

## Notifications and donors of organs and tissues for transplantation: discard and cost estimates for the public health system

Notificações e doações de órgãos e tecidos para transplante: descarte e custos estimados para o sistema público de saúde

Notificaciones y donantes de órganos y tejidos para trasplante: disposición y costos estimados para el sistema de salud pública

Rosane Almeida de Freitas<sup>1</sup>, Cátia Millene Dell Agnolo<sup>1</sup>, Willian Augusto de Melo<sup>2</sup>, Rafael Rodrigo da Silva Pimentel<sup>3</sup>, Lucas Vinícius de Lima<sup>1</sup>, Sandra Marisa Pelloso<sup>1</sup>, Maria Dalva de Barros Carvalho<sup>1</sup>.

### ABSTRACT

**Objective:** Analyze the number of discards of organs and tissues from patients with Brain Death in the state of Paraná and estimate the financial costs for the health system. **Methods:** Exploratory cross-sectional retrospective study. All deaths occurred in the state of Paraná, Brazil, from 2011 to 2015. **Results:** A total of 1,013 patients were studied; the number of donors for single organs was 1,013, and the number of donors for paired tissues/organs was 2,026. Approximately 34.5% of transplant costs were associated with discards. Discards of corneas (30.0%) and eyeballs (93.5%) increased over the course of the study period. Heart, lung, and pancreas discards remained relatively stable. There was a 100% increase in liver discards, and the number of discarded kidneys increased from 9 in 2011 to 60 in 2015. The heart had the lowest discard percentage (0.8%). **Conclusion:** Discards of corneas and eyeballs were high, especially in older age groups, suggesting that procurement could have been avoided. Liver and kidney discards increased considerably. Studies of this nature should be carried out to evaluate the quality and effectiveness of the donation and transplantation processes, as well as the outcomes in terms of financial costs to the public system.

**Keywords:** Organ donation, Tissue donation, Organ transplantation, Tissue and organ procurement, Cost analysis.

### RESUMO

**Objetivo:** Analisar o número de descartes de órgãos e tecidos de pacientes em Morte Encefálica no estado do Paraná e estimar os custos financeiros para o sistema de saúde. **Métodos:** Estudo exploratório, transversal, retrospectivo. Todos os óbitos ocorreram no estado do Paraná, Brasil, de 2011 a 2015. **Resultados:** Foram estudados 1013 pacientes; o número de doadores para órgãos únicos foi de 1013 e o para tecidos/órgãos pareados foi de 2.026. Aproximadamente 34,5% dos custos de transplante foram associados a descartes. Descartes de córneas (30,0%) e globos oculares (93,5%) aumentaram ao longo do período de estudo. Os descartes de coração, pulmão e pâncreas permaneceram relativamente estáveis. Houve um aumento de 100% nos descartes de fígado, e o número de rins descartados aumentou de 9 em 2011 para 60 em 2015. O coração teve o menor percentual de descarte (0,8%). **Conclusão:** Os descartes de córneas e globos oculares foram elevados, principalmente em faixas etárias mais avançadas, sugerindo que aquisição poderia ter sido evitada. As devoluções de fígado e rim aumentaram consideravelmente. Estudos dessa natureza devem ser realizados para avaliar a qualidade e eficácia dos processos, bem como os resultados em termos de custos financeiros para o sistema público.

**Palavras-chave:** Doação de órgãos, Doação de tecidos, Transplante de órgãos, Aquisição de órgãos e tecidos, Análise de custos.

<sup>1</sup> State University of Maringá (UEM), Maringá - PR.

<sup>2</sup> State University of Paraná (UNESPAR), Paranavaí - PR.

<sup>3</sup> State University of São Paulo (USP), São Paulo - SP.

## RESUMEN

**Objetivo:** Analizar el número de descartes de órganos y tejidos de pacientes con Muerte Encefálica en Paraná y estimar los costos financieros para el sistema de salud. **Métodos:** Estudio exploratorio, transversal, retrospectivo. Todas las muertes ocurrieron en Paraná, Brasil, de 2011 a 2015. **Resultados:** Fueron estudiados 1013 pacientes; el número de donantes de órganos individuales fue de 1013 y de emparejados fue de 2026. Aproximadamente el 34,5% de los costos de trasplante se asociaron con descartes. Descartes de córneas (30,0%) y globos oculares (93,5%) aumentaron a lo largo del período de estudio. Los descartes de corazón, pulmón y páncreas se mantuvieron relativamente estables. Hubo un aumento del 100% en los descartes de hígado y el número de riñones descartados aumentó de 9 en 2011 a 60 en 2015. El corazón tuvo el porcentaje de descarte más bajo (0,8%). **Conclusión:** Los descartes de córneas y globos oculares fueron altos, especialmente en los grupos de mayor edad, lo que sugiere que se podría haber evitado la adquisición. Los retornos hepáticos y renales han aumentado. Estudios de esta naturaleza pueden evaluar la calidad y eficacia de los procesos, así como los resultados en términos de costes económicos para el sistema público.

**Palabras clave:** Donación de órganos, Donación de tejidos, Trasplante de órganos, Obtención de tejidos y órganos, Análisis de costos.

---

## INTRODUCTION

Brazil is a world reference in transplants and currently has the largest public health system in the world, the Unified Health System (MINISTÉRIO DA SAÚDE, 2018). This system ranks second in the world, after the United States, in absolute number of transplants. In recent years, Brazil has seen an increase in effective donors, from 10.7 per million population (pmp) in 2011 to 14.1 pmp in 2015 and 16.6 pmp in 2017 (BRAZILIAN TRANSPLANTATION REGISTRY, 2017).

Between 2010 and 2017, there was a 69% increase in the number of effective donors in the country. Of the 27 states in Brazil, those with the highest number of effective donors in 2017 were Santa Catarina, with 40.8 pmp, followed by Paraná, with 38.0 pmp. In these two states, donations increased by 10.9% and 26.2%, respectively (BRAZILIAN TRANSPLANTATION REGISTRY, 2017). Approximately 96% of all transplant procedures in the country are funded by the Brazilian Unified Health System through comprehensive and cost-free care to the patient (MINISTÉRIO DA SAÚDE, 2018a).

In 2017, Paraná ranked first in transplantations in Brazil, with a total of 52.9 organs pmp, of which 41.2 pmp were from deceased donors and 11.7 pmp from live donors (BRAZILIAN TRANSPLANTATION REGISTRY, 2017).

One of the major impediments to organ transplantation is the availability of viable organs, either because of the lack of donation or the quality of donated organs. Many changes have been made to increase the number of organs available for donation; the most notable example is the acceptance of marginal organs, i.e., organs from patients with hepatitis B. However, despite the increase in the number of donors, many discards have been observed during the procurement process, making systems-based improvements necessary in pre-procurement assessment of organs and post-procurement preservation (KIM KH et al., 2019).

Although transplantations represent a significant achievement of twentieth-century medicine for the treatment of organ failure, the maintenance and growth of transplantation is threatened by the high financial costs, and strategies to reduce costs are needed (AXELROD DA, et al., 2017).

Therefore, this study aimed to analyze the number of discards of organs and tissues from patients with Brain Death (BD) in the state of Paraná and estimate the financial costs for the health system.

## METHODS

This is an exploratory cross-sectional and retrospective study on donation, procurement, discarding, and transplantation of organs and tissues from patients with BD and on the financial costs to the health system in the state of Paraná, from 2011 to 2015.

Brazil is a developing country located in South America, with a surface area of 8,514,876.60km<sup>2</sup> and an estimated population of 206,081,432 people in 2017. It has a well-structured and consolidated system for organ transplants, and rates of transplantation have increased in recent years. However, there are also size able disparities between states and regions (BRAZILIAN TRANSPLANTATION REGISTRY, 2017).

Paraná has a population of 11,242,720 inhabitants and is in the South region of Brazil, which ranks third in population (29.4 million inhabitants) and ranks first in the number of effective donors (34.1 pmp).

The data was sourced from the database of the State Transplant Center of Paraná, which compiles reports sent by the Organ Procurement Organizations (OPO) and prepared by the Intra-Hospital Commissions for Organ and Tissue Donation for Transplantation, which belong to the State Transplant Center of Paraná.

It was included data on donation, procurement, non-procurement, transplantation, and discarding of organs and tissues in Paraná, from 2011 to 2015, considering the age limit for each organ/tissue. Data on heart valves, bones and skin were excluded because there were no available informations.

The data were organized in a Microsoft Excel 2010 spreadsheet and analyzed using Epi Info software, version 7.2.1. Data were described using simple descriptive statistics, which allowed the calculation of absolute and relative frequencies for the variables considered.

To estimate the costs of transplants, we used spreadsheets from the Management System for the Table of Procedures and Medicines and the Department of Informatics (MINISTÉRIO DA SAÚDE, 2018), which provides data for each stage of the donation and transplantation process in Brazilian *reais* (BRL). Cost data were converted into US dollars (US\$) using the exchange rate on the last day of this research study, which equated US\$ 1.00 to BRL 3.90, according to the Central Bank of Brazil (MINISTÉRIO DA SAÚDE, 2015).

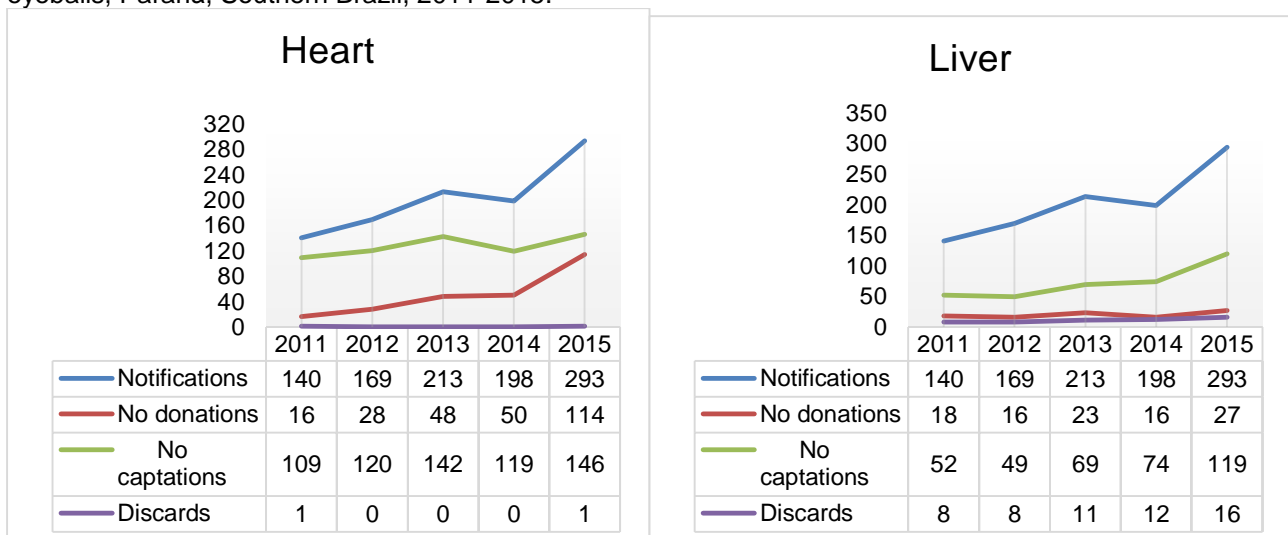
The research was approved by the Research Ethics Committee of the State University of Maringá under number 1.470.684.

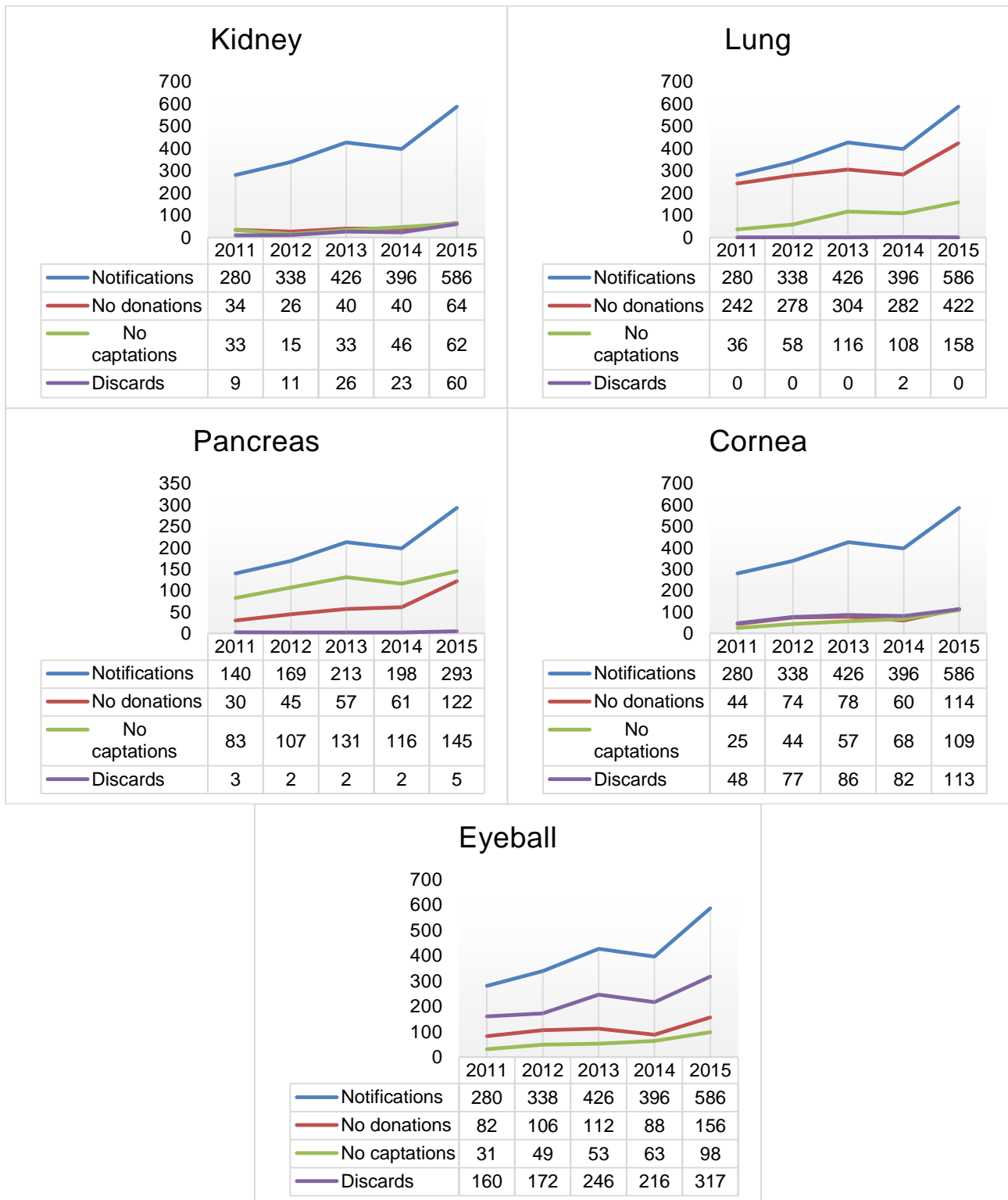
## RESULTS

A total of 1,013 patients with BD were studied (single organs), with 2,026 donations of paired tissues/organs. All organs/tissues showed an increase of notifications over the period, but it could be observed that there was an increase in the number of non-donations and non-captation (**Figure 1**).

Also, there was a progressive increase in the discard rates for corneas and eyeballs during the years studied. Lung and pancreas discards remained relatively stable, while liver discards increased by 100%. The number of discarded kidneys jumped from 9 in 2011 to 60 in 2015 (**Figure 1**).

**Figure 1** - Number of notifications, no donations, no captations, and discarded organs, corneas, and eyeballs, Paraná, Southern Brazil, 2011-2015.





Source: Freitas RA, et al., 2022.

Among the tissues and organs studied, the highest donation percentage was observed for liver (90.1%), followed by kidneys (89.9%) and the corneas (81.7%). Regarding the organs/tissues non-procured, the lungs (95.6%), the heart (84.0%) and the pancreas (83.4%) stood out (Table 1).

As for the discard percentage, it was observed highest percentage for eyeballs (93.5%), followed by corneas (30.0%) and the pancreas (12.1%). The heart was the organ with the lowest discard rate (0.8%) (Table 1).

**Table 1** - Data on donation, procurement, non-procurement, transplantation, and discarding of organs, corneas, and eyeballs, Paraná, Southern Brazil, 2011-2015

Organs/ Notifications	Donated		Procured		Non-procured		Transplanted		Discarded	
	n	%	n	%	n	%	n	%	n	%
Heart=1013	757	74.7	121	16.0	636	84.0	120	99.2	1	0.8
Lung=2026	498	24.6	22	4.4	476	95.6	20	90.9	2	9.1
Kidneys=2026	1822	89.9	1633	89.6	189	10.4	1504	92.1	129	7.9
Liver=1013	913	90.1	550	60.2	363	39.8	495	90.0	55	10.0
Pancreas=1013	698	68.9	116	16.6	582	83.4	102	87.9	14	12.1
Corneas=2026	1656	81.7	1353	81.7	303	18.3	947	70.0	406	30.0
Eyeballs=2026	1482	73.1	1188	80.2	294	19.8	77	6.5	1111	93.5

**Source:** Freitas RA, et al., 2022.

The corneas and the eyeballs of donors aged 50 to 64 years old were among the most frequently discarded tissues. This age group also had the highest discard rate for all organs, except for the pancreas (the highest discard rate was in the 18-to-34 age group) and the heart; only one heart in this age group was discarded (**Table 2**).

**Table 2** - Distribution of discarded (procured, but not transplanted) organs and tissues by age group, Paraná, Southern Brazil, 2011-2015.

Organs/tissues Age group (years)	Heart		Lung		Kidneys		Liver		Pancreas		Corneas		Eyeball	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
< or = 5	-	-	-	-	-	-	2	3.6	-	-	1	0.2	4	0.3
6 to 10	-	-	-	-	-	-	1	1.8	-	-	5	1.2	8	0.7
11 to 17	-	-	2	100	3	2.3	-	-	2	14.3	25	6.2	61	5.5
18 to 34	1	100	-	-	9	7.0	8	14.5	8	57.1	112	27.6	314	28.3
35 to 49	-	-	-	-	28	21.7	13	23.6	1	7.1	91	22.4	321	28.9
50 to 64	-	-	-	-	51	39.5	23	41.8	3	21.4	127	31.3	325	29.3
= or > 65	-	-	-	-	38	29.5	8	14.5	-	-	45	11.1	78	7.0
<b>Total</b>	<b>1</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>129</b>	<b>100</b>	<b>55</b>	<b>100</b>	<b>14</b>	<b>100</b>	<b>406</b>	<b>100</b>	<b>1111</b>	<b>100</b>

**Source:** Freitas RA, et al., 2022.

Overall, 85.3% of eyeballs were discarded because the available stock met the existing demand. The most frequent reason for discarding corneas was quality (39.4%), followed by shelf life (35.7%). Clinical contraindications were the main discard reasons for liver (45.5%), pancreas (35.7%), and kidney donations (34.1%) (**Table 3**).

It is worth mentioning that, despite being low, reasons for disposal related to logistical and operational problems are still perceived, with emphasis on the kidneys (16.3%), liver (7.3%) and corneas (6.7%) (**Table 3**).

**Table 3** - Distribution of discard causes for corneas, eyeballs, and organs compared to the total procured, Paraná, Southern Brazil, 2011-2015

Reason	Heart		Lung		Kidneys		Liver		Pancreas		Corneas		Eyeball	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Clinical contraindication	-	-	-	-	44	34.1	25	45.5	5	35.7	49	12.1	19	1.7
Serology	-	-	-	-	-	-	-	-	-	-	15	3.7	14	1.3
Maintenance/ischemia time	-	-	-	-	42	32.6	10	18.2	3	21.4	-	-	-	-
Technical/logistical problems	-	-	-	-	21	16.3	4	7.3	-	-	27	6.7	12	1.1
Rejection of organ	-	-	-	-	13	10.1	8	14.5	2	14.3	-	-	-	-
No recipient	-	-	-	-	5	3.9	5	9.1	4	28.6	-	-	-	-
Quality	-	-	-	-	1	0.8	1	1.8	-	-	160	39.4	48	4.3
Shelf life	-	-	-	-	-	-	-	-	-	-	145	35.7	32	2.9
Stock meeting demand	-	-	-	-	-	-	-	-	-	-	-	-	948	85.3
Other causes	1	100	2	100	3	2.3	2	3.6	-	-	10	2.5	38	3.4
<b>Total</b>	<b>1</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>129</b>	<b>100</b>	<b>55</b>	<b>100</b>	<b>14</b>	<b>100</b>	<b>406</b>	<b>100</b>	<b>1111</b>	<b>100</b>

Source: Freitas RA, et al., 2022.

**Table 4** provides an estimate of the financial costs associated with organ, cornea, and eyeball discards in the state of Paraná. The most expenses for discards were observed on eyeball transplantations (93.5%). Overall, the expenses accounted 34.5% of the founding for transplantations in Paraná during the years analyzed.

**Table 4** - Estimate of financial costs associated with discarded organs, corneas, and eyeballs, Paraná, Southern Brazil, 2011-2015

Organs/tissues	Procured		Expenses for discards		
	n	Value US\$	n	%	Value US\$
Heart	121	37,386.58	1	0.8	308.98
Lung	22	13,657.60	2	9.1	1,241.60
Kidneys	1633	504,564.34	129	7.9	39,858.42
Liver	550	416,735.00	55	10.0	41,673.50
Pancreas	116	87,893.20	14	12.1	10,607.80
Corneas	1353	134,014.65	406	30.0	40,214.30
Eyeball	1188	255,182.40	1111	93.5	238,642.80
<b>General</b>	<b>4983</b>	<b>1,449,433.77</b>	<b>1718</b>	<b>34.5</b>	<b>372,547.40</b>

Source: Freitas RA, et al., 2022.

## DISCUSSION

It was possible to observe that despite the increase in the number of notifications of organs and tissues for transplantation, the rates of non-donated and non-captured organs/tissues increased in the analyzed period, with emphasis on eyeballs and corneas. Moreover, expenditure estimates for discarded organs/tissues accounted for 34.5% of the funding for transplantation.

Despite the advances observed in the country regarding the rates of organ transplantation, there are still logical and operational barriers that compromise the process and need to be overcome by public health programs, such as observed in our results (COELHO GHF, et al., 2019).

Organ transplantation is growing despite a global climate of cost containment. Thus, studies analyzing the economic and financial implications of the quality and distribution of donated organs are crucial for transplant managers (AXELROD DA, et al., 2017). Moreover, the scarcity of studies and, consequently, the lack of knowledge about the factors that contribute to the high rates of organ discard are cause for worldwide concern (MATAS AJ, et al., 2013).

Our study showed a progressive increase in discarded corneas and eyeballs, which agrees with national data. The discard rate over the five years studied was 30.0% for corneas, which is lower than the national average (37.0%) and the average for the South Region of the country (44%), where Paraná is located (AGÊNCIA NACIONAL DE VIGILÂNCIA SANITÁRIA, 2017).

Studies from other regions showed slightly lower numbers. The Northeast region reported 28.2% discard rate, and a tissue bank from the same region reported a rate of 21.9% over 15 months of follow-up (FREIRE IL, et al., 2015; FREIRE ILS, et al., 2014); in some other Brazilian eye-banks, cornea discard rates were even lower, ranging from 10% to 17.0% (AGÊNCIA NACIONAL DE VIGILÂNCIA SANITÁRIA, 2017). Worldwide, approximately 100,000 corneal transplantations are performed per year, which makes corneas the most transplanted tissue (LAMM V, et al., 2014). Even so, corneas remain scarce. A study found that there is only one cornea available for every 70 cornea requests (GAIN T, et al., 2016).

According to our data, quality was the main reason for discarding corneas (39.4%), followed by expired shelf life (35.7%). In another study in the Northeast region of Brazil, poor tissue quality accounted for 31.1% of discards, followed by stromal infiltrate (23.2%) and positive anti-HBc serology (20.5%) (FREIRE IL, et al., 2014). In Brazil, the main reasons for discarding corneas were shelf life (12.7%) and anti-HBc serology (7.4%), followed by inappropriate quality (4.3%) and HBsAg serology (2.4%) (AGÊNCIA NACIONAL DE VIGILÂNCIA SANITÁRIA, 2017).

It is known that quality is one of the main factors associated with refusal, and quality is higher in the corneas of young donors. One way to improve tissue quality and thus reduce refusal would be to limit the donor's age. However, it is worth noting that the decision to reduce the quality of tissue donors requires an analysis of the number of patients waiting for a transplant and the number of tests provided for transplantation. In the waiting states (each technician) has many positive numbers, with positive numbers, they are not recommended in the breeder's age list, as they are reduced, although they increase the tissue of the captured value, although they are made available for the optical lenses available (PESSOA JLE, et al., 2019).

Corneal tissue quality may be affected by inadequate corneal preservation during patient hospitalization (FREIRE IL, et al., 2014). A Brazilian study carried out in intensive care units showed that 59.4% of hospitalized patients had corneal lesions, primarily punctate lesions (55.1%) and corneal ulceration (11.8%) (WERLI-ALVARENGA A, et al., 2011). Thus, maintaining eye lubrication and palpebral closure during hospitalization is essential to maintain ocular tissue quality (FREIRE IL, et al., 2014). The process of evaluating potential corneal donors must be changed to reduce losses and costs (FREITAS RA, et al., 2019).

In our study, corneas from donors aged 50 to 64 years old had the highest discard rate (31.3%). Among all donors 50 years or older, the discard rate increased to 42.4%. This rate is similar to that reported in other regions of the country (45.4% – Northeast) (FREIRE IL, et al., 2014). The number of young donors has been decreasing worldwide because of population aging. In this context, the number of donors aged 50 and over has been increasing over the last decade (ALTINKURT E, et al., 2021).

However, what truly stood out in our research was the increase in discarded eyeballs over the years studied. We observed a mean increase of 93.5%, which contrasted with national-level data showing a stable discard rate for eyeballs (AGÊNCIA NACIONAL DE VIGILÂNCIA SANITÁRIA, 2017). It should be noted that the main cause for eyeball discards in our study was that the stock met the demand (85.3%); that is, procurement was not justified.

Among the evaluated organs, the heart, lung and pancreas had stable discard rates, whereas there was a 100% increase in liver discards. It is worth noting that the number of discarded kidneys jumped from 9 in 2011 to 60 in 2015.

The kidney discard rate in our study was 7.9%, which is lower than the rate reported in other developed countries such as the United States (17.3% from 2000 to 2015) (MOHAN S, et al., 2018) and the United Kingdom (12%), although the organs were from deceased donors (CALLAGHAN CJ, et al., 2014); however, the kidney discard rate in our study was higher than that in other countries, such as Saudi Arabia (5.0%) (HEJAILI F, et al., 2017).

The proportion of discarded kidneys has increased in the United States, the causes of which are not yet fully understood. Approximately 17.3% of procured kidneys were discarded, with an increase from 4.9% in 2000 to 19.0% in 2015 (MOHAN S, et al., 2018). The main reasons for discarding kidneys in our study were clinical contraindications (34.1%), that could be better evaluated prior to procurement; followed by maintenance and time of ischemia (32.6%), which can be improved; and technical/logistical problems (16.3%), that can be avoided.

Rejection of the kidney and the lack of a recipient accounted for 11.6% and 5.3% of discards, respectively, in our study; however, we do not know whether these organs were from marginal donors. Other sites have reported rates and lower than ours (Saudi Arabia; 6.7%) (HEJAILI F, et al., 2017). Organ shortage is one of the biggest challenges in the field of organ transplantation. Furthermore, the percentage of discarded kidneys continued to rise to 20% (COOPER M, et al., 2018).

In the United States, the primary reason for discarding kidneys was that there was “no recipient identified”, which indicates a possible failure to properly distribute these kidneys to centers/patients that accept marginal organs (MOHAN S, et al., 2018). No one knows for sure whether the discarding of kidneys has resulted in greater rigor in the selection of organs by the transplant centers or other systemic causes (SCHOLD JD, et al., 2013; MOHAN S, et al., 2016; MATAS AJ, et al., 2014).

A study conducted in the United States showed considerable geographic variation in discard rates, which reinforces the conclusion that factors other than organ quality may contribute to kidney discards (MOHAN S, et al., 2018). This finding demonstrates the need for regional studies, especially in countries with an extensive geographical area such as Brazil.

Donors of lower-quality kidneys are described as marginal and have been the focus of several studies in recent years; however, there are still controversies. Some authors argue that the transplantation of lower-quality kidneys is safe, and recipients may have superior outcomes compared to patients on dialysis (BAE S, et al., 2016; PATZER RE PASTAN SO, 2014; GANDOLFINI I, et al., 2014). Another study in the United States found a higher number of marginal donors among donors of discarded organs during a 15-year follow-up period (MOHAN S, et al., 2018).

When comparing the frequency of discards between marginal donors (36.2%) and standard donors (16%) in Saudi Arabia, a higher percentage was observed in the former group, and these findings were statistically significant (HEJAILI F, et al., 2017). In the US, kidneys from donors who were older, female, black, obese, diabetic, hypertensive, or positive for the hepatitis C virus (HCV) were significantly more likely to be discarded, as were those from donors with multiple unfavorable characteristics (MOHAN S, et al., 2018).

From the financial point of view, it is reported that the complexity of renal transplantations is increasing, and costs have thus also increased. The increased complexity and cost of such procedures may make transplants less financially attractive, which can lead to a reduction in organ use in addition to limiting access to transplants for higher-risk populations, especially in countries where the cost of kidney transplantation is not borne by the government (AXELROD DA, et al., 2017). However, previous research on the economics of renal transplantation shows that there are important cost-related savings associated with ending long-term dialysis, even with organs from marginal donors (AXELROD DA, et al., 2017; HELD PJ, et al., 2016).

Due to a shortage of kidneys available for transplantation in the United States, approximately 5,000 to 10,000 renal patients die prematurely each year, in addition to another 100,000 who suffer the



consequences of dialysis treatment. A study that assessed the cost-effectiveness of government compensation to donors concluded that, by compensating kidney donors, the government would save on dialysis costs and improve quality of life for transplant recipients, representing a substantial gain for society at a very small cost (HELD PJ, et al., 2016).

Although the percentage of livers discarded in our study was small, this figure doubled in five years. Previous studies have suggested that liver transplantation poses a major challenge because of the severity of disease-related organ distribution (AXELROD DA, et al., 2017).

The pancreas discard rate was 12.1%, with the main causes being clinical contraindications, maintenance/ischemia and lack of a recipient. These causes are potentially preventable with improvements in patient assessment, the maintenance of potential donors, and the distribution of organs. Studies of pancreas discards are scarce.

Cost data are estimates and may not indicate the exact amount because they are based on payment listings rather than the amount actually paid, as we did not have access to such data for this study. In addition, costs associated with the donation process were not calculated, as organs were obtained from donors with BD, and the same donor could have donated multiple organs, which would have hampered a proper analysis of the costs associated with the donation process.

Thus, the costs of discards are even higher when the costs associated with the donation process are taken into account, in addition to the costs of procurement. Furthermore, the costs associated with marginal donors were not computed, since we did not have this information in our database.

Another important limitation, for which is data not available for this study, is the discard rate of marginal organs compared to no marginal organs, which could provide additional information for a better evaluation of this process.

## CONCLUSION

Discards of corneas and eyeballs were more prevalent in advanced age groups, including cases in that captation should have been avoided. Heart and lung have few discards, probably due to the lower number of viable organs. Liver and kidney had considerable increase in discards. It was observed that discards accounted for approximately 34.5% of transplant costs. The discards bring a burden to the public coffers, since there is a high investment in the whole process from donation to the capture of organs and the final objective, which would be the effective transplantation, to be not reached. This research can help identify flaws in the process that lead to the disposal of organs and generate unnecessary expenses for the public health system, in addition to not reducing the long waiting list for a transplant.

## ACKNOWLEDGMENTS

We thank the State Transplant Center of Paraná and the organ procurement organizations in the state of Paraná for making data available to the researchers.

---

## REFERENCES

1. AGÊNCIA NACIONAL DE VIGILÂNCIA SANITÁRIA. ANVISA. Relatório de avaliação de dados de produção dos bancos de tecidos humanos-2016. 2017. Available at:<http://portal.anvisa.gov.br/documents/4048533/4994360/Relatório+de+Avaliação+dos+Dados+de+Produção+dos+Bancos+de+Tecidos+-+2016.pdf/576a9302-b3d5-4c98-80c1-d88bd33666d6>. Accessed on: October 28, 2018.
2. ALTINKURT E, et al. Analysis of 23 Years of Cornea Donor Data From an Eye Bank in Turkey. *Exp Clin Transplant*, 2021; 19: 1191-1196.
3. AXELROD DA, et al. The changing financial landscape of renal transplant practice: A national cohort analysis. *Am J Transplant*, 2017; 17: 377-389.
4. BAE S, et al. Changes in discard rate after the introduction of the Kidney Donor Profile Index (KDPI). *Am J Transplant*, 2016; 16: 2202-2207.

5. BRAZILIAN TRANSPLANTATION REGISTRY. Official report of Brazilian organ transplantation society. Organ transplantation in Brazil (2010-2017). Year XXIII, n.4, Jan./Dec. 2017. 2017. Available at: <http://www.abto.org.br/abtoV03/Upload/file/RBT/2017/rbt-imprensa-leitura-compressed.pdf>. Accessed October 18, 2018.
6. CALLAGHAN CJ, et al. The discard of deceased donor kidneys in the UK. *Clin Transplant*, 2014; 28: 345-353.
7. COELHO GHF, et al. Doação de órgãos e tecidos humanos: a transplantação na Espanha e no Brasil. *Rev Bioét*, 2019; 27.
8. COOPER M, et al. Report of National Kidney Foundation Consensus Conference to Decrease Kidney Discards. *Clin Transplant*, 2018; 33.
9. FREIRE IL, et al. Harnessing of corneas captured and processed for transplantation in an ocular tissue bank of North-Eastern Brazil. *Rev Gaucha Enferm*. 2014; 35: 14-20.
10. FREIRE ILS, et al. Causes for the discards of corneas collected by the ocular tissues bank from Rio Grande do Norte. *Rev Pesqui: Cuid Fundam Online*, 2015; 7: 1867.
11. FREITAS RA, et al. Do Donated Corneas Become Transplanted Corneas? The Causes of Discard in Southern Brazil. *Cornea*, 2019; 38: 419-425.
12. GAIN P, et al. Global survey of corneal transplantation and eye banking. *JAMA Ophthalmol*, 2016; 134: 167-173.
13. GANDOLFINI I, et al. The Kidney Donor Profile Index (KDPI) of marginal donors allocated by standardized pretransplant donor biopsy assessment: Distribution and association with graft outcomes. *Am J Transplant*, 2014; 14: 2515-2525.
14. HEJAILI F, et al. Trends in deceased donor kidney availability and utilization in the Kingdom of Saudi Arabia. *Exp Clin Transplant*, 2017; 15: 381-386.
15. HELD PJ, et al: A cost-benefit analysis of government compensation of kidney donors. *Am J Transplant*, 2016; 16: 877-885.
16. KIM KH, et al. Current Status of Discarded Grafts in Korean Organ Transplantation. *Transplantation Proceedings*, 2019; 51: 1478-1480.
17. LAMM V, et al. Corneal blindness and xenotransplantation. *Xenotransplantation*, 2014; 21: 99-114.
18. MATAS AJ, et al. OPTN/SRTR 2011 annual data report: Kidney. *Am J Transplant*, 2013; 13: 11-46.
19. MATAS AJ, et al. OPTN/SRTR 2012 annual data report: Kidney. *Am J Transplant*, 2014; 14: 11-44.
20. MINISTÉRIO DA SAÚDE. Banco central do Brasil. Câmbios e capitais internacionais. Taxas de câmbio. Cotações e boletins. 2015. Available at: <https://www4.bcb.gov.br/pec/taxas/port/ptaxnpesq.asp?id=txcotacao>. Accessed on: October 28, 2018.
21. MINISTÉRIO DA SAÚDE. Departamento de informática do SUS. Sistema de gerenciamento da tabela de procedimentos, medicamentos e OPM do SUS (SIGTAP). 2018. Available at: <http://sigtap.datasus.gov.br/tabela-unificada/app/sec/inicio.jsp>. Accessed on: October 28, 2018.
22. MINISTÉRIO DA SAÚDE. Doação de órgãos: Transplantes, lista de espera e como ser doador. 2018. Available at: <http://portalms.saude.gov.br/saude-de-a-z/doacao-de-orgaos>. Accessed on: October 28, 2018.
23. MOHAN S, et al. Factors leading to the discard of deceased donor kidneys in the United States. *Kidney Int*, 2018; 94: 187-198.
24. MOHAN S, et al. The weekend effect alters the procurement and discard rates of deceased donor kidneys in the United States. *Kidney Int*, 2016; 90: 157-163.
25. PATZER RE, PASTAN SO. Kidney transplant access in the Southeast: View from the bottom. *Am J Transplant*, 2014; 14: 1499-1505.
26. PESSOA JLE, et al. Distribuição do tecido ocular no Estado de São Paulo: análise por razões de descarte de córneas. *Rev Lat Am Enfermagem*, 2019; 27.
27. SCHOLD JD, et al. The association of center performance evaluations and kidney transplant volume in the United States. *Am J Transplant*, 2013; 13: 67-75.
28. WERLI-ALVARENGA A, et al. Corneal injuries: Incidence and risk factors in the Intensive Care Unit. *Rev Lat Am Enfermagem*, 2011; 19: 1088-1095.