

## Special article

# Spanish Heart Transplantation Registry. 26th Official Report of the Spanish Society of Cardiology Working Group on Heart Failure and Heart Transplantation (1984–2014)



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## Article history:

Available online 9 October 2015

## Keywords:

Heart transplantation  
Registry  
Survival

## ABSTRACT

**Introduction and objectives:** We present the characteristics and outcomes of heart transplantation in Spain since it was first performed in 1984.

**Methods:** A descriptive analysis of the characteristics of recipients, donors, the surgical procedure, and the outcomes of heart transplantations performed in Spain until 31 December 2014.

**Results:** In 2014, 266 procedures were performed, making a time series of 7289 transplantations. The temporal analysis confirmed a significant worsening of the clinical profile of recipients (higher percentage of older patients, patients with severe renal failure, insulin-dependent diabetes, previous cardiac surgery, and previous mechanical ventilation), of donors (higher percentage of older donors and greater weight mismatch), and of the procedure (higher percentage of emergency transplantations, reaching 41.4% in 2014, and ischemia time > 240 min). Mechanical assist devices were used less than in 2013; in 2014 they were used in 18.8% of all transplant recipients. Survival at 1, 5, 10, and 15 years was 76%, 65%, 52%, and 38%, respectively, and has remained stable since 1995.

**Conclusions:** Cardiac transplantation activity in Spain has remained stable in recent years, at around 250 procedures per year. Despite a clear deterioration in donor and recipient characteristics and surgical times, the mortality outcomes have remained comparable to those of previous periods in our environment. The growing use of circulatory assist devices before transplantation is also confirmed.

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## Registro Español de Trasplante Cardíaco. XXVI Informe Oficial de la Sección de Insuficiencia Cardíaca y Trasplante Cardíaco de la Sociedad Española de Cardiología (1984–2014)

## RESUMEN

**Introducción y objetivos:** Se presentan las características y resultados del trasplante cardíaco en España desde que empezó su actividad en mayo de 1984.

**Métodos:** Se realiza un análisis descriptivo de las características de los receptores, los donantes, el procedimiento quirúrgico y los resultados de los trasplantes cardíacos realizados en España hasta el 31 de diciembre de 2014.

**Resultados:** Durante 2014 se han realizado 266 procedimientos, con lo que la serie histórica consta de 7.289 trasplantes. El análisis temporal confirma un empeoramiento significativo del perfil clínico de los receptores (mayor porcentaje de pacientes añosos, con insuficiencia renal grave, diabetes

## Palabras clave:

Trasplante cardíaco  
Registro  
Supervivencia

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The collaborators are listed in the [appendix](#).

insulinodependiente, cirugía cardíaca previa y ventilación mecánica), de los donantes (mayor porcentaje de donantes añosos y con mayor discordancia de peso) y del procedimiento (mayor porcentaje de trasplante urgente, que en 2014 alcanza el 41,4%, y con tiempo de isquemia > 240 min). El uso de dispositivos de asistencia mecánica ha disminuido respecto a 2013, y en 2014 supone el 18,8% del total de pacientes. La supervivencia a 1, 5, 10 y 15 años es del 76, el 65, el 52 y el 38% respectivamente, y permanece estable desde 1995.

**Conclusiones:** La actividad de trasplante cardíaco en España permanece estable en los últimos años, con alrededor de 250 procedimientos al año. A pesar del claro empeoramiento de las características de donantes, receptores y tiempos quirúrgicos, se mantienen unos resultados en mortalidad comparables a los del entorno y se confirma un uso creciente de los dispositivos de asistencia circulatoria antes del trasplante.

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### Abbreviations

ECMO: extracorporeal membrane oxygenation

## INTRODUCTION

Since 1991, the Spanish Heart Transplantation Registry has published reports of the clinical and surgical characteristics and the overall results of cardiac transplant procedures performed in Spain.<sup>1–25</sup> This article describes the data on the transplant population to 31 December 2014. As is already well-known, the greatest strength of the Spanish Heart Transplantation Registry is the inclusion and exhaustive updating of all heart transplant procedures performed in all hospitals in Spain since May 1984, regardless of their characteristics and outcomes. Also, data are collected prospectively in a common database and are agreed upon and updated by all the transplantation groups.

## METHODS

### Patients and Centers

Nineteen centers contributed data to the Spanish Heart Transplantation Registry, 18 of which are currently still active (Table 1). Two centers are dedicated solely to pediatric transplantation and 3 others perform both adult and pediatric transplantation. The number of procedures performed annually is summarized in Figure 1. The whole series consists of 7289 procedures. Data were lost in 12 cases, including information on follow-up. Those cases were not included in the analysis, and the final sample size was 7277 cases. Of the 266 procedures carried out in 2014, 12 (4.5%) were performed in pediatric patients (age < 16 years). The types of procedures carried out in 2014 and in the whole series are summarized in Table 2.

### Procedures

The database comprises 175 clinical variables, pre-established by consensus from all groups, collecting data on the recipient, donor, surgical technique, immunosuppression, and follow-up. As of 2013, data are introduced and updated electronically and in real

time using an application available on the internet and specifically designed for this purpose. The database support is a Microsoft Excel file. This method replaces the previous one, in which each center sent data to the registry director in Microsoft Access format via e-mail. An external CRO (contract research organization)—currently ODDS, S.L.—is responsible for database maintenance, quality control, and statistical analysis.

Ethics committee approval, auditing, and registration with the Ministry of Health were carried out in line with the Spanish Organic Law on Data Protection 15/1999.

### Statistics

Continuous quantitative variables are reported as mean  $\pm$  standard deviation, and categorical quantitative variables are reported as percentages. Results are organized according to year of transplantation, dividing the total sample into 3 groups (1984–1993, 1994–2003, and 2004–2014). In some variables (such as donor age, emergency transplant, and ischemia time), the data were also

**Table 1**

Centers (by Order of First Transplantation Performed) Participating in the Spanish Heart Transplantation Registry (1984–2014)

1.	Hospital de la Santa Creu i Sant Pau, Barcelona
2.	Clínica Universitaria de Navarra, Pamplona
3.	Clínica Puerta de Hierro, Majadahonda, Madrid
4.	Hospital Marqués de Valdecilla, Santander
5.	Hospital Reina Sofía, Córdoba (adult and pediatric)
6.	Hospital Universitario y Politécnico La Fe, Valencia
7.	Hospital Gregorio Marañón, Madrid (adult and pediatric)
8.	Fundación Jiménez Díaz, Madrid (1989–1994)
9.	Hospital Virgen del Rocío, Seville
10.	Hospital 12 de Octubre, Madrid
11.	Hospital Universitario de A Coruña, A Coruña (adult and pediatric)
12.	Hospital Bellvitge, L'Hospitalet de Llobregat, Barcelona
13.	Hospital La Paz, Madrid (pediatric)
14.	Hospital Central de Asturias, Oviedo
15.	Hospital Clínic, Barcelona
16.	Hospital Virgen de la Arrixaca, El Palmar, Murcia
17.	Hospital Miguel Servet, Zaragoza
18.	Hospital Clínic, Valladolid
19.	Hospital Vall d'Hebrón, Barcelona (pediatric)

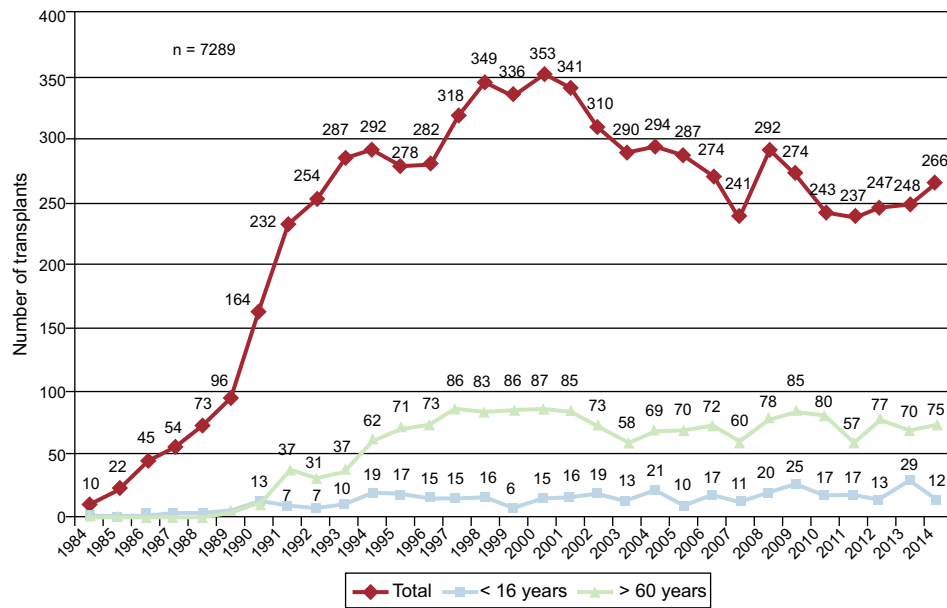


Figure 1. Annual number of transplantations (1984–2014), total and by age group.

analyzed annually for the whole series. Differences between groups were analyzed using a nonparametric test for temporal trends (Kendall's tau) for categorical variables, and analysis of variance with polynomial fit for quantitative variables. Survival curves were calculated using the Kaplan-Meier method, and survival curves were compared with the log rank test. A  $P$  value  $< .05$  was considered statistically significant.

## RESULTS

### Recipient Characteristics

In 2014, mean recipient age was  $50 \pm 16$  years (0.02–73 years); 75% were men. The most common underlying diagnoses were ischemic cardiomyopathy (25.9%), dilated nonischemic cardiomyopathy (27.8%), cardiomyopathy of valvular origin (4.5%), and other causes (41.7%). Recipient patient characteristics by transplantation period are summarized in Table 3. There were significant trends toward older recipients, female sex, and unusual causes of underlying heart disease. There was an increase in pre-transplant existing conditions known to affect prognosis, such as insulin-dependent diabetes, infection, and cardiac surgery or mechanical ventilation

Table 2  
Spanish Heart Transplantation Registry (1984–2014). Type of Procedure

Procedure	2014	1984–2014
De novo heart transplantation	255	6957
Retransplantation	5	171
Combined retransplantation	1	6
Combined transplantations	6	143
Heart-lung	3	72
Heart-kidney	3*	61
Heart-liver	—	8
Total	266	7277

\* Includes combined retransplantation.

prior to transplantation. Retransplantation frequency remained stable at around 2.4% in the period 1984–2014. In contrast, pulmonary vascular resistance values prior to transplantation were significantly reduced throughout the time series.

Although fewer emergency transplantations were carried out in 2014 than in 2013, a strongly increasing trend was observed in emergency transplantation over the whole time series ( $P < .00001$ ) (Figure 2). At the same time, the use of mechanical circulatory assist devices increased ( $P < .00001$ ) compared with traditional balloon counterpulsation, with mechanical circulatory assist devices coming into use significantly in the last decade (Figure 3). Use of extracorporeal membrane oxygenation (ECMO) and ventricular assist devices—both pulsatile and continuous flow—is particularly evident from 2009 onward (Figure 4). Between 2009 and 2014, the use of ECMO doubled, and that of continuous flow support increased exponentially (from 2.0% in 2009 to 15.7% in 2014).

### Donor Characteristics and Ischemia Time

Donor characteristics by time interval and for 2014 are summarized in Table 4. Donor age increased significantly over the whole series, with  $> 50\%$  of donors considered suboptimal (age  $> 45$  years) in 2014 (Figure 5). The number of female donors progressively increased, as did the percentage of transplants to a male recipient from a female donor (22.9% in 2014). Increases were also found in cardiac arrest prior to donation (17.4% in 2014), and in ventricular dysfunction on echocardiography prior to extraction (3.3% in 2014). Also, the number of donors who died due to stroke increased, with a decrease in those dying from trauma (Figure 6).

Ischemia time increased over the whole series. In 2014, as in the previous decade, more than one quarter of patients received a transplant with an ischemia time of  $> 240$  min (Table 4, Figure 7).

### Immunosuppression

In 2014, 87.9% of recipients received some type of induction immunosuppressive therapy, mostly basiliximab (84.5%). Figure 8 shows the progressive increase of basiliximab in induction

**Table 3**  
Recipient Characteristics in the Spanish Heart Transplantation Registry (1984-2014)

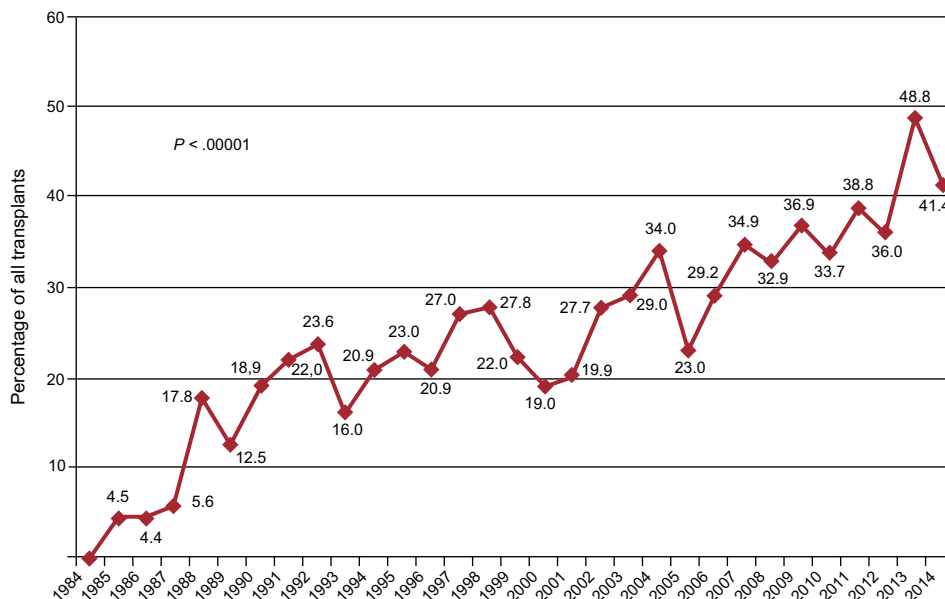
	1984-1993 (n = 1230)	1994-2003 (n = 3148)	2004-2014 (n = 2899)	P (trend)	2014 (n = 266)
Age, years	46.7 ± 13.4	50.4 ± 14.6	49.6 ± 16.5	< .001	49.9 ± 15.8
< 16 years	3.9	4.8	6.6	< .001	4.5
> 60 years	10.0	24.3	27.4	< .001	28.2
Sex, male	85.8	81.1	76.0	< .001	75.2
BMI	24.2 ± 4	25.0 ± 4.5	24.9 ± 4.7	< .001	24.8 ± 4.3
Underlying etiology				< .001	
Nonischemic dilated	39.8	34.3	27.1		27.8
Ischemic	30.8	30.0	26.0		25.9
Valvular	10.5	7.6	7.4		4.5
Other	24.9	28.1	39.6		41.7
PVR (WU)	2.6 ± 1.8	2.3 ± 1.8	2.4 ± 2.1	< .001	2.2 ± 1.3
Creatinine > 2 mg/dL	7.0	6.1	7.9	.131	5.8
Bilirubin > 2 mg/dL	19.7	17.8	17.8	.35	16.8
Insulin-dependent diabetes	8.5	12.9	17.3	< .001	21.4
Moderate-severe COPD	9.3	11.2	9.8	.109	13.7
Previous infection	4.0	9.4	13.8	< .001	14.0
Previous cardiac surgery	25.3	26.5	29.1	.024	30.1
Heart retransplantation	2.8	2.1	2.6	.84	2.3
Mechanical ventilation prior to transplantation	8.3	10.3	15.7	< .001	11.7
Emergency transplantation	18.1	23.6	35.1	< .001	41.4

BMI, body mass index; COPD, chronic obstructive pulmonary disease; PVR, pulmonary vascular resistance. Values expressed are mean ± standard deviation or percentages.

immunosuppression to its current predominant use. In the period 2009-2014, 80% of patients were induced with interleukin-2 inhibitors (basiliximab or daclizumab, primarily basiliximab), replacing the widespread use of OKT3 in earlier periods.

Initial immunosuppression in 2014 was predominantly with tacrolimus (86.7%) as a calcineurin inhibitor, mycophenolate mofetil or mycophenolic acid (96.1%) as an antiproliferative, and

steroids (96.9%). Figure 9 shows the immunosuppressors used initially and at the end of follow-up for the whole series. Over an average follow-up of 7 years, 61.6% of patients remained on corticoids. As can be seen, toward the end of follow-up, tacrolimus was used almost as much as cyclosporin, despite the predominant use of cyclosporin in initial immunosuppression regimens. Azathioprine use remains almost anecdotal, and notably,



**Figure 2.** Annual percentage of emergency transplantations of the total population (1984-2014).

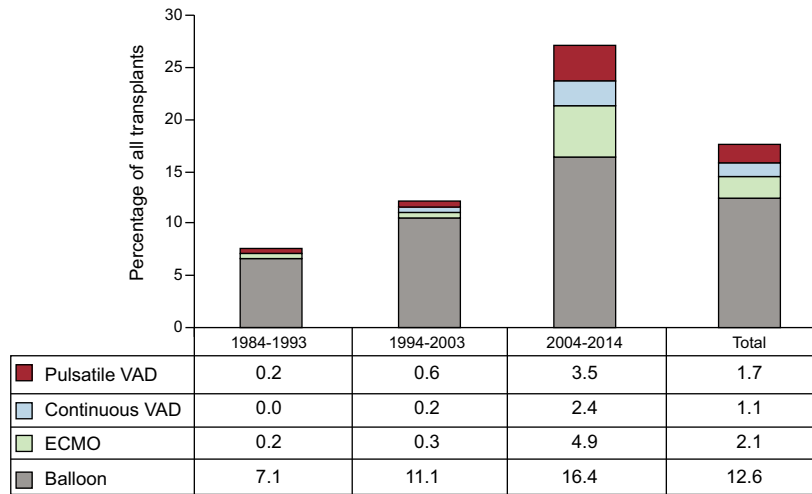


Figure 3. Distribution of type of pretransplant circulatory support, by time period. ECMO, extracorporeal membrane oxygenation; VAD, ventricular assist device.

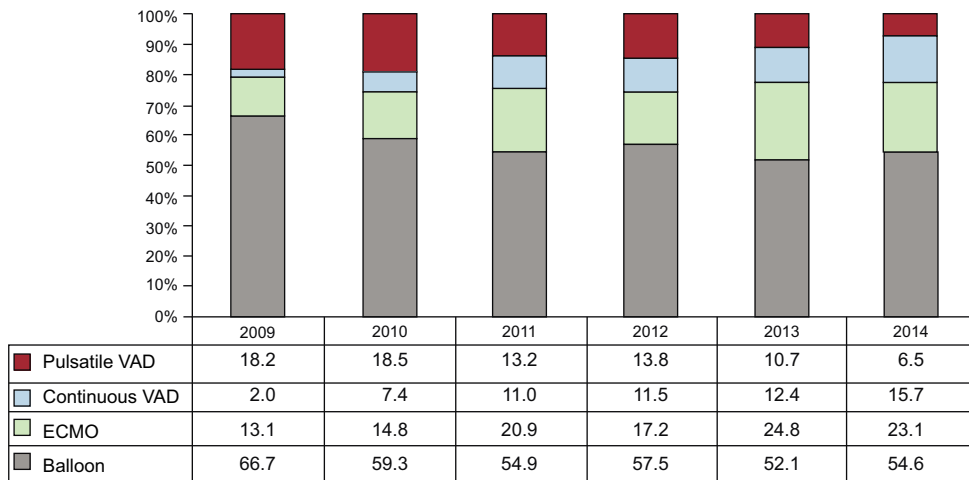


Figure 4. Distribution of type of pretransplant circulatory support in the period 2009-2014. ECMO, extracorporeal membrane oxygenation; VAD, ventricular assist device.

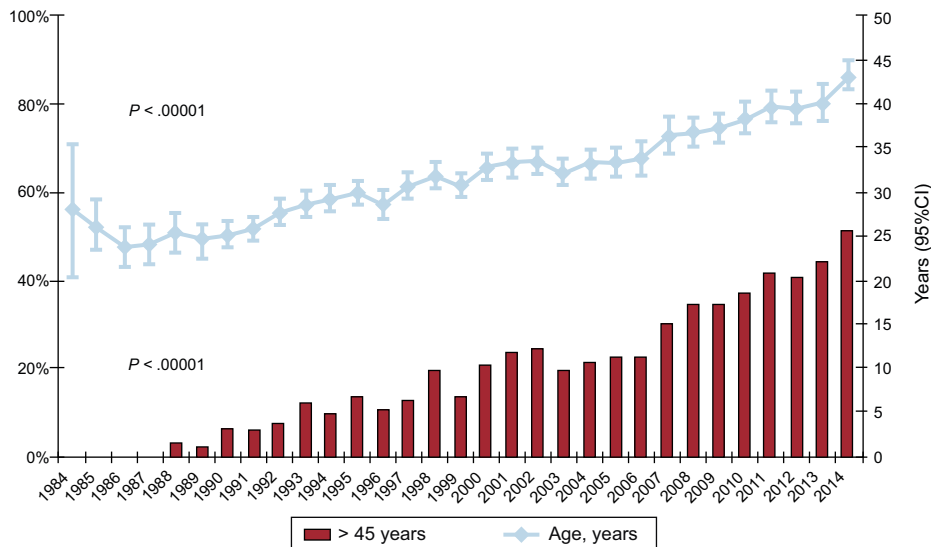


Figure 5. Annual changes in donor age and percentage of donors older than 45 years (1984-2014). 95%CI, 95% confidence interval.

**Table 4**  
Donor Characteristics and Ischemia Times in the Spanish Heart Transplantation Registry (1984-2014)

	1984-1993 (n = 1230)	1994-2003 (n = 3148)	2004-2014 (n = 2899)	p (trend)	2014 (n = 266)
Age, years	26.5 ± 10.3	31.3 ± 12.9	37.4 ± 14.6	.067	43.6 ± 14.9
Age > 45 years	7.6	19.3	37.3	<.001	53.8
Sex, male	78.4	70.9	65.7	<.001	62.0
Female donor-male recipient	17.8	20.9	21.2	.045	22.9
Weight, kg	69.4 ± 13.4	70.1 ± 16.1	72.6 ± 18.0	.007	75.0 ± 18.3
Recipient/donor weight	1.0 ± 0.2	1.0 ± 0.3	1.0 ± 1.0	<.001	1.0 ± 0.9
Recipient/donor weight > 1.20	13.3	15.8	11.1	<.001	9.4
Recipient/donor weight < 0.8	13.8	14.7	19.7	<.001	21.1
Pretransplantation cardiac arrest <sup>a</sup>	3.0	7.2	11.1	<.001	17.4
Predonation echocardiography <sup>b</sup>				<.001	
Not done	52.5	21.0	6.0		1.4
Normal	47.1	77.7	91.4		95.3
Mild generalized dysfunction	0.3	1.2	2.7		3.3
Ischemia time, min	160.8 ± 61.4	184.8 ± 61.7	205.4 ± 64.3	.06	199.6 ± 72.6
≤120 min	27.0	18.0	11.5	<.001	15.0
121-180 min	36.2	28.3	22.2		22.6
181-240 min	28.1	36.7	38.7		35.0
> 240 min, %	8.7	17.1	27.6		27.4

Values expressed are mean ± standard deviation or percentages.

<sup>a</sup> Of 3621 transplantations.

<sup>b</sup> Of 5959 transplantations.

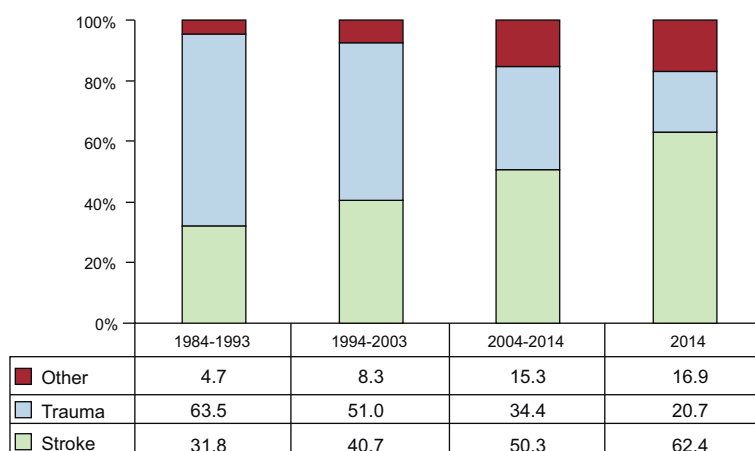
27.9% of patients were on treatment with mTOR inhibitors (everolimus or sirolimus) at the most recent follow-up.

Annual changes in the use of the different calcineurin inhibitors and antimetabolites are shown in Figures 10 and 11, respectively. Tacrolimus use equaled cyclosporin use in 2005, and tacrolimus use has continued to increase since then, becoming the most-used calcineurin inhibitor in initial immunosuppression. A similar trend was seen between mycophenolate mofetil and azathioprine, which were used equally between 1999 and 2001, then from 2009 mycophenolate became the predominant antimetabolite in initial immunosuppression, with azathioprine being used minimally. The annual changes in the use of mTOR inhibitors (sirolimus, everolimus) in initial immunosuppression are shown in Figure 12. These drugs were used initially at an

appreciable percentage between 2005 and 2007; then their use fell to minimal.

## Survival

The actuarial survival for the whole series at 1, 5, 10, 15, and 20 years at 31 December 2014 is summarized in Figure 13. This represents an average mortality of approximately 2% to 3% per year after the first post-transplant year, with a median survival of 10.9 years. There were significant differences depending on recipient age at the time of transplantation and the type of procedure. Survival was significantly better in patients younger than 16 years than in those aged 16 to 60 years. Likewise, survival was



**Figure 6.** Changes by time period of causes of death of heart donors.

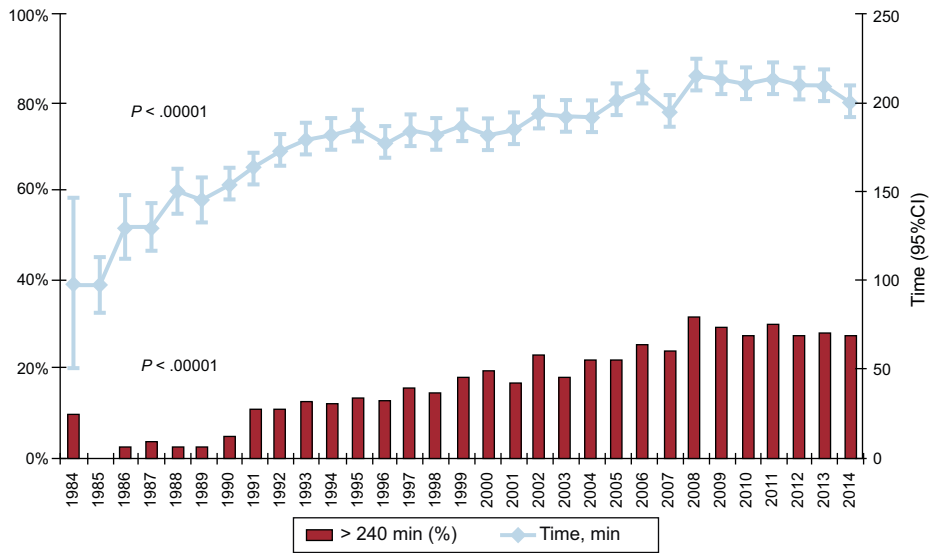


Figure 7. Annual changes in ischemia time and percentage with ischemia time > 240 min (1984-2014). 95%CI, 95% confidence interval.

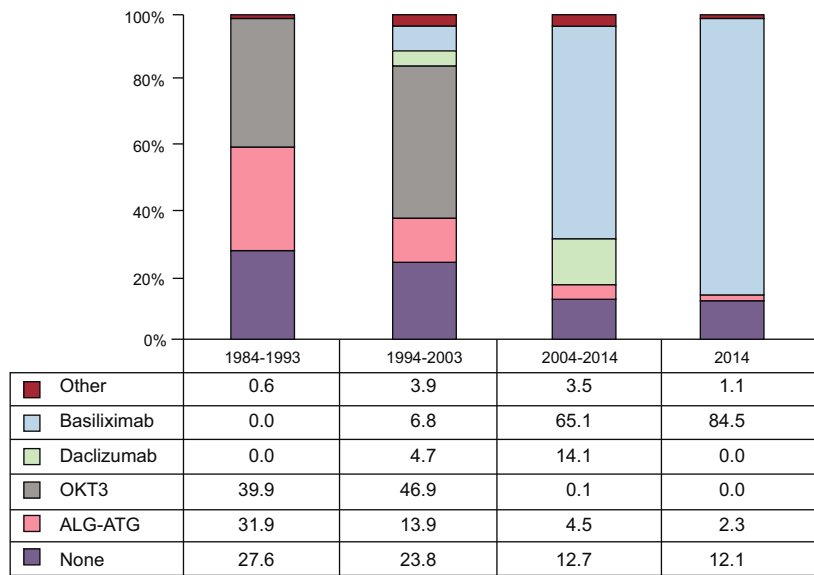


Figure 8. Drugs used in induction immunosuppression. ALG, antilymphocyte globulin; ATG, antithymocyte globulin.

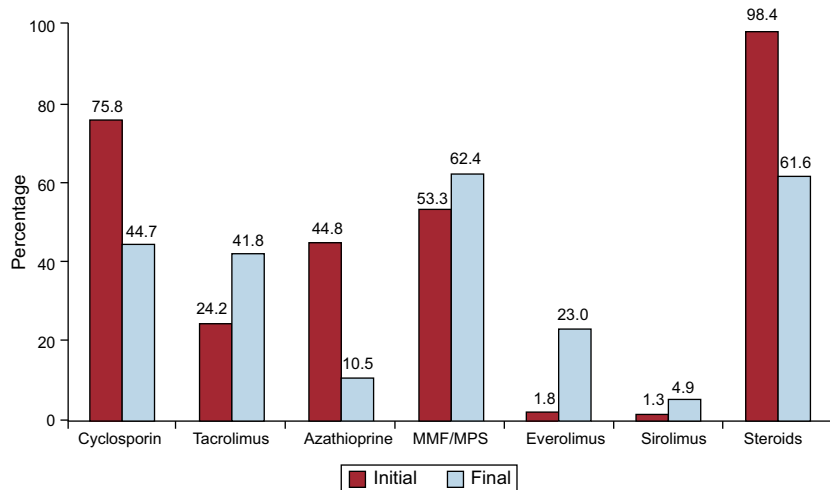
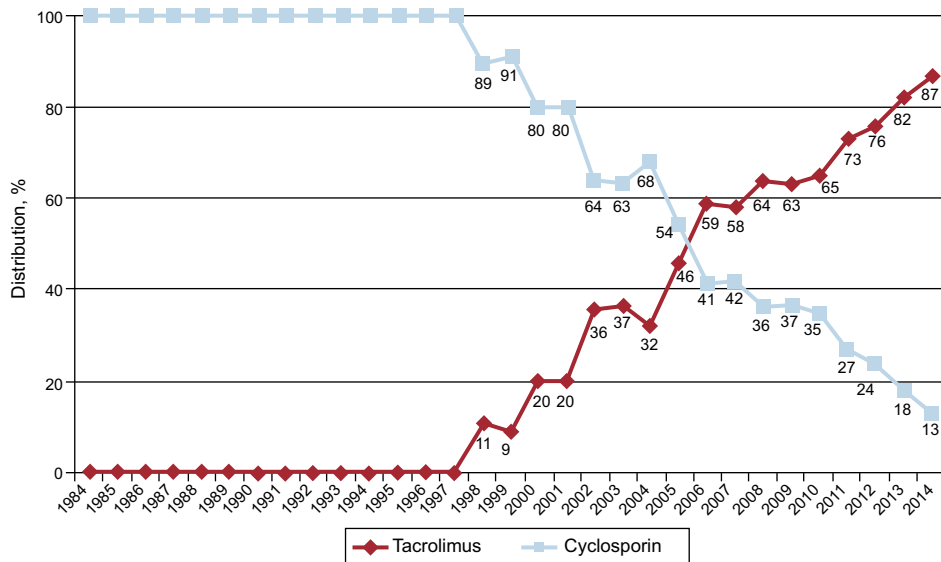


Figure 9. Initial and maintenance immunosuppression for the whole series (1984-2014). Progressive changes by type of drug: at time of transplantation and at end of follow-up. MMF, mycophenolate mofetil; MPS, mycophenolate sodium.



**Figure 10.** Annual changes in use of calcineurin inhibitors (cyclosporin and tacrolimus) in initial immunosuppression in the total sample (1984-2014).

significantly better in patients aged 16 to 60 years than in those older than 60 years (Figure 14). There were also highly significant differences between heart transplantation alone; combined cardiac and renal, hepatic, or pulmonary transplantation; and retransplantation (Figure 15). Survival was also significantly affected by donor age older than 45 years (Figure 16).

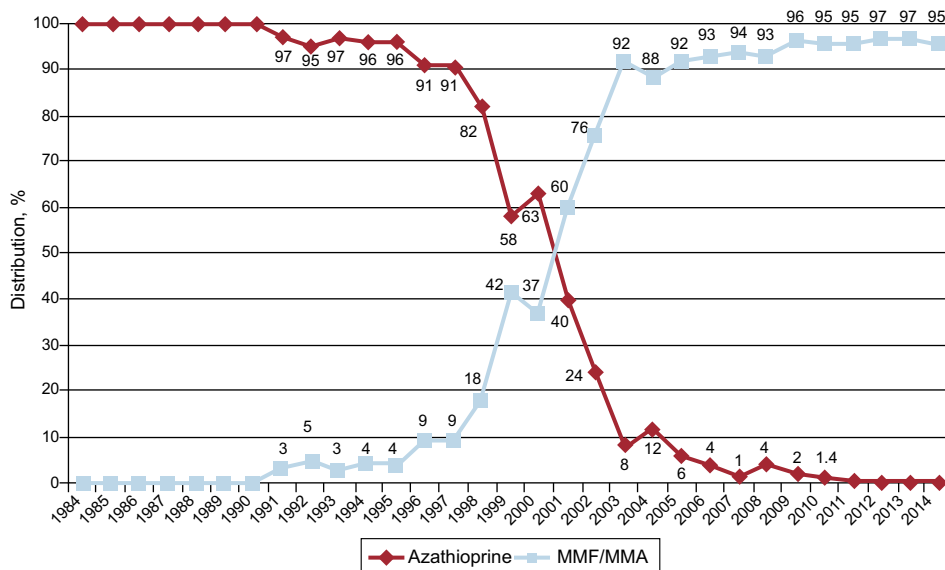
In the whole series, highly significant differences ( $P < .00001$ ) were found in survival between elective transplantation and emergency transplantation (Figure 17). Analysis of the period 2009-2014, in which use of mechanical assist devices increased appreciably, showed that the worst survival was in emergency transplantations done with ECMO assistance; there were no significant differences between emergency and elective transplantations that used counterpulsation balloon or ventricular assist devices (Figure 18). The differences between the types of transplant according to the condition of the patient at the time

of intervention are established over the first 6 months post-transplant, with a subsequent parallel curve pattern.

After the first decade (1984-1993), there was a significant improvement in mid-term and long-term survival, influenced mainly by a lower mortality in the early post-transplant stages (Figure 19). Over the last decade (2004-2013), there was a non-significant trend ( $P = .064$ ) toward improved survival from the third or fourth post-transplant year compared with the decade immediately prior (1994-2003) (Figure 19).

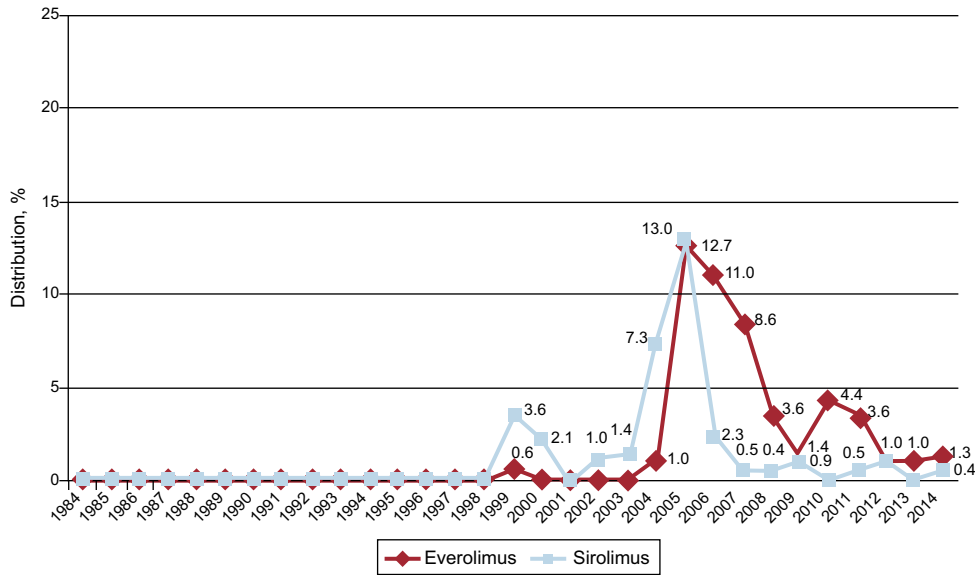
### Causes of Death

In the total population, the most common cause of death was vascular disease of the graft/sudden death (19.7%), followed by infection (16.5%), primary graft failure (14.3%), and neoplasia



**Figure 11.** Annual changes in use of antimetabolites (azathioprine and mycophenolate mofetil/mycophenolic acid) in initial immunosuppression in the total sample (1984-2014). MMA, mycophenolic acid; MMF, mycophenolate mofetil.





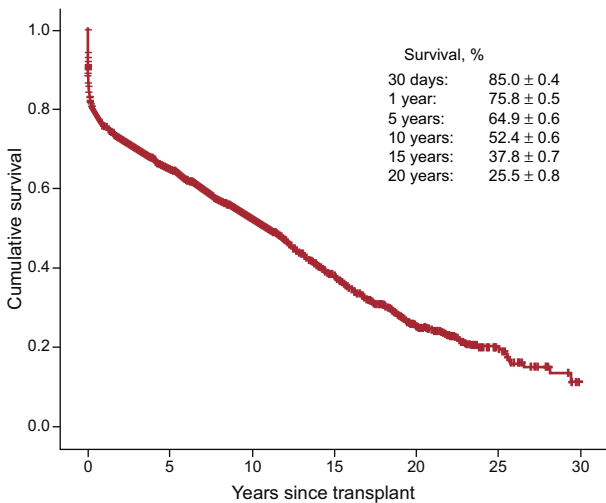
**Figure 12.** Annual changes in use of mTOR inhibitors (sirolimus and everolimus) in initial immunosuppression in the total sample (1984-2014). The differences in values compared with reports from previous years are due to rounding or to differences owing to the continued updating of the database by participating groups.

(12.5%) (Figure 20). Cause of death changed depending on time post-transplant (Figure 20). In the first post-transplant month, almost 50% of deaths were due to primary graft failure. From 1 month to 1 year post-transplant, the most common causes of death were acute rejection (15.6%) and, above all, infection (35.4%). After the first year, the most common causes were the different manifestations of vascular disease of the graft (29.5%), and tumors (21.3%). Over time, the main causes of death in the first year have changed significantly, with more deaths due to primary graft failure and fewer deaths due to acute rejection (Figure 21). However, between the first and fifth years post-transplant, only deaths due to vascular disease of the graft/sudden death have decreased significantly, while deaths due to acute rejection have increased (Figure 22).

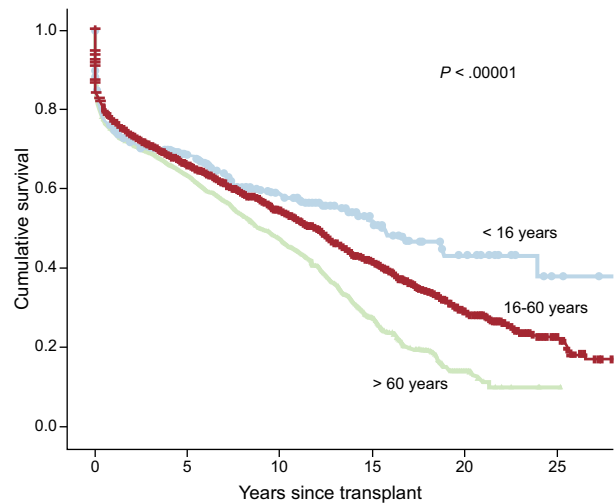
**DISCUSSION**

Heart transplantation activity in Spain in 2014 has remained stable compared with recent years, after the appreciable reduction at the beginning of the century. The present report confirms the trend in procedure characteristics observed over the past 5 years, we toward recipients with complex clinical profiles, a high proportion of emergency transplantations, a high percentage of suboptimal donors, and relatively long ischemia times. Despite these generally unfavorable circumstances, the mortality outcomes from Spanish teams have remained stable, and we have even started to see a trend toward improved mortality at mid-term follow-up.

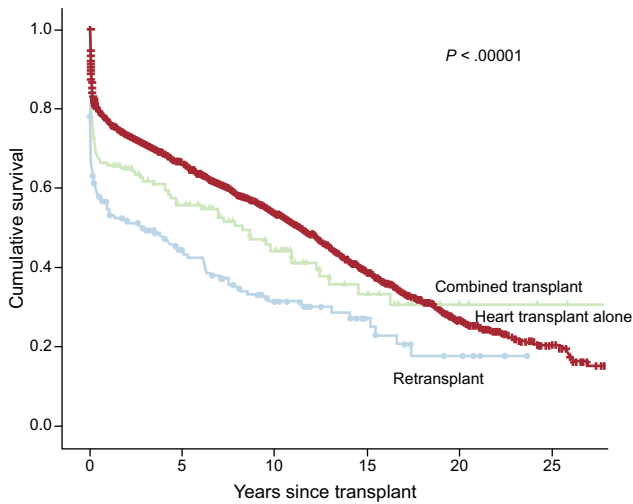
Approximately 1 in every 5 transplants in Spain is to a recipient with some sort of circulatory assist device, equally divided



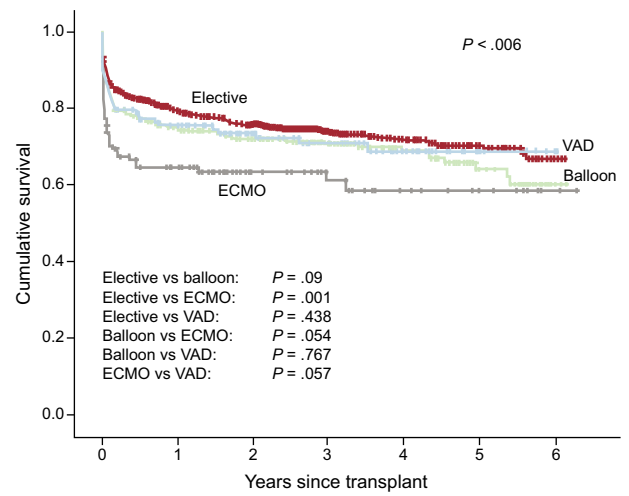
**Figure 13.** Overall survival curve for the whole series.



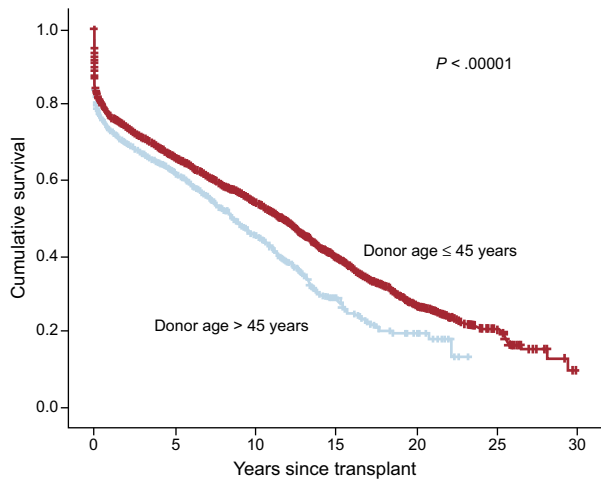
**Figure 14.** Survival curve comparison by recipient age at time of transplant (< 16 years, 16-60 years, and > 60 years).



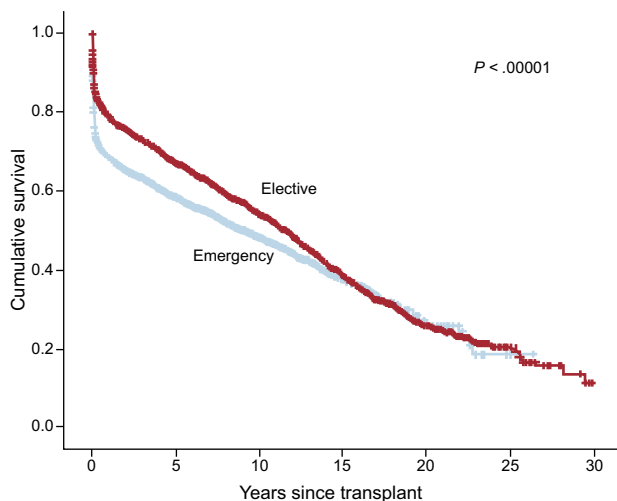
**Figure 15.** Survival curve comparison for heart transplant alone; combined heart and kidney, liver, or lung transplant; and heart retransplantation.



**Figure 18.** Survival curve comparison between elective transplantations, emergency transplantations without ventricular assistance, and emergency transplantations with ventricular assistance (2009-2014). ECMO, extracorporeal membrane oxygenation; VAD, ventricular assist device.



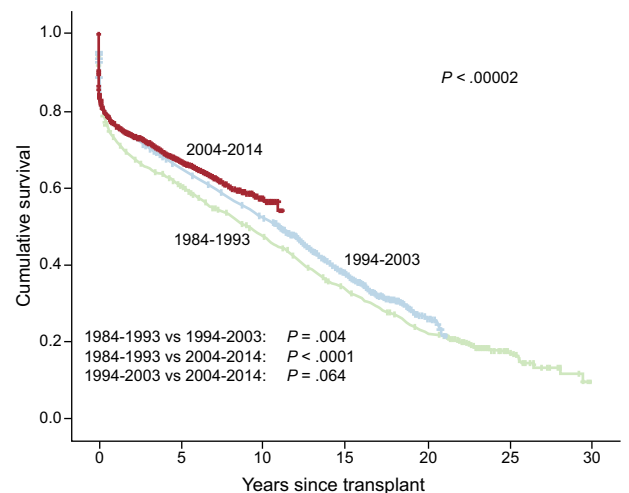
**Figure 16.** Survival curve comparison for heart transplant by donor age.



**Figure 17.** Survival curve comparison between elective and emergency transplantations.

between ECMO and circulatory assist devices (pulsatile, or usually continuous). The growing use of circulatory assistance prior to transplantation is a worldwide trend, as shown by data from the registry of the International Society for Heart and Lung Transplantation,<sup>26</sup> and has been common practice in Spain since 2009. Our analysis reveals that stabilization of the most severely unwell patients with ventricular assist devices achieves excellent early and mid-term results, close to those obtained in elective transplantation. However, in our series, the prognosis of recipients supported with ECMO was significantly less favorable, a finding similar to other population analyses.<sup>27,28</sup> All these findings seem to indicate that use of ECMO is probably more appropriate as a bridge to decision than as a bridge to transplantation, in which case the device should be upgraded to a longer-term device.

Significant changes were also evident in the donor characteristics. In particular, the number of older donors and the proportion of donors considered suboptimal (age > 45 years) have increased since the first years of transplantation. In 2014, donor age peaked at a mean age of 44 years, and 54% of donors were suboptimal. This



**Figure 19.** Survival curve comparison of the total sample by period of transplantation (10-year intervals since 1984).

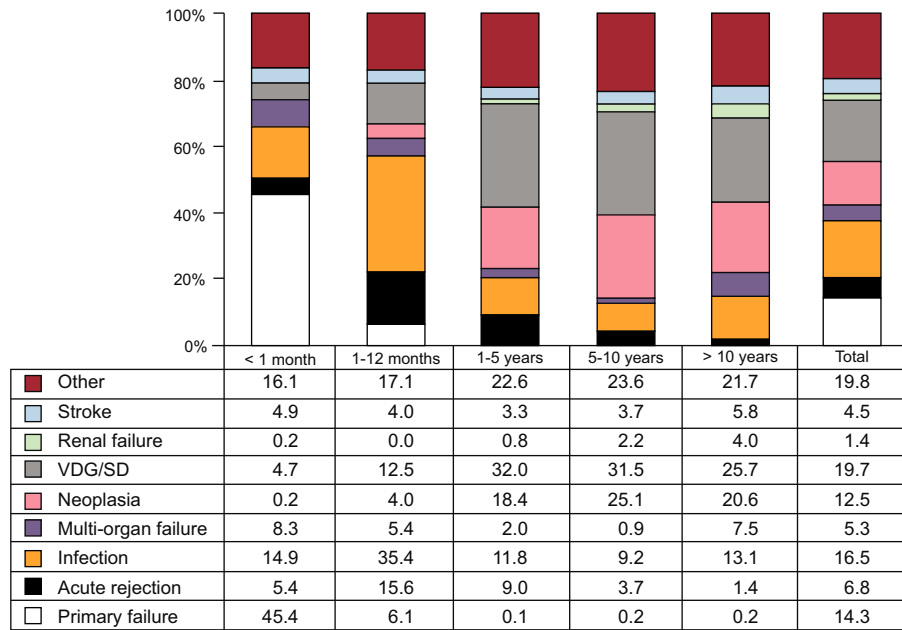


Figure 20. Causes of death, by time since transplantation and in the whole series (1984-2014). SD, sudden death; VDG, vascular disease of the graft.

reflects the effort of Spanish teams to offer a clinically effective therapeutic option at a time when donors are relatively scarce and also in worse condition. However, the prognostic effect of such variables must be taken into account when analyzing the outcomes of our programs, especially in the mid- and long-term.

Survival curve analysis shows that despite the increasingly complex clinical circumstances of current transplantations, early mortality remains at a level similar to that of previous periods and is comparable to that reported in the international registry for similar periods.<sup>26</sup> It is also noteworthy that in patients who received a transplant in the past decade, from the third or fourth year post-transplant, they have an almost significantly better survival than patients who received a transplant in the decade immediately prior. A cause of death analysis might offer some keys to these findings. In the first post-transplant year, the proportion of deaths due to primary graft failure has increased significantly, which is not surprising given the worse conditions of recipients at the time of transplantation (ongoing widespread use of ECMO as

circulatory support instead of ventricular assist devices,<sup>29,30</sup> worse hemodynamic status,<sup>31</sup> longer ischemia times, and use of suboptimal donors). This increase is compensated, however, by better control of acute severe rejection, which has gone from being the cause of death in 27% in the first decade of the series, to 10% in the most recent decade, without an increase in fatal infections (due to improved diagnosis, prophylaxis, and treatment of infections). In deaths occurring between the first and fifth year, there was a significant reduction in those due to vascular disease of the graft and sudden death (a common manifestation of vascular disease in this post-transplant period). Undoubtedly, Spanish teams practice an aggressive diagnostic strategy toward this serious and limiting post-transplant complication, and above all, implement known effective treatments against this disease, such as the universal use of statins from the time of transplantation in immunosuppressed individuals. In this regard, we must highlight the predominant use of tacrolimus as a calcineurin inhibitor. Tacrolimus has a differential action from that of cyclosporin on microvascular disease

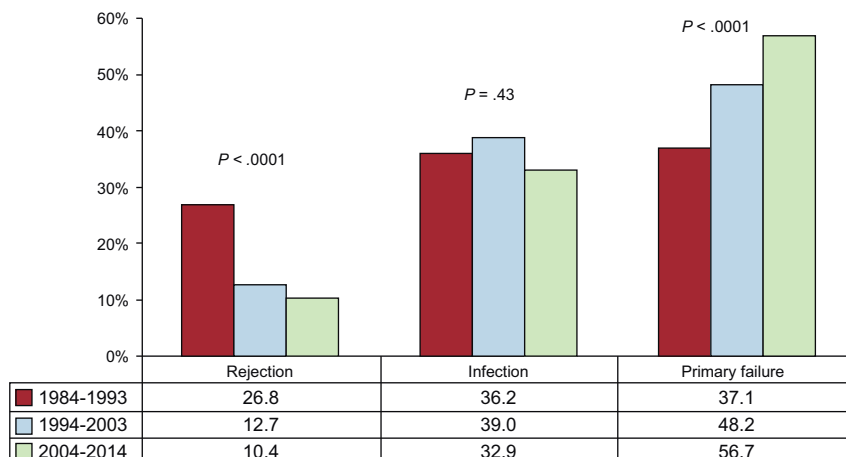
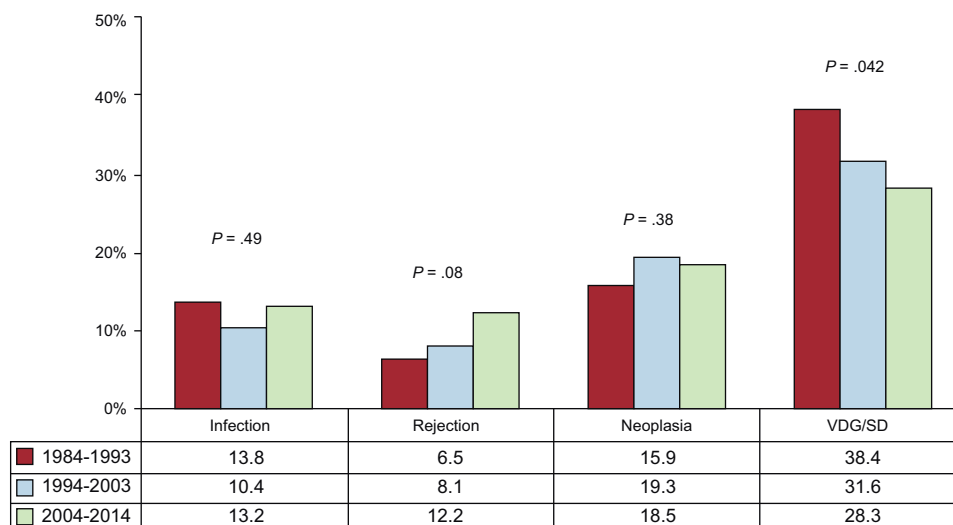


Figure 21. Causes of death in first year after transplantation in the whole series (1984-2014).



**Figure 22.** Cause of deaths occurring in the first year and fifth year after transplantation in the whole series (1984–2014). SD, sudden death; VDG, vascular disease of the graft.

and remodeling of epicardial coronary arteries of the graft<sup>32</sup> and on the cardiovascular risk profile.<sup>33</sup> The same can be said for the use of mycophenolate compared with azathioprine.<sup>34</sup> In this regard, the widespread use of mTOR inhibitors (mainly everolimus)<sup>35</sup> is particularly relevant, at 28% of patients during follow-up.

## CONCLUSIONS

Cardiac transplantation activity in Spain has remained stable in recent years, with around 250 procedures per year. Despite the worsening and complexity of the current clinical setting (use of suboptimal donors, mechanical circulatory support), Spanish teams have managed to maintain mortality outcomes, with a progressive improvement in mid-term prognosis.

## ACKNOWLEDGEMENTS

We acknowledge the statistical support given by ODDS, S.L.

## FUNDING

The Spanish Heart Transplantation Registry is partially funded by an unconditional grant from Novartis.

## CONFLICTS OF INTEREST

F. González-Vílchez receives remuneration from Roche and Astellas for participating in the follow-up and statistical analysis committee, and for educational papers and presentations; and from Roche, Astellas, and Novartis for travel expenses. A. Villa receives a grant from St. Jude Medical and has received remuneration from St. Jude Medical for educational papers and presentations. J. Segovia has received remuneration from Novartis and Roche for educational papers and presentations.

## APPENDIX. COLLABORATORS IN THE SPANISH HEART TRANSPLANTATION REGISTRY 1984-2014

Clínica Universitaria Puerta de Hierro, Majadahonda, Madrid	Manuel Gómez-Bueno, Francisco Hernández Pérez, Luis Alonso-Pulpón, Alberto Forteza Gil, Santiago Serrano-Fiz, Raúl Burgos Lázaro, Carlos García Montero, and Evaristo Castedo Mejuto
Hospital Universitario y Politécnico La Fe, Valencia	Ignacio Sánchez-Lázaro, Luis Martínez-Dolz, Mónica Cebrián Pinar, and Soledad Martínez Penades
Hospital Universitario de A Coruña, A Coruña	María J. Paniagua-Martín, Eduardo Barge-Caballero, José J. Cuenca-Castillo, Francisco Estévez-Cid, and Gonzalo Barge-Caballero
Hospital Universitario Reina Sofía, Córdoba	Amador López-Granados and Juan Carlos Castillo-Diéguez
Hospital Universitario Marqués de Valdecilla, Santander	Manuel Cobo, Miguel Llano-Cardenal, José A. Vázquez de Prada, and Francisco Nistal Herrera
Hospital Gregorio Marañón (adultos), Madrid	Manuel Martínez Sellés, Juan Fernández-Yáñez, Iago Sousa, and Pablo Díez
Hospital Universitario 12 de Octubre, Madrid	Miguel Ángel Gómez Sánchez and Laura Morán Fernández
Hospital de la Santa Creu i Sant Pau, Barcelona	Viçens Brossa, Sònia Mirabet, and Laura López
Hospital Universitario Virgen del Rocío, Seville	Diego Rángel Sousa and José Manuel Sobrino
Hospital Universitario de Bellvitge, L'Hospitalet de Llobregat, Barcelona	Nicolás Manito, Josep Roca-Elías, and Joel Salazar-Mendiguchía
Clínica Universitaria de Navarra, Pamplona	Cristian Delgado Domínguez and Ignacio Bibiloni Lage
Hospital Clínic Universitari, Barcelona	M. Ángeles Castel, Marta Farrero, and Ana García-Álvarez
Hospital Universitario Central de Asturias, Oviedo	José Luis Lambert, Beatriz Díez de Molina, and María José Bernardo Rodríguez
Hospital Universitario Gregorio Marañón (infantil), Madrid	Manuela Camino and Constanancio Medrano
Hospital Universitario Virgen de la Arrixaca, El Palmar, Murcia	Domingo Pascual-Figal, Iris Garrido-Bravo, and Francisco Pastor Pérez
Hospital Universitario Miguel Servet, Zaragoza	Teresa Blasco-Peiró, Marisa Sanz-Julvé, and Ana Pórtoles Ocampo
Hospital Clínic Universitario, Valladolid	Luis de la Fuente Galán, Javier López Díaz, and Ana María Correa Fernández
Hospital Universitario La Paz, Madrid	Luis Guereta, Luz Polo, and Carlos Labrandero
Hospital Universitario Vall d'Hebron, Barcelona	Dimpna C. Albert Brotons, Ferrán Gran Ipiña, and Raúl Abella

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