Epidemiology of corneal transplantation before achieving the Zero Queue

Epidemiologia do transplante de córnea antes de atingir a Fila Zero

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ABSTRACT

Objective: To outline the epidemiological profile of cornea donors and recipients before reaching queue zero.

Methods: Epidemiological study, of quantitative approach, with transversal, analytical design, analyzing database records from the Health Secretary of the State of Ceará, from 2013 to 2015.

Results: We obtained 1,558 cornea donors and 2,287 cornea recipients from 2013 to 2015. Most donors were male, capital residents, from 21 to 40 years old. Of donated eyeballs, 14.52% were disposed, due to poor condition, infiltration or positive serology. The recipients were predominantly women over 60 years old. The procedures were mostly elective, due to bullous keratopathy (28%). Regarding emergency transplants, ulcer (38.51%) and retransplant (35.14%) were most prevalent. Predominantly, transplants were funded by the Unified Health System.

Conclusion: The majority of patients who were submitted to corneal transplantation are senile, especially females, therefore should be cautiously observed. On the other hand, donors are mainly male and young, reflecting the high number of tragic accidents. The surgery for bullous keratopathy is the most frequent among elective transplants, while the ulcer surgery is the main cause of emergency procedures. The fact that most surgeries were financed by the Unified Health System reflects the importance of this system.

RESUMO

Objetivo: Traçar o perfil epidemiológico dos doadores e receptores de córnea antes de atingir a Fila Zero.

Métodos: Estudo epidemiológico, de abordagem quantitativa, com delineamento transversal e analítico, analisando registros da base de dados da Secretaria de Saúde do Estado do Ceará, de 2013 a 2015.

Resultados: Foram obtidos 1.558 doadores de córnea e 2.287 receptores de córnea, de 2013 a 2015. A maioria dos doadores era homem, procedente da capital, de 21 a 40 anos. Dentre os globos oculares doados, 14,52% foram descartados por má condição, infiltração ou sorologia positiva. Os receptores eram predominantemente mulheres acima de 60 anos de idade. Os procedimentos foram majoritariamente eletivos, devido à ceratopatia bolhosa (28%). Já para transplantes de emergência, a úlcera (38,51%) e o retransplante (35,14%) foram os mais prevalentes. Em geral, os transplantes foram custeados pelo Sistema Único de Saúde.

Conclusão: A maioria dos pacientes submetidos a transplantes de córnea foram do grupo etário senil, principalmente do sexo feminino, devendo esse grupo ser observado com cautela. Em contrapartida, os doadores eram, principalmente, homens e jovens, refletindo o alto número de pessoas que morrem devido a acidentes trágicos. A cirurgia de ceratopatia bolhosa foi a mais frequente dentre os transplantes eletivos; já a de úlcera foi a principal causa dos procedimentos de emergência. O fato de a maioria das cirurgias ter sido financiada pelo Sistema Único de Saúde reflete a importância desse sistema.

INTRODUCTION

Corneal transplantation (CT) is a procedure of extreme relevance in ophthalmology because of its important role in visual recovery. Besides being one of the most common and successful transplants, it is important to highlight that corneal disease is the third leading cause of blindness globally, after cataract and glaucoma, with 10 million people affected bilaterally.[1,2,3] Etiologically, cornea can be affected by numerous degenerative, dystrophic, infectious and inflammatory diseases, and there may also be secondary corneal damage caused by trauma at the ocular surface.[3,4,5] However, one should consider some key factors for a successful CT, such as the surgeon skill level and the risks of tissue rejection, transplantation infection, glaucoma, and astigmatism development.[6]

In the international context, it was evident that, in 2013, 3970 corneal graft procedures were performed in Canada, while in the United States this number reached more than 48000. With the improvement of surgical techniques and an increasing demand for tissues, this area has undergone significant changes over the last decade.[1,7] In Brazil, the state of Ceará has three eye banks located at the Hospital Geral de Fortaleza (HGF), the Banco de Olhos do Ceará (BOC) and the Banco de Olhos da Santa Casa de Misericórdia de Sobral (BOSCS), where there is the family interview, training, capture, processing, conservation and availability of the corneas to be transplanted. The information collected regarding the CT of the institution in question is kept at the HGF itself and sent to the Secretaria de Saúde do Estado do Ceará - Brasil (SESA), the state's health secretary.[8]

Since 2016, Ceará has been showing a "zero queue" for CT, a goal established by the Associação Brasileira de Transplante de Órgãos (ABTO), the Brazilian association of organ transplantation. This means that there is no need to wait for the tissue, as it is already available for surgery.[8] This improved supply capacity is probably due to the infrastructure provided by the three eye banks on the state, along with government campaigns developed to encourage corneal donation, although it is still possible to improve such policies. In this context, the purpose of this work was to study the profile of corneal donors and recipients in the state of Ceará - Brazil, which culminated in the "zero queue" in 2016, highlighting the great relevance in terms of science of an efficient transplantation model.

METHODS

HGF database records available at SESA (years 2013, 2014, and 2015) were quantified, followed by a cross-sectional analysis (data from the state of Ceará, at the Northeastern Region of Brazil). The variables analyzed for corneal donors were gender, age group, whether the cornea came from the capital or the countryside, as well as whether they were eligible, or not, for transplant. The reasons for corneas to be discarded were listed and accounted. For the patients receiving the cornea, gender, age range, the pathology that caused the need for CT, the surgery type for CT (elective or emergency) and the funding type (governmental/public, health insurance or private) were analyzed.

The data collected were tabulated and analyzed using Excel 2010 software (*Microsoft Office®, Washington, USA*). The graphs were plotted by the same software. The study was approved by the Research Ethics Committee of Centro Universitário Christus, (CAAE number 88888318.4.0000.5049) and followed the ethical directives from the Declaration of Helsinki.

RESULTS

Corneal donors

The data collection showed a total of 1,558 donors, mainly male (74.20%) and from the capital (89.41%), while the others were from the countryside (Table 1). Regarding the age range, they were mostly from 21 to 40 years old (35.75%), followed by the age group of 41 to 60 years old (34.98%). Age range below (zero to 20 years old) or above (61 to 80 years old) presented lower contributions, with 15.15% and 14.12%, respectively (Figure 1A).

Table 1. Distribution of donors and recipients by demographic features (2013-2015)

	2013	2014	2015	Total
Gender of donors				
Male	388 (76.1)	370 (73.3)	398 (73.3)	1,156 (74.2)
Female	122 (23.9)	135 (26.7)	145 (26.7)	402 (25.8)
Total	510 (100)	505 (100)	543 (100)	1,558 (100)
Residence of donors				
Capital	484 (94.9)	460 (91.1)	449 (82.7)	1,393 (89.4)
Countryside	26 (5.1)	45 (8.9)	94 (17.3)	165 (10.6)
Total	510 (100)	505 (100)	543 (100)	1,558 (100)
Gender of recipients				
Male	341 (47.8)	369 (48.6)	400 (49.1)	1,110 (48.5)
Female	373 (52.2)	390 (51.4)	414 (50.9)	1,177 (51.5)
Total	714 (100)	759 (100)	814 (100)	2,287 (100)

Results expressed as n (%).

Moreover, eyeball usage was around 80% in 2013, 2014, and 2015 (Figure 2). Regarding the eyeballs that were discarded, the main reasons for disposal were poor condition (60.54%), the presence of corneal infiltrate (23.56%), and positive serology (5.36%) (Table 2).

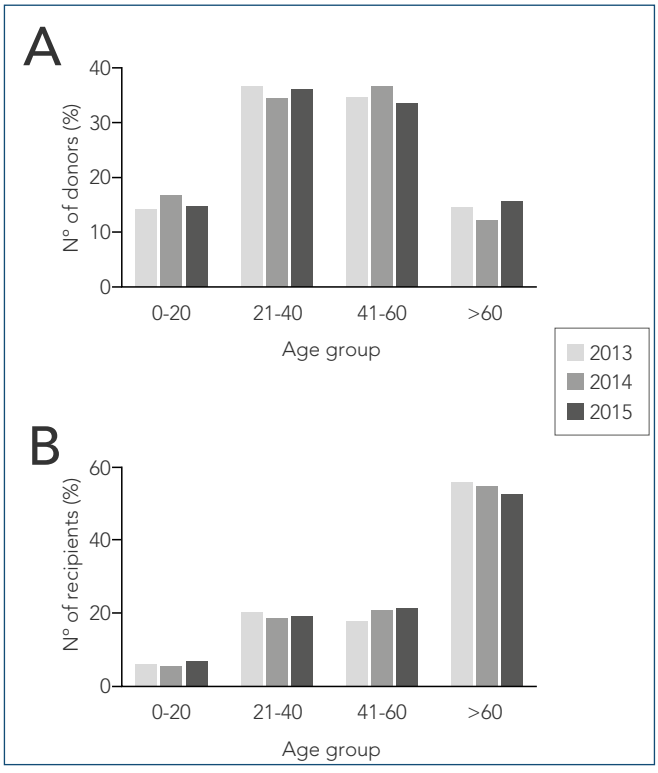


Figure 1. (A) Graph representing the number of donors by age group from 2013 to 2015. (B) Graph representing the number of corneas utilized and discarded during the years 2013 to 2015.

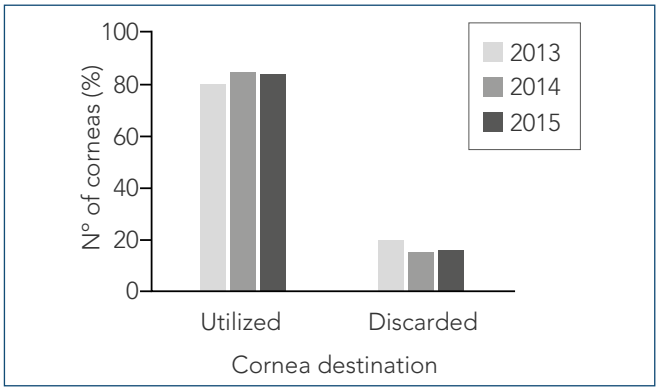


Figure 2. Graph representing the number of recipients by age group.

Corneal receptors

Taking corneal receptors into account, 2,287 receptors were found between 2013 and 2015, the majority being female (51.47%) (Table 1). The predominant age group was individuals over 60 years old, representing 54.39% of the total (Figure 1B).

Regarding the surgery type of CT, the elective surgeries were more frequent (84.13%) than the emergency ones. Moreover, the elective ones showed a gradual increase over the 3 years (Table 3). Among the elective procedures, the main indication was in bullous keratopathy (28.02%) cases (Figure 3A). On the other hand, ulcers (38.51%), corneal retransplantation (ReT) (35.14%), and descemetocele (26.35%) were the major causes of CT urgency surgeries (Figure 3B).

Table 2. Reasons for eyeball disposal

Reason for discarding	2013	2014	2015	Total
Poor condition	115 (57.5)	75 (49.6)	126 (73.5)	316 (60.5)
Corneal infiltrate	47 (23.5)	49 (32.5)	27 (15.8)	123 (23.5)
Positive serology	12 (6.0)	8 (5.3)	8 (4.7)	28 (5.4)
Lattice	6 (3.0)	8 (5.3)	-	14 (2.7)
Sepsis	6 (3.0)	4 (2.6)	2 (1.2)	12 (2.3)
Inconclusive serology	4 (2.0)	2 (1.3)	2 (1.2)	8 (1.5)
Leucoma-opacity	3 (1.5)	2 (1.3)	1 (0.6)	6 (1.1)
Gunpowder presence	5 (2.5)	-	-	5 (1.0)
Corneal foreign body	-	1 (0.7)	1 (0.6)	2 (0.4)
Phacoemulsification with intraocular lens implant	-	-	2 (1.2)	2 (0.4)
Without serology	2 (1.0)	-	-	2 (0.4)
Ocular trauma	-	-	2 (1.2)	2 (0.4)
Pterygium	-	1 (0.7)	-	1 (0.2)
Ocular hypotony	-	1 (0.7)	-	1 (0.2)
Total	200 (100)	151 (100)	171 (100)	522 (100)

Results expressed as n (%).

Table 3. Information about corneal transplants

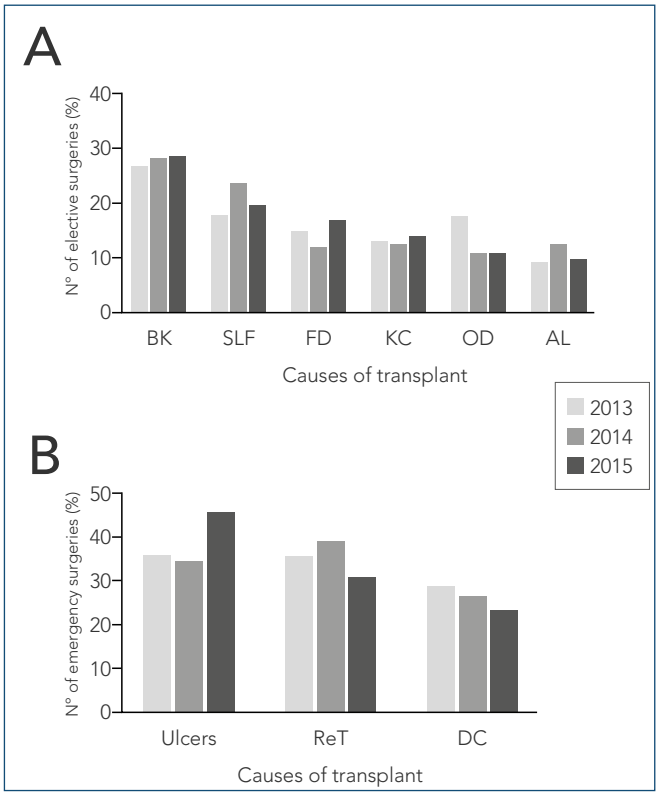
	2013	2014	2015	Total
Type of transplantation depending on urgency				
Emergency surgery	139 (19.5)	111 (14.6)	113 (13.9)	363 (15.9)
Elective surgery	575 (80.5)	648 (85.4)	701 (86.1)	1,924 (84.1)
Total	714 (100)	759 (100)	814 (100)	2,287 (100)
Health care system classification for transplants				
SUS	566 (79.3)	611 (80.5)	566 (69.5)	1,743 (76.2)
Health insurance	136 (19.0)	140 (18.4)	198 (24.3)	474 (20.7)
Private	12 (1.7)	8 (1.1)	50 (6.2)	70 (3.1)
Total	714 (100)	759 (100)	814 (100)	2,287 (100)

SUS: Unified Health System.

In addition, most of the performed transplants (76.21%) were funded by the Brazilian public health system.

DISCUSSION

According to the most recent report by the ABTO, CT in Brazil ranks second in total numbers of transplants performed in 2019, second only to kidney transplantation.[9] In this context, it is important to know the epidemiological information about the donors and receptors that helped Brazil to reach such high number of surgeries, thus promoting the zero queue in Ceará in 2016. This achievement became easier because the state has three eye banks, improving the logistics and distribution of the tissue during the years of 2013 to 2015, resulting in a reduced queue time for the transplantation.



BK: bullous keratopathy; SLF: secondary or late failure; FD: Fuchs dystrophy; KC: keratoconus; OD: other dystrophies; AL: any leucoma; ReT: retransplant; DC: descemetocele.

Figure 3. (A) Graph representing the main causes of elective corneal surgery from 2013 to 2015. (B) Graph representing the main causes of emergency corneal surgery from 2013 to 2015.

In a study on corneal donors carried out in the state of Rio Grande do Norte, in the Northeastern Region of Brazil, poor tissue quality was found as the main cause of eyeball disposal and there was a predominance of males (71.4%)[10], corroborating the present study. The prevalence of males among donors can be justified, in part, by the fact that they are the most frequent among external causes of death (automobile accidents, firearm accidents, murder, among others). Another reason relies in risky behaviors they frequently present (such as alcoholism and smoking), which increases their chance to develop cardiovascular diseases.[11] However, in the state of Rio Grande do Norte, there was a higher prevalence of donors coming from cities in the metropolitan region, differing from the results of the present study, in which the majority of donors came from the capital, in addition to differing in the most common age group of 40-60 years old,[10] in which we found it to be the second most prevalent.

In Pernambuco, a state also in the Northeastern Region of Brazil, a study on the profile of corneal receptors found that the majority were female (54%) and that the predominant age group was 61-80 years old (35%)[12], corroborating the present study. The prevalence of recipients over 60 can be explained, in part, by the demographic transition that Brazil has been presenting, with the increase in life expectancy of the population, with a consequent increase in the elderly population, whose morbidity and mortality profile accentuates the complex picture of non-communicable diseases and illnesses, which demand a continuous and multidisciplinary structure of the health system.[13] In Pernambuco, the main diagnoses of patients on the waiting list for CT were leucoma (33%), keratoconus (22%), and bullous keratopathy (18%), which differed from the present study, in which keratoconus was the fourth most prevalent cause of elective CT (13.25%), leucomas were the least prevalent cause (10.62%), and bullous keratopathy was the main cause (28.02%). The bullous keratopathy was higher in the elderly population can be justified by the fact that it occurs more often after phacoemulsification for cataract extraction, a surgery that is very common in the older population.

In a study carried out in the capital of Ceará, in Brazil, on the epidemiological profile and the main indications of keratoplasty in patients seen in HGF from 2006 to 2010, the mean age of recipients was 49 years old, differing from ours, which showed more prevalence in people over 60 years old. The majority (70.3%) of the procedures were performed electively, data that corroborate the present study, as well as the main indications for CT, which were bullous keratopathy (25%), and leucoma (21%).[14]

Moreover, regarding the gender and the age of CT recipients, a study conducted in Italy showed that the majority of the individuals who were transplanted were men (58.8%), which was different from the current study, and the age range demonstrated was 33 to 69 years old.[15]

Research conducted in Porto Alegre, in the state of Rio Grande do Sul, South region of Brazil, evaluated the serological profile of candidates for cornea donation. During the study period (2006-2012), most donors were male, the average age was 58.7 years old, and there was 23% retention due to serological disability, the most prevalent being the anti-HBc marker, followed by Hepatitis C Virus, and Human Immunodeficiency Virus.[16] Still in this context, studies in Germany have shown that in the last two decades a higher percentage of corneas were discarded before transplantation, considering criteria such as endothelial evaluation, clinical history and donor serology. Accordingly, the current study has shown positive serology as the third leading cause of eyeball discarding. Therefore, virologic analysis is necessary to minimize the risks of infection to the recipient, being a mandatory prerequisite for an eye bank, although false positives are common, considering hemolysis, autolysis and

bacterial contamination in post-mortem donors, resulting in more corneal discards.[17]

Regarding the receptors, a study conducted in Auckland, New Zealand, from 1999 to 2009, found that the average age was 46.4 years old, differing from this study. As for procedures, most transplants were performed by the public health system, in accordance with this study, and the most common clinical indications were keratoconus, retransplantation, corneal dystrophy, bullous keratopathy, corneal ulcer, trauma and viral keratitis, differing from what was found in our study.[18] A study conducted in Ontario, Canada, from 2000-2009, found that most recipients were also female, and the mean age was 69 years old. Moreover, the main indications for transplantation were pseudophakic corneal edema, retransplantation, Fuchs dystrophy and anterior keratoconus,[19] These findings were similar to our study.

In addition, a review study comparing the development of CT in the five regions of Brazil showed that, between 2002 and 2014, there was an increase in the absolute number of CT and in the percentage of transplants needed in all regions of the country. The Northeastern region was the second region with the lowest demand for transplants and, in the years 2013 and 2014, it was the second region with the highest absolute number of transplants performed. Despite the impressive progress, healthcare providers were still not well-prepared to approach family members requested to authorize the organ donation of a relative recently deceased, the refusal of the family being one of the main reasons for not donating corneas. This leaded to the adoption of a different approach by these health providers, such as talking about the empathy for the relatives of the possible donor and the possibility of optimizing the quality of life of other patients in order to have an increase in the number of donors and, consequently, in the number of transplants performed.[20]

In a study in Ethiopia, transplantation remained a challenge for many patients in low-resource situations. The surgical technique was complicated because of a lack of infrastructure support, including a lack of adequately equipped eye banks and operating rooms, and limited access to trained cornea surgeons and appropriate postoperative follow-up.[21] There was a contrast with what was observed in the present study in Ceará, Brazil, which presented three eye banks and the necessary resources to achieve the "zero queue" in 2016 in corneal transplants, which were performed in several hospitals with a qualified surgical team.

In this context, we could observe that the SUS is one of the broadest and most complex public health systems in the world, ranging from the simplest care, through Primary Health Care, to organ transplantation, ensuring full, universal, and free access for the entire population of the country, without discrimination. Therefore, despite presenting some flaws, which need improvement, SUS is extremely important for good health care in Brazil, being able to improve the quality of life of countless Brazilians,[22] which was reinforced by the results of this study, which demonstrated that most transplants were financed by this system.

This article presents some strengths, such as being the pioneer in Brazil to attend to the epidemiological profile of corneal donors and recipients, since most studies only report the characteristics of transplant patients. It is extremely advantageous to present data of both donors and recipients, since it allows the readers to evaluate the use of eyeballs and reasons for disposal, for example. Nevertheless, readers should be mindful of some study limitations, such as the absence of information about the type of surgical technique performed in the transplant (penetrating or lamellar), due to the lack of these data in the medical records analyzed, and, especially, the reduced geographical area evaluated, which is restricted to a single Brazilian state. However, despite the limited geographic space, this paper presents an expressive sample that satisfactorily represents the three years prior to the establishment of a "zero queue" for corneal transplantation in a reference service of the country, which would not be possible with the analysis of multiple states, since many unfortunately did not reach the "zero queue" status.

In short, the main site for corneas in the state of Ceará, Brazil, was the capital Fortaleza. Male donors represent the majority in the 20-60 age group, and the main reasons for discarding the eyeballs were poor conditions and corneal infiltrates. Among corneal receptors, there was a discrete predominance of females. Most surgeries were performed on an elective basis, with bullous keratopathy being the main surgical indication and having SUS as the main paying source. Knowledge of the epidemiological profile of corneal donors and recipients in the present study provided information that enabled optimization of the quality of donated corneas, in addition to stimulating more public policies that might alert the population to the main corneal diseases.

REFERENCES

1. Eye Bank Association of America. 2014 Eye Banking Statistical Report. 2015 [cited 2020 Feb 28]. Available from: https://restoresight.org/wp-content/uploads/2015/03/2014_Statistical_Report-FINAL.pdf
2. Gain P, Jullienne R, He Z, Aldossary M, Acquart S, Cognasse F, et al. Global survey of corneal transplantation and eye banking. JAMA Ophthalmol. 2016;134(2):167-73.

3. Tan DT, Dart JK, Holland EJ, Kinoshita S. Corneal transplantation. Lancet. 2012;379(9827):1749-61.
4. Cruz GK, Azevedo IC, Carvalho DP, Vitor AF, Santos VE, Ferreira Júnior MA. Clinical and epidemiological aspects of cornea transplant patients of a reference hospital. Rev Lat Am Enfermagem. 2017;25:e2897.
5. Moreno GL, Souza LB, Freitas D, Sato EH, Vieira LA. Transplante de córnea e o conhecimento do procedimento pelos pacientes. Arq Bras Oftalmol. 2003;66(6):797-801.
6. Sommer A, Taylor HR, Ravilla TD, West S, Lietman TM, Keenan JD, et al.; Council of the American Ophthalmological Society. Challenges of ophthalmic care in the developing world. JAMA Ophthalmol. 2014;132(5):640-4.
7. Robert M, Choronzey M, Lapointe J, Meunier LP, Harissi-Dagher M, Germain M, et al. Evolution of corneal transplantation in the Province of Quebec from 2000 to 2011. Cornea. 2015;34(8):880-7.
8. Morais D. Banco de Olhos do HGF amplia atendimento. Ceará; 2018 [citado 2022 Feb 28]. Disponível em: https://www.saude.ce.gov.br/2018/07/05/73124/
9. Associação Brasileira de Transplante de Órgãos (ABTO). Dimensionamento dos Transplantes no Brasil e em cada estado. São Paulo: Registro Brasileiro de Transplantes; 2019 [citado 2022 Feb 28]. Disponível em: https://site.abto.org.br/wp-content/uploads/2020/06/RBT-2019-leitura-1.pdf
10. Silva MF, Gomes AT, Freire IL, Dantas BA, Torres VG. Caracterização sociodemográfica e epidemiológica dos doadores de córneas do banco de tecidos oculares do Rio Grande do Norte. Rev Bras Pesqui Saúde. 2014;16(3):32-7.
11. Sousa AH, Costa LH, Nóbrega MF, Linhares RA, Gomes RK. Políticas públicas de saúde: elaboração de uma tecnologia aplicada à saúde dos homens. Mostra Interdisciplinar do curso de Enfermagem. c2014 [citado 2019 Maio 8]. Disponível em: http://publicacoesacademicas.unicatolicaquixada.edu.br/index.php/mice/article/view/1783
12. Almeida HG, Souza AC. Epidemiological profile of patients waiting for penetrating keratoplasty in state of Pernambuco - Brazil. Rev Bras Oftalmol. 2014;73(1):28-32.
13. Miranda GM, Mendes AC, Silva AL. Population aging in Brazil: current and future social challenges and consequences. Rev Bras Geriatr Gerontol. 2016;19(3):507-19.
14. Bezerra FC. Perfil epidemiológico e indicações de ceratoplastia em pacientes atendidos no Hospital Geral de Fortaleza no período 2006 a 2010. Escola de Saúde Pública do Ceará. c2017 [citado 2019 Maio 9] Disponível em: http://extranet.hgf.ce.gov.br/jspui/handle/123456789/197
15. Frigo AC, Fasolo A, Capuzzo C, Fornea M, Bellucci R, Busin M, et al. Corneal transplantation activity over 7 years: changing trends for indications, patient demographics and surgical techniques from the Corneal Transplant Epidemiological Study (CORTES). Transplant Proc. 2015;47(2):528-35.
16. Lunardelli A, Alvarenga RB, Assman ML, Brum DE, Barison MA. Serological profile of candidates for corneal donation. Rev Bras Oftalmol. 2014;73(5):282-86.
17. Röck T, Beck R, Jürgens S, Bartz-Schmidt KU, Bramkamp M, Thaler S, et al. Factors influencing the virological testing of cornea donors. Medicine. 2017;96(47):61-5.
18. Crawford AZ, McKelvie J, Craig JP, McGhee CN, Patel DV. Corneal Transplantation in Auckland, New Zealand, 1999-2009. Cornea. 2017;36(5):546-52.
19. Boimer C, Lee K, Sharpen L, Mashour RS, Slomovic AR. Evolving surgical techniques of and indications for corneal transplantation in Ontario from 2000 to 2009. Can J Ophthalmol. 2011;46(4):360-6.
20. Almeida HG, Hida RY, Kara-Júnior N. Review of developments in corneal transplantation in the regions of Brazil - Evaluation of corneal transplants in Brazil. Clinics. 2016;71(9):537-43.
21. Ayalew M, Tilahun Y, Holsclaw D, Indaram M, Stoller NE, Keenan JD, et al. Penetrating Keratoplasty at a Tertiary Referral Center in Ethiopia. Cornea. 2017; 36(6):65-8.
22. Brasil. Ministério da Saúde. Sistema Único de Saúde (SUS): estrutura, princípios e como funciona. Brasília (DF): 2019 [citado 2019 Fev 28]. Disponível em: https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/s/sus-estrutura-principios-e-como-funciona