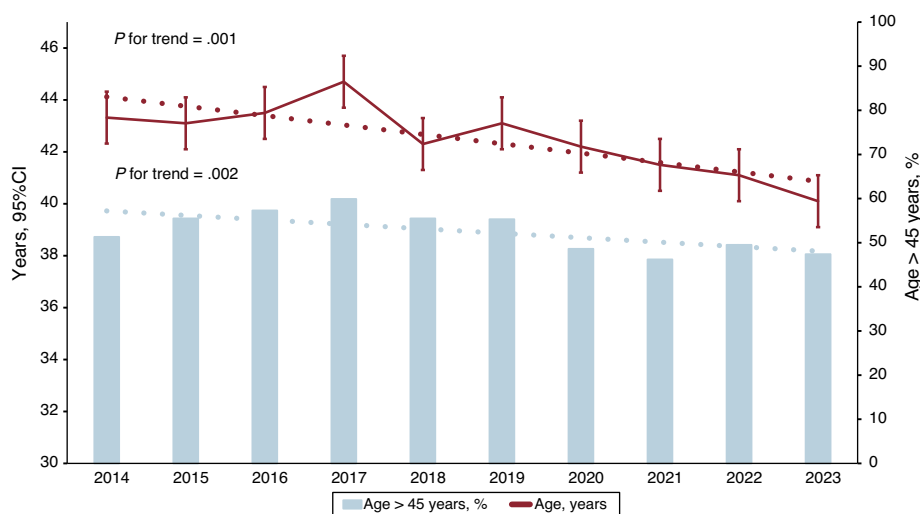
**Figure 4.** Annual changes in donor age (continuous red line) and the percentage of donors older than 45 years (2014-2023) (blue bars). The dotted lines indicate the linear adjustment lines of the temporal trend. This figure is shown in color in the online version of the article.

Table 5
Induction immunosuppression in the Spanish heart transplant registry (2014-2023)

Immunosuppressants	2014-2016 (n=846)	2017-2019 (n=925)	2020-2022 (n=891)	P for trend	2023 (n=325)
<i>Calcineurin inhibitors</i>				<.001	
Cyclosporin	12.0	5.3	3.7		1.0
Tacrolimus	91.9	95.0	97.6		99.0
<i>Antiproliferative agents</i>				.89	
Mycophenolate mofetil/mycophenolic acid	99.1	99.2	99.1		100.0
Azathioprine	0.9	0.8	0.9		0.0
<i>m-TOR inhibitors</i>				>.999	
Sirolimus	0.4	0.5	0.4		0.7
Everolimus	1.8	1.4	1.0	.22	3.7
<i>Steroids</i>	97.1	97.1	98.4	.10	98.4
<i>Induction</i>				.06	
No	15.3	17.7	17.6		16.8
ALG/ATG	3.2	4.1	4.6		5.9
Anti-CD25	81.2	76.8	77.7		76.6
Other	0.4	0.3	0.1		0.6

ALG, antilymphocyte globulin; anti-CD25, basiliximab, daclizumab; ATG, antithymocyte globulin. Values express percentages.

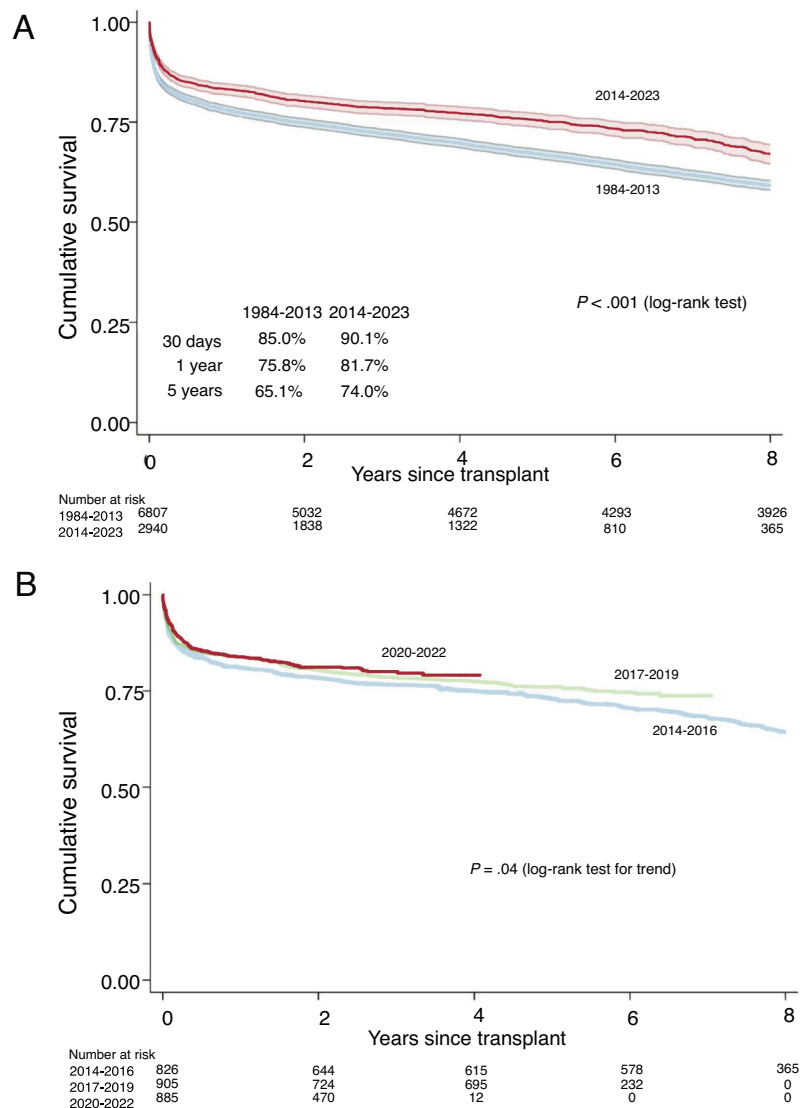


Figure 5. A: comparison of survival curves between the 2014 to 2023 and 1984 to 2013 periods. B: comparison of survival curves from 2014 to 2023 by triennium.

Table 6
Univariable analysis of survival by baseline characteristics of the recipient, donor, and procedure (2014–2023)

Variable	Hazard ratio (95%)	P
<i>Recipient age</i>		
< 18 y	1	
18–60 y	1.3 (0.9–1.7)	.13
> 60 y	1.9 (1.4–2.5)	< .001
<i>Underlying etiology</i>		
Nonischemic dilated	1	
Ischemic dilated	1.5 (1.3–1.8)	< .001
Other	1.3 (1.1–1.5)	.01
<i>Type of transplant</i>		
Isolated transplant	1	
Combined transplant	2.0 (1.2–3.1)	< .01
Retransplant	1.1 (0.7–1.9)	.61
<i>Donor age</i>		
≤ 45 y	1	
> 45 y	1.2 (1.0–1.4)	.02
<i>Donation after circulatory death</i>	1.4 (0.8–2.5)	.28
<i>Urgency code</i>		
Elective	1	
Urgent	1.3 (1.2–1.5)	< .001
<i>Type of support*</i>		
No support	1	
Balloon pump	0.8 (0.5–1.2)	.23
ECMO	1.8 (1.4–2.2)	< .001
Ventricular support	1.3 (1.1–1.5)	< .01
<i>Pretransplant creatinine > 2 mg/dL</i>	1.4 (1.2–1.6)	< .001
<i>Pretransplant mechanical ventilation</i>	2.0 (1.6–2.4)	< .001
<i>Pretransplant infection</i>	1.5 (1.2–1.8)	< .001
<i>Pretransplant diabetes</i>	1.3 (1.1–1.5)	< .01

95%CI, 95% confidence interval; ECMO, extracorporeal membrane oxygenation.

DISCUSSION

The results of the Spanish heart transplant registry updated to 2023 can be summarized in the following points. Firstly, certain trends identified in the previous report³ have become consulsated. For instance, there has been a renewed increase in the number of procedures, although it remains uncertain whether this correlates with the rise in donation after circulatory death. Similarly, there was an increase in the proportion of female recipients. As can be seen in previous studies, this increase was actually due to the absolute decrease in male recipients in the last 20 years.⁴ This proportional increase also explains the uptick in atypical underlying heart disease etiologies, which are generally more prevalent in women. Finally, recipients' pretransplant clinical status has progressively improved, which is in line with the use of more advanced circulatory support systems and a refinement of recipient selection processes.

Second, there was a notable increase in urgent transplants, reversing the downward trend observed in previous years. This finding is undoubtedly related to the shift in the use of different types of circulatory support, with an increase in the use of extracorporeal membrane oxygenation vs ventricular assist devices. The revisions in the urgency criteria⁵ by the Spanish National Transplant Organization (NTO), based on the recommendations from transplant centers, are certainly responsible for these findings, even though they came into force well into 2023.

Third, a tendency was detected for more favorable donor characteristics, as evidenced by the fall in the percentage of suboptimal donors. In addition, there was a decrease in transplants with known unfavorable recipient-donor interactions, such as those due to sex discordance (male recipient-female donor).

Fourth, there was a progressive increase in donation after circulatory death, as well as in donation characteristics that are particularly well-managed in this setting.

Fifth, the results showed significantly improved survival in the last triennium (2020–2022) vs the first triennium of the decade, in contrast to the stabilization in survival data described in the

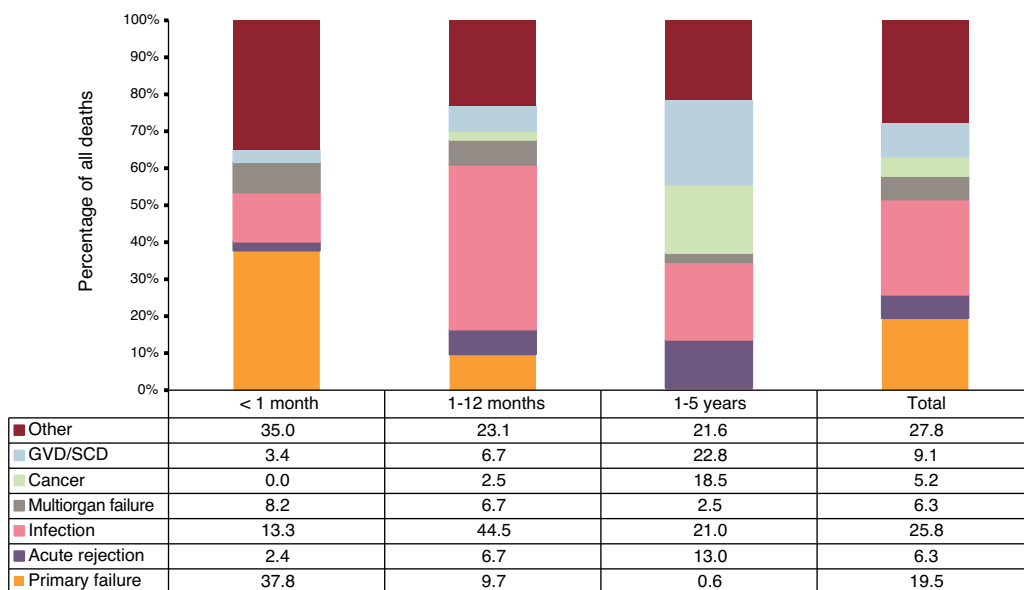


Figure 6. Main causes of death by time since transplant in the 2014 to 2023 period. GVD/SCD, graft vascular disease/sudden cardiac death. Each cause of death is reported as a percentage of total patient deaths in the specific period.

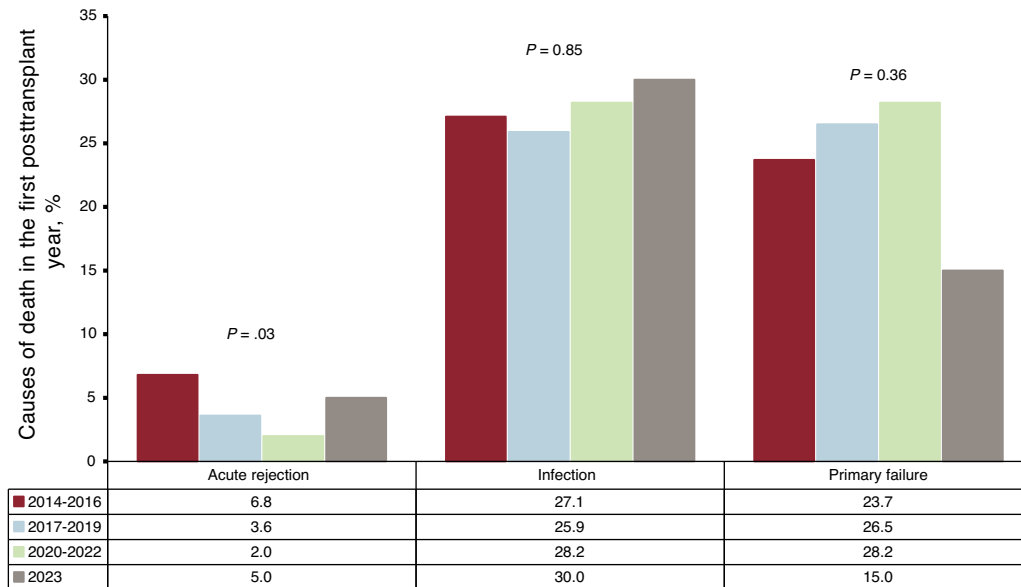


Figure 7. Changes over time in the main causes of death in the first posttransplant year in the 2014 to 2023 period by triennium.

previous report.³ Although the cause of this improvement would require a more detailed analysis that is beyond the scope of the present report, it is highly likely that a combination of the tendencies shown in previous reports would robustly explain these findings.

Limitations

This study has the limitations inherent to a registry of unaudited procedures.

CONCLUSIONS

The data from recent years have confirmed a tendency toward an increase in the number of transplants, which is highly likely to be related to the uptick in donation after circulatory death. The slight improvement in survival outcomes probably reflects better recipient selection and pretransplant management and a refined acceptance process for donors.

FUNDING

This work has not received any funding.

ETHICAL CONSIDERATIONS

The present registry was approved by the Biomedical Research Ethics Committee of Hospital Universitario La Fe and was conducted with the recipients’ informed consent. The report considers donor and recipient sex to be possible predictive variables, as indicated in the descriptive tables of the manuscript.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

No artificial intelligence was used in the preparation of this article.

AUTHORS’ CONTRIBUTIONS

F. González-Vílchez drafted the manuscript. All authors have contributed to the data collection, have critically revised the manuscript, and have approved its publication in the current form.

CONFLICTS OF INTEREST

None.

APPENDIX 1. COLLABORATORS IN THE SPANISH HEART TRANSPLANT REGISTRY 1984 TO 2023

Center	Collaborators
Hospital Universitario Marqués de Valdecilla, Santander, Cantabria	Manuel Cobo-Bealustegui, Miguel Llano-Cardenal, José Antonio Vázquez de Prada, Francisco Nistal-Herrera, Cristina Castrillo
Hospital Universitario Central de Asturias, Oviedo, Asturias	Beatriz Díaz-Molina, Vanesa Alonso-Fernández, Cristina Fidalgo-Muñiz
Hospital Universitario Virgen del Rocío, Sevilla	Antonio Grande-Trillo, Diego Rangel-Sousa
Hospital de la Santa Creu i Sant Pau, Barcelona	Marta De Antonio-Ferrer, Laura López
Hospital Clínic Universitari, Barcelona	Marta Farrero-Torres, Ángeles Castells, Pedro Caravaca, Eduard Solé
Hospital Universitari Bellvitge, L’Hospitalet de Llobregat, Barcelona	José González-Costello, Elena García-Romero, Carles Díez-López, Fabrizio Sbraga, Pablo Catalá-Ruiz, Lorena Herrador
Hospital General Universitario Gregorio Marañón, Madrid (adults)	Zorba Blázquez, Iago Sousa, Javier Castrodeza, Eduardo Zatañán, Adolfo Villa, Carlos Ortiz-Bautista, Manuel Martínez-Sellés
Hospital General Universitario Gregorio Marañón, Madrid (pediatric)	Manuela Camino-López, Nuria Gil-Villanueva, Juan Miguel Gil-Jaurena
Hospital Universitari i Politècnic La Fe, Valencia	Raquel López-Viella, Víctor Donoso-Trenado, Soledad Martínez-Penadés, Ignacio Sánchez-Lázaro

(Continued)

Center	Collaborators
Hospital Universitario Reina Sofía, Córdoba	Francisco Carrasco-Ávalos
Hospital Universitario Clínica Puerta de Hierro-Majadahonda, Majadahonda, Madrid	Manuel Gómez-Bueno, Javier Segovia-Cubero, Cristina Mitroi, Mercedes Rivas-Lasarte, Sara Lozano-Jiménez, Jose María Vieitez-Flórez
Hospital Universitario 12 de Octubre, Madrid	María Dolores García-Cosío, Laura Morán-Fernández, Javier González Martín, Irene Marco-Clement
Complejo Hospitalario Universitario A Coruña, A Coruña	María Jesús Paniagua-Martín, Eduardo Barge-Caballero, Gonzalo Barge-Caballero, David Couto-Mallón, Daniel Enríquez-Vázquez
Hospital Universitario La Paz, Madrid (pediatric)	Luis García-Guereta Silva, Álvaro González-Rocafort, Carlos Labrandero de Lera
Hospital Universitario La Paz, Madrid (adults)	Inés Ponz de Antonio, Adriana Rodríguez-Chaverri
Hospital Clínico Universitario, Valladolid	Luis de la Fuente-Galán, Javier Tobar-Ruiz
Hospital Universitario Virgen de la Arrixaca, El Palmar, Murcia	Iris P. Garrido-Bravo, Francisco J. Pastor-Pérez, Domingo A. Pascual-Figal
Hospital Universitario Miguel Servet, Zaragoza	Teresa Blasco-Peiró, Ana Pórtoles-Ocampo, Ana Marcén-Mirabete
Clínica Universidad de Navarra, Pamplona	Gregorio Rábago-Juan-Aracil, Rebeca Manrique-Antón, Leticia Jimeno-San Martín
Hospital Universitario de Gran Canaria Dr. Negrín, Las Palmas de Gran Canaria	Antonio García-Quintana, María del Val Groba-Marco, Mario Galván-Ruiz, Miguel Fernández de Sanmamed-Girón
Hospital Universitari Vall d'Hebron, Barcelona	Ferrán Gran-Ipiña, Paola Dolader

REFERENCES

1. Vázquez de Prada. Registro Español de Trasplante Cardíaco. Primer Informe Oficial. *Rev Esp Cardiol.* 1991;44:293-296.
2. Cuzick J. 1985. A Wilcoxon-type test for trend. *Statistics in Medicine.* *Stat Med.* 1985;4:87-90.
3. González-Vílchez F, Hernández-Pérez F, Almenar-Bonet L, et al. Spanish Heart Transplant Teams. Spanish heart transplant registry. 34th official report of the Heart Failure Association of the Spanish Society of Cardiology. *Rev Esp Cardiol.* 2023;76:901-909.
4. García-Cosío MD, González-Vílchez F, López-Vilella R, et al. Gender differences in heart transplantation: Twenty-five year trends in the nationwide Spanish heart transplant registry. *Clin Transplant.* 2020;34:e14096.
5. González-Costello J, Pérez-Blanco A, Delgado-Jiménez J, et al. Review of the allocation criteria for heart transplant in Spain in 2023. SEC-Heart Failure Association/ONT/SECCE consensus document. *Rev Esp Cardiol.* 2024;77:69-78.