

2.7 Follow-up

Introduction

Follow-up registry of corneal grafts is a requirement to control quality. Analysis of the numerous factors influencing the results will make it possible to continuously improve the quality of care in the chain of corneal transplantation by corrective and preventive measures.

At the outset of grafting only the surgeon and the patient were interested in follow-up results. Later on, eye banks became involved. With the increasing international exchange of tissue, health authorities consider it their duty to control safety by setting rules, making legislation and collecting follow-up data concerning serious adverse reactions and events.^{144,145,146}

Defining outcome became important. The number of graft failures, clear grafts, central endothelial cell densities, graft survival, the extent of visual ability and patients' satisfaction, adverse events and adverse reactions are measurable results.

The main interest of the patient is that he or she is satisfied with the procedure, the postoperative visual ability and the graft survival time.^{337,338} Today the degree of satisfaction is objectively assessed with Quality Of Life (QOL) score.³³⁹ The patient should be informed about the benefits as well as the risks of a corneal transplantation. This allows him to accept or reject the surgery. Providing the patient with the proper information and thus enabling him to make the choice to undergo surgery is legally required in the Netherlands "Wet op de Geneeskundige Behandelingen Overeenkomst" (WGBO).³⁴⁰ In most cases the patient is not worried about the serious adverse events and reactions as the occurrence is very low (see chapter 2.3.1 and 2.3.2).

The surgeon is interested in all results: first of all to inform the patient correctly and second, to improve his surgical techniques and postoperative procedures by comparing own results to national and international data and third to analyze trends and developments.

The eye bank staff is interested whether their selection criteria resulted in clear grafts postoperatively.

Depending on the registration level of follow-up data and subsequent analysis (surgeon related, centre related, nationally or internationally related) more comparisons can be made. It is a pity that usually the clinical follow-up registration is not integrated with the eye bank registration, with the exception of the registration in the Netherlands in the period 1995-2006. Coupling data from eye banks with clinical follow-up is the most ideal situation as it offers the possibility to analyse the effect of donor and tissue processing related factors on clinical outcome. In this respect, fitting in the scope of this thesis the following outcomes are of importance.

Outcomes

Graft failure

Graft failure is defined as a non functional graft due to an abnormal contour requiring re-grafting or due to loss of transparency as observed by the surgeon. The causes of graft failure may be diverse: primary failure, slow endothelial decompensation, high irregular astigmatism, infection, immunological failure, traumatic wound dehiscence, disease recurrence in the graft and epithelial problems are all possible reasons for graft failure.^{306,341,342,343,344,345} A high intra ocular pressure may attribute to graft failure.

Primary failure, slow endothelial decompensation and infections are failures, which may be ascribed to an impaired quality or safety of the donor tissue (see chapter 2.3.2 and 2.4). A slow endothelial decompensation or late endothelial failure (LEF) is described as a gradual decompensation and failure of corneal grafts without an apparent cause, unresponsive to corticosteroids and without a rejection episode, correlated to the time of graft failure. Once the follow-up period exceeds the 5 years' limit, the majority of graft failures is due to LEF.^{211,346} Graft failure is often presented as percentage of the total number of grafts performed. This is only informative when all recipients have the same follow-up time. The Kaplan Meier survival curves are a more informative method for the analysis of graft survival.^{347,348}

Clear Graft

A clear graft is defined as a graft that has not lost transparency as observed by the surgeon. Unfortunately, no objective method is yet available. For the description of corneal transparency in the patient's records descriptive qualifications are used varying from cloudy to crystal clear.

Graft transparency may be affected by epithelial, stromal or endothelial disorders and the causes may be both donor related and recipient related (see chapter 2.1). The donor related epithelial defects have been discussed together with the other serious adverse reactions. The donor related loss of stromal transparency is generally caused by the impaired function of the endothelium (see chapter 2.1 and chapter 2.4). In the first weeks after transplantation however a corneal swelling might occur due to osmotic processes and disturbance of corneal hydration, this as a consequence of the presence of remaining dehydrating agents such as dextran in the donor stroma (for example after OC). Different groups of factors affect the functioning of the endothelium. Procedures related are the surgical handling, surgical trauma and the number of early postoperative technical complications.

Recipient related factors are the indication and initial diagnosis for PK and the age of the recipient. These factors determine the peripheral endothelial cell density of the recipient part of the cornea.

Together with the donor ECD this contributes to the observed central cell density in the graft after continued re-distribution after grafting. Presenting percentages of endothelial cell loss is not very informative if data on the post transplant time are lacking.

Postoperative central endothelial cell density

Endothelial cell loss in corneal grafts takes place at an accelerated rate, even if an overt allograft rejection is absent or additional surgical interventions are required. Whereas initial endothelial cell loss has been found to be substantial and rapid, later cell loss appears to be slow (see chapter 2.1).³⁴⁹

As long as the ECD remains above a critical level (300-500 cells/mm²), the grafts usually stay clear and functional (see chapter 2.1 and 2.4). Endothelial cell loss 15-20 years after perforating keratoplasty is 72-77%.^{211,350} The hypothesis is that late endothelial cell loss may be caused by inflammation, a chronic break-down of the blood aqueous barrier or a chronic slow immunological rejection but not by an acute allograft rejection.³⁵

Every eye bank is interested in the post operative endothelial cell loss. Six weeks to three months after grafting, central endothelial cell loss will reflect the original donor cell density and the viability of the donor cells. Apoptotic and necrotic processes with an onset before and during surgery will proceed after grafting. Later on, the effect of surgical trauma (trephination and suturing) will be reflected, as the donor cells will rearrange to compensate the loss of cells at the wound margin. At even later stages, the remaining cells in the periphery of the recipient cornea may interfere with the observed central cell loss after wound closure.

Corneal thickness

Changes in corneal thickness reflect an impaired function of the endothelium. An increase in thickness results in loss of transparency. When corneal thickness is used as outcome measurement, it concerns the central corneal thickness (CCT).

This may be measured by optical pachymetry, interferometry, ultrasonic pachymetry, and the now most frequently used optical coherence tomography and topographic systems, based on the scanning slit principle.^{351,352} With the newer methods smaller inter-observer variations are achieved compared to the older techniques.³⁵² With this the CCT as a parameter becomes more reliable.

The biological variability in corneal thickness between healthy individuals is believed to be caused by variation in the amount of corneal stroma tissue. It is therefore a measurement of tissue mass and corresponding biomechanical parameters such as bending rigidity. A central thickness of 0.523 mm and a peripheral thickness of 0.660 mm in healthy individuals is shown, with small differences between men and women. Differences in thickness in different age groups are described with significant thinning in the corneal periphery in the higher age groups.³⁵³ Corneal thickness measurements can vary during the day.²¹⁹

Until now corneal pachymetry played a minor role in the post-operative control of the graft. Authors described that the thickness in the first postoperative days is followed by a decrease in thickness in the following months and a stabilizing thickness after 3-6 months.^{351,354} Corneal grafts with a CCT of 0.59 mm or thicker at 3 months post transplantation have been described to be at greater risk of failure than those with thicknesses of less than 0.59 mm.³⁵⁰ Long after keratoplasty (> 10 years) some find the corneal thickness similar to the measurement 2 years after the procedure^{354,355} while others find a slight increase in corneal thickness.³⁵⁰ It is expected that with the currently more reliable methods to assess the CCT, it may be considered as a standard outcome measurement.

Graft survival

The parameters for graft survival are the survival time and the percentage of clear grafts at a certain point in time. Graft survival time is defined as the time between surgery and the moment where failure or loss of transparency is assessed by the surgeon. To compensate for the variation in follow-up time Kaplan and Meier have developed a method where the results are grouped into time intervals. This method is often described as actuarial. The results are presented as a curve, where percentage cumulated survival is plotted against survival time or as mean survival time for different follow-up periods by life table estimates.^{347,348,136}

The graft survival curve visualizes the overall story of grafting. In keratoconus patients corneal grafting is very successful,^{338,356} while in patients with highly vascularised corneas the outcome is less favourable and compared to organ transplants even poor.^{123,136,225,357} Although many clinical factors affecting graft survival are well known less is known about the relation between eye banking procedures and graft survival (see chapter 5).^{225,228} Long-term graft outcome is relevant for at least two reasons. Many recipients are young and like to know the long term expectations for their graft, as it is well known that re-grafting has a less favourable prognosis. The second reason is that the final impact of various surgical techniques is only visible after decades of observation.

Serious adverse events

A serious adverse event (SAE) is defined in the EU directive as "any untoward occurrence associated with the procurement, testing, processing, storage and distribution of tissues and cells that might lead to the transmission of a communicable disease, to death or life-threatening, disabling or incapacitating conditions for patients or which might result in, or prolong, hospitalisation or morbidity".^{144,145,146}

SAEs may occur at any stage from procurement to distribution of the cornea. Their registration is important for the professionals in the eye bank, for the corneal surgeons and the health authorities for continuous improvement of procedure and the reduction of risks. The surgeon and the patient at first may be unaware of a SAE. As consequences may manifest themselves in a later stage, the surgeon and the patient should be informed as soon as possible. Examples are keratoconus (suspect) and PTK, PRK or Lasik treated corneas. In all cases, this may lead to insufficient visual results but the actual risk is not yet known. Screening methods, OCT and topography have been described to detect the phenomena in the donor eye but routine application of these methods in eye banks is still not possible.^{261,358,359,360,361,362} Other examples are HLA matching errors between donor and recipient, transplantation of donor tissue, designated for other procedures than the requested, such as a cornea, originally intended for ALKP but later used in a posterior keratoplasty procedure.

Serious adverse reactions

A serious adverse reaction (SAR) is defined as: "an unintended response, including a communicable disease, in the donor or in the recipient associated with the procurement or human application of tissues and cells that is fatal, life-threatening, disabling, incapacitating or which results in, or prolongs, hospitalisation or morbidity".^{143,144,145}

SAR may include transmission of a severe ocular or systemic viral, bacterial or fungal infection or malignancy possibility attributable to the transplanted tissue; primary failure and delayed epithelial closure (see chapter 2.3.1, 2.3.2, 2.4, 5). A primary failure is defined as a graft failing to clear after surgery.^{363,364,365} This diagnosis is assessed by the surgeon either, shortly after surgery or at a later point during recovery (see chapter 5). According to the definition technical problems leading to a primary failure and endophthalmitis not transferred by the donor tissue are excluded.

Notifying the eye bank of a SAR is extremely important as investigation of possible causes is then feasible and appropriate measures can be taken. Notification to health authorities is important for the risk assessment and concurrent rules and regulations. The suspicion of transmission of a serious life threatening disease should be reported to the eye bank and health authorities to prevent transplantation of other tissues from that particular donor. Delayed epithelial closure may also be considered a SAR when the trend deviates from normal (see chapter 5) as it might be the first sign of less than optimal donor tissue and impending graft failure.

Visual disability

As visual disability is a common indication for corneal grafting, a change in this is a valuable measurement to test the success of the treatment. An accepted outcome is the visual acuity. While visual acuity may be a convenient outcome measurement, the link between visual acuity and visual disability, of interest for the patient, can be tenuous.

The best corrected visual acuity (BCVA), obtained with spectacle or contact lens irrespective of the patient's preference, is generally registered. The influence of ocular morbidity on visual acuity may be a serious confounder in BCVA. Other visual function tests as parameters for success of the transplantation are studied, i.e. wave front aberrometry,^{366,367} different forms of contrast sensitivity³⁶⁸ and stray light tests.^{369,370} These tests may play a larger role to assess the benefits of the current lamellar keratoplasty procedures.^{368,371,372}

Patient's satisfaction

The increased interest for Quality of Life (QOL) as an outcome measure has led to the development of numerous questionnaires to construct this parameter in the field of ophthalmology.³³⁹ For measurement of QOL after keratoplasty the Visual Function Index-14 or modified versions as the Penetrating Keratoplasty Visual Function Questionnaire are used.^{337,339,373,374,375} It has been shown that patient's satisfaction is correlated with the presence of a clear graft, independence of contact lens correction, and having a better vision in the operated eye than the other eye.^{337,376,377} It is shown that for the satisfaction of the patient the visual acuity of the non operated eye plays an important role and therefore should be recorded.^{375,378}

Concluding remarks

In the literature graft failure and clear graft are often used as outcome measures. The last decades adequate and easy to use equipment is available, objectively assessed outcomes as endothelial cell density and corneal thickness should be included and considered to be more informative. To measure the change in visual disability the BCVA on its own is not sufficient. Currently the applications of additional evaluation methods are explored. The patient's satisfaction score will be leading in defining relevant outcome results.

Corneal graft registries

General

Data of graft outcome can be collected in various ways. Much of what is reported comes from retrospectively collected data in case series, usually with a relatively short follow-up. There are randomized clinical trials with prospectively collected data. Another way is prospective and protocolled collecting of outcome data in corneal graft registries, together with pre operative and operative data in a uniform way over a prolonged period of time. Those registries offer the possibility to find in a scientific way factors affecting the success of corneal transplantation. Information regarding the effect of general donor parameters, the effect of eye banking procedures on donor tissue and in turn their influence on graft outcome could be obtained by coupling graft registries with eye bank registries. This requires a registration of these data in eye bank systems.

Historical

The first large scale multicentre corneal graft registry was the Australian Corneal Graft Registry, which was established in 1985 and now holds records of more than 20.000 grafts, some of which have been followed for over 20 years.^{225,311} A number of follow-up registries followed, the British register in Bristol,³¹⁰ as well as the Dutch (this thesis) and the Swedish registers.³¹² In the Netherlands, a single centre registration started in 1976.³⁷⁹ To this data set, the information about grafts performed between 1939 and 1967 has been added. Detailed information on patients, donors and surgery reported in the theses of Deutman and Kok van Alphen was introduced in the data set.^{79,80}

Since 1980, eye bank data of more than 41.000 corneal donors have been electronically available in the Netherlands. As the Cornea Bank Amsterdam (CBA) was the only national bank till 2004, coupling of these data with the National Corneal Follow-up Registry offered the possibility to analyze the influence of eye banking processes and selecting procedures for donor tissue on graft outcome (see chapter 4,5,6). Results of other corneal graft registries show changing indications over long periods^{136,307,379,380,381,382,383,384} and a different distribution of indications in various parts of the world.^{123,385,386,387} For instance in the Netherlands during time a change is observed for the various procedures such as increased graft size and an extended period of corticosteroid treatment after transplantation (Pels, personal communication).

Registration of serious adverse events and reactions

The European Parliament and Council launched in 2004 “the tissue and cells directive” 2004/23/EC and in 2006 directive 2006/17/EC and 2006/86/EC. These directives, in addition to setting standards, require notification of adverse events and adverse reactions to the national authorities.^{144,145,146}

In the Netherlands the organisation “Transfusion Reactions In Patients” (TRIP)³⁸⁸ is designated by the Ministry of Health to fulfil this function. TRIP was used to look after the vigilance of blood and blood products.³⁸⁸ In 2007 an EU funded project: “Vigilance and Surveillance” was started by EUSTITE (European Union Standards and Training in the Inspection of Tissue Establishments).³⁸⁹ This project has the objective to propose common systems for definition, classification and reporting of SAE and SAR that are consistent with vigilant systems elsewhere in the world. A well organised, national and international collection, supported by follow-up registries, of SAEs and SARs data, crucial to define risks, will stimulate and accelerate improvements in eye banking and corneal grafting.

References

1. Park DJ, Karesh JW. Topographic anatomy of the eye: an overview. In: Tasman W, Jaeger EA (eds). *Duane's Ophthalmology on DVD-rom. Foundations of Ophthalmology Volume 1*. 2009 edition: Lippincott Williams & Wilkins.
2. Nishida T. Cornea, anatomic and physiologic overview. In: Krachmer JH, Mannis MJ, Holland EJ (eds), *Fundamentals of Cornea and External Disease*. St. Louis, Missouri: Mosby-Year Book Inc; 2005:3-27.
3. Smolek MK, Klyce SD. Cornea. In: Tasman W, Jaeger EA (eds). *Duane's Ophthalmology on DVD-rom, Foundations of Ophthalmology Volume 1*. Edition Lippincott Williams & Wilkins 2009.
4. Dogru M, Chen M, Shimmura S, Tsubota K. Corneal epithelium and stem cells. In: Brightbill FS(ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 4. St Louis. Mosby Elsevier; 2009:25-31.
5. Hanna C, O'Brien JE. Cell production and migration in the epithelial cell layer of the cornea. *Arch Ophthalmol* 1960; 64:536-539.
6. Hanna C, Bicknell DS, O'Brien JE. Cell turnover in the adult human eye. *Arch Ophthalmol* 1961; 65:695-698.
7. Lauweryns B, van den Oord JJ, de Vos R, Missotten L. A new epithelial cell type in the human cornea. *Invest Ophthalmol Vis Sci* 1993; 34:1983-1990.
8. Lavker RM, Tseng SC, Sun TT. Corneal epithelial stem cells at the limbus: looking at some old problems from a new angle. *Exp Eye Res* 2004; 78:433-446.
9. Dua HS, Azuara-Blanco A. Limbal stem cells of the epithelium. *Surv Ophthalmol* 2000; 44:415-425.
10. Thoft RA, Friend J. The X, Y, Z hypothesis of corneal epithelial maintenance. *Invest Ophthalmol Vis Sci*. 1983; 24:1442-1443.
11. Dawson DG, Watsky MA, Geroski DH, Edelhauser HF. Cornea and Sclera. In: Tasman W, Jaeger EA (eds). *Duane's Ophthalmology on DVD-rom, Duane's Foundations of Clinical Ophthalmology, volume 2*. Lippincott Williams & Wilkins, 2009.
12. Pfister RR. The normal surface of corneal epithelium: a scanning electronic microscopic study. *Invest Ophthalmol* 1973; 12:654-668.
13. Argüeso P, Gipson IK. Epithelial mucins of the ocular surface: structure, biosynthesis and function. *Exp Eye Res* 2001; 73:281-289.
14. Holly FJ, Lemp MA. Tear physiology and dry eyes. *Surv Ophthalmol* 1977; 22:69-87.
15. Gipson IK, Spurr-Michaud SJ, Tisdale AS. Anchoring fibrils from a complex network in human and rabbit cornea. *Invest Ophthalmol Vis Sci* 1987; 28:212-220.
16. Komai Y, Ushiki T. The three dimensional organization of collagen fibrils in the human cornea and sclera. *Invest Ophthalmol Vis Sci* 1991; 32:2244-2258.

17. Newsome DA, Gross J, Hassell JR. Human corneal stroma contains three distinct collagens. *Invest Ophthalmol Vis Sci* 1982; 22:376-381.
18. Marshall GE, Konstas AG, Lee WR. Collagens in ocular tissues. *Br J Ophthalmol* 1993; 8:515-524.
19. Klyce SD, Beuerman RW. Structure and function of the cornea. In: Kaufman HE, Barron BA, McDonald MB, Waltman SR (eds). *The Cornea*. New York, Churchill Livingstone; 1988:3-54.
20. Maurice DM. The structure and transparency of the cornea. *J Physiol* 1957; 136:263-286.
21. Meek KM, Blamires T, Elliott GF, Gyi TJ, Nave C. The organisation of collagen fibrils in the human corneal stroma: a synchrotron X-ray diffraction study. *Curr Eye Res* 1987; 6:841-846.
22. Newton RH, Meek KM. The integration of the corneal and limbal fibrils in the human eye. *Biophys J* 1998; 75:2508-2512.
23. Meek KM, Boote C. The organization of collagen in the corneal stroma. *Exp Eye Res* 2004; 78:503-512.
24. Møller-Pedersen T. A comparative study of human corneal keratocyte and endothelial cell density during aging. *Cornea* 1997; 16:333-338.
25. Borcharding MS, Blacik JJ, Sittig RA, Bizzell JW, Breen M, Weinstein HG. Proteoglycans and collagen fibre organization in human corneoscleral tissue. *Exp Eye Res* 1975; 21:59-70.
26. Maurice DM. Clinical physiology of the cornea. *Int Ophthalmol Clin* 1962; 2:561-572.
27. Müller LJ, Pels E, Schuurmans LR, Vrensen GF. A new three dimensional model of the organization of proteoglycans and collagen fibrils in the human cornea stroma. *Exp Eye Res* 2004; 78:493-501.
28. Müller LJ, Pels L, Vrensen GF. Ultrastructural organization of human corneal nerves. *Invest Ophthalmol Vis Sci* 1996; 37:476-488.
29. Müller LJ, Vrensen GF, Pels L, Cardozo BN, Willekens B. Architecture of human corneal nerves. *Invest Ophthalmol Vis Sci* 1997; 38:985-994.
30. Müller LJ, Marfurt CF, Kruse F, Tervo TM. Corneal nerves: structure, contents and function. *Exp Eye Res* 2003; 76:521-542.
31. Johnson DH, Bourne WM, Campbell RJ. The ultrastructure of Descemet's membrane. I. Changes with age in normal corneas. *Arch Ophthalmol* 1982; 100:1942-1947.
32. Waring GO, Bourne WM, Edelhauser HF, Kenyon KR. The corneal endothelium. Normal and pathologic structure and function. *Ophthalmology* 1982; 89:531-590.

33. Yee RW, Matsuda M, Schultz RO, Edelhauser HF. Changes in the normal corneal endothelial cellular pattern as a function of age. *Curr Eye Res* 1985; 4:671-678.
34. Bourne WM, Nelson LR, Hodge DO. Central corneal endothelial cell changes over a ten-year period. *Invest Ophthalmol Vis Sci* 1997; 38:779-782.
35. Armitage WJ, Dick AD, Bourne WM. Predicting endothelial cell loss and long-term corneal graft survival. *Invest Ophthalmol Vis Sci* 2003; 44:3326-3331.
36. Treffers WF. Human corneal endothelial wound repair. In vitro and in vivo. *Ophthalmology* 1982; 89:605-613.
37. Rao SK, Ranjan Sen P, Fogla R, Gangadharan S, Padmanabhan P, Badrinath SS. Corneal endothelial cell density and morphology in normal Indian eyes. *Cornea* 2000; 19:820-823.
38. Matsuda M, Yee RW, Edelhauser HF. Comparison of the corneal endothelium in an American and a Japanese population. *Arch Ophthalmol* 1985; 103:68-70.
39. Yunliang S, Yuqiang H, Ying-Peng L, Ming-Zhi Z, Lam DS, Rao SK. Corneal endothelial cell density and morphology in healthy Chinese eyes. *Cornea* 2007; 26:130-132.
40. Padilla MD, Sibayan SA, Gonzales CS. Corneal endothelial cell density and morphology in normal Filipino eyes. *Cornea* 2004; 23:129-135.
41. Van Dooren BT. The corneal endothelium reflected. Thesis. Erasmus University Rotterdam, 2006.
42. Amann J, Holley GP, Lee SB, Edelhauser HF. Increased endothelial cell density in the paracentral and peripheral regions of the human cornea. *Am J Ophthalmol* 2003; 135:584-590.
43. Dawson DG, Geroski DH, Edelhauser HF. Corneal endothelium: structure and function in health and disease. In: Brightbill FS(ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 4. St Louis, Mosby Elsevier; 2009:57-70.
44. Edelhauser HF. The balance between corneal transparency and edema: The Proctor Lecture. *Invest Ophthalmol Vis Sci* 2006; 47:1755-1767.
45. Carlson KH, Bourne WM, McLaren JW, Brubaker RF. Variations in human endothelial cell morphology and permeability to fluorescein with age. *Exp Eye Res* 1988; 47:27-41.
46. Hoppenreijns VP. Effects of growth factors on wounded corneal endothelium. Thesis Universiteit Utrecht 1994.
47. Sperling S. Early morphological changes in organ cultured human corneal endothelium. *Acta Ophthalmol* 1978; 56:785-792.
48. Schimmelpfennig B. Inhomogeneous distribution of human cornea endothelial cells. *Klin M Bl* 1982; 180:350-351.
49. Joyce NC, Mekler B, Neufeld AH. In vitro pharmacologic separation of corneal endothelial migration and spreading responses. *Invest Ophthalmol Vis Sci* 1990; 31:1816-1826.

50. Dohlman CH. Physiology of the cornea: corneal edema. In: Smolin G and Thoft RA (eds). *The Cornea* (ed1). Boston, Little, Brown and Company; 1983:3-17.
51. Edelhauser HF, Geroski HF and Ubels JL. Physiology. In: Smolin G and Thoft RA (eds). *The Cornea* (ed 3). Boston. Little, Brown and Company; 1994; 3:25-47.
52. Fischbarg J, Maurice DM. An update on corneal hydration control. *Exp Eye Res* 2004; 78:537-541.
53. Meek KM, Leonard DW, Connon CJ, Dennis S, Khan S. Transparency, swelling and scarring in the corneal stroma. *Eye* 2003; 17:927-936.
54. Harris JE. Currents thoughts on the maintenance of corneal hydration in vivo. *Arch Ophthalmol* 1967; 78:126-132.
55. Donn A, Maurice DM, Mills NL. Studies on the living cornea in vitro II. The active transport of sodium across the epithelium. *Arch Ophthalmol* 1959; 62:748-757.
56. Bonanno JA. Regulation of corneal epithelial intracellular pH. *Optom Vis Sci* 1991; 68:682-686.
57. Hedbys BO, Mishima S, Maurice DM. The inbibitions pressure of the corneal stroma. *Exp Eye Res* 1963; 2:99-111.
58. Hatton MP, Perez VL, Dohlman CH. Corneal oedema in ocular hypotony. *Exp Eye Res* 2004; 78: 549-552.
59. Castoro JA, Bettelheim AA, Bettelheim FA. Water gradients across bovine cornea. *Invest Ophthalmol Vis Sci* 1988; 29:963-968.
60. Bettelheim FA, Plessy B. The hydration of proteoglycans of bovine cornea. *Biochim Biophys Acta*. 1975;381:203-214.
61. Maurice DM. The permeability to sodium ions of the living rabbit's cornea. *J Physiol* 1951; 112:367-391.
62. Hodson S. The regulation of corneal hydration by a salt pump requiring the presence of sodium and bicarbonate ions. *J Physiol* 1974; 236:271-302.
63. Hull DS, Green K, Boyd M, Wynn HR. Corneal endothelium bicarbonate transport and the effect of carbonic anhydrase inhibitors on endothelial permeability and fluxes and corneal thickness. *Invest Ophthalmol Vis Sci*. 1977; 16:883-892.
64. Bonanno JA. Identity and regulation of ion transport mechanisms in the corneal endothelium. *Prog Retin Eye Res*. 2003; 22:69-93.
65. Bourne WM, Nagataki S, Brubaker RF. The permeability of the corneal endothelium to fluorescein in the normal human eye. *Curr Eye Res* 1984; 3:509-513.
66. Watsky MA, McDermott ML, Edelhauser HF. In vitro corneal endothelial permeability in rabbit and human: the effects of age, cataract surgery and diabetes. *Exp Eye Res* 1989; 49:751-767.
67. Geroski DH, Matsuda M, Yee RW. Pump function of the human corneal endothelium. Effects of age and corneal guttata. *Ophthalmology* 1985; 92:759-763.

68. Burns RP, Bourne WM, Brubaker RF. Endothelial function in patients with corneal guttata. *Invest Ophthalmol Vis Sci* 1981; 20:77-85.
69. Harris JE. Symposium on the cornea. Introduction: Factors influencing corneal hydration. *Invest Ophthalmol* 1962; 1:151-157.
70. Rosenthal P, Klyce SD. Contact lens induced edema. In Dabezies OH (ed): *Contact Lenses, The CIAO guide to Basic Science and Clinical Practice*. Grune & Stratton, Orlando, FL, 1984.
71. Liesegang TJ. Physiologic changes of the cornea with contact lens wear. *CLAO J* 2002; 28:12-27.
72. Nieuwendaal CP, Odenthal MT, Kok JH, Venema HW, Oosting J, Riemsdag FC, Kijlstra A. Morphology and function of the corneal endothelium after long-term contact lens wear. *Invest Ophthalmol Vis Sci* 1994; 35:3071-3077.
73. Gonnering R, Edelhauser HF, Van Horn DL, Durant W. The pH tolerance of rabbit and human corneal endothelium. *Invest Ophthalmol Visual Sci* 1979; 18:373-390.
74. Hjortdal JO, Ehlers N, Andersen CU. Some metabolic changes during human corneal organ culture. *Acta Ophthalmol.* 1989; 67:295-300.
75. Zirm EK. Eine erfolgreiche totale Keratoplastik. *Graefes Clini Exp Ophthalmol* 1906; 64:580-593.
76. Zirm ME. Eduard Konrad Zirm and the "wondrously beautiful little window". *Refract Corneal Surg* 1989; 5:256-257.
77. Armitage WJ. Developments in corneal preservation. In: Reinhard T and Larkin F(eds). *Essentials in Ophthalmology, Corneal and External disease*. Berlin Heidelberg, Springer; 2007:101-114.
78. Wilson SE, Bourne MD. Corneal Preservation. *Survey of Ophthalmology* 1989; 237-258.
79. Deutman A.F. *Transplantatio Corneae*. Thesis 1940 Leiden University. Editor Sijthoff, Leiden 1940.
80. Kok-van Alphen C.C. *Bijdrage tot de Keratoplastiek* Thesis, Leiden University, Editor: IJdo E. NV, Leiden 1951.
81. Völker-Dieben HJM. Long term follow-up study of 19 patients who received 22 corneal grafts between 1939 and 1948 from eye enucleated because of malignant melanoma. In: Völker-Dieben HJM, *The effect of immunological and non immunological factors on corneal graft survival. A single center study*. Dordrecht, Dr W. Junk Publishers; 1984:23-30.
82. Völker-Dieben HJM. Survival of 44 corneal grafts obtained from eyes enucleated because of malignant melanoma. In: Völker-Dieben HJM, *The effect of immunological and non immunological factors on corneal graft survival. A single center study*. Dordrecht, Dr W. Junk Publishers; 1984:31-40.

83. Filatov VP. Transplantation of the cornea. *Arch Ophthalmol* 1935; 13:321-347.
84. Filatov VP Transplantation of cornea from preserved cadaver eyes. *Lancet*.1937; 1:1395-1402.
85. Basu PK, Hasany S. Autolysis of the cornea of stored human donor eyes. *Can J Ophthalmol* 1974; 9:229-35.
86. Stocker FW. Storage of donor corneas in the recipient's serum prior to grafting. *Pac Med Surg* 1968; 76:31-34.
87. Eastcott HH, Cross AG, Leigh AG, North DP. Preservation of corneal graft by freezing. *Lancet* 1954; 1:237-239.
88. Sperling S. A simple apparatus for controlled rate corneal freezing. *Acta Ophthalmol* 1977; 55:1-8.
89. Sperling S. A simple apparatus for controlled rate corneal freezing II. *Acta Ophthalmol* 1981; 59:134-141.
90. Capella JA, Kaufman HE, Robbins JE. Preservation of viable corneal tissue. *Cryobiology* 1965; 2:116-121.
91. Böhnke M, Draeger J, Sturmer B, Rethwisch K. Cryopreservation of organ-cultured donor corneas. In: Brightbill FS (ed). *Corneal Surgery*, ed 1. St Louis, Mosby Co; 1986:114-123.
92. Erdmann L, Ehlers N. Long term results with organ cultured, cryopreserved human corneal grafts. Re-examination of 17 patients. *Acta Ophthalmol* 1993; 71:703-706.
93. Farias RJ, Sousa LB, Lima Filho AA, Lourenco AC, Tanakai MH, Freymuller E. Light and electron microscopy evaluation of lyophilized corneas. *Cornea* 2008; 27:791-794.
94. Armitage WJ, Rich SJ. Vitrification of organized tissues. *Cryobiology* 1990; 27: 483-491.
95. Mc Carey BE, Kaufman HE. Improved corneal storage. *Invest Ophthalmol* 1974; 13:165-173.
96. Bigar F, Kaufman HE, McCarey BE, Binder BS. Improved corneal storage for penetrating keratoplasties in man. *Am J Ophthalmol* 1975; 79:115-120.
97. Aquavella JV, van Horn DL, Haggerty CJ. Corneal preservation using M-K medium. *Am J Ophthalmol* 1975; 80:791-799.
98. McCarey BE, Meyer RF, Kaufman HE. Improved corneal storage for penetrating keratoplasties in humans. *Ann Ophthalmol* 1976;a 8:1488-1492,1495.
99. McCarey BE. Corneal Storage and handling. In Kaufman HE, Zimmerman T. *Current concepts in ophthalmology*. St. Louis: C.V. Mosby, 1976;b:134-163.
100. Kaufman HE, Varnell ED, Kaufman S, Beuerman RW, Barron BA. K-Sol corneal preservation. *Am J Ophthalmol* 1985; 100:299-304.

101. Lindstrom RL, Doughman DJ, Skelnik DL, Mindrup EA. Corneal preservation at 4 degrees C with chondroitin sulfate containing medium. *Trans Am Ophthalmol Soc* 1987; 85:332-349.
102. Chu W. The past twenty-five years in eye banking. *Cornea* 2000; 19:754-765.
103. Mizukawa T, Manabe R. Recent advances in keratoplasty, with special reference to the advantage of liquid preservation. *Nippon Ganka Kiyo* 1968; 19:1310-1318.
104. Sieck EA, Enzenauer RW, Cornell FM, Butler C. Contamination of K-Sol corneal storage medium with *Propion bacterium acnes*. *Arch Ophthalmol* 1989; 107:1023-1024.
105. Lindstrom RL, Kaufman HE, Skelnik BS et al. Optisol corneal storage medium. *Am J Ophthalmol* 1992; 114:345-356.
106. Lass JH, Bourne WM, Musch DC, Sugar A, Gordon JF, Reinhart WJ, Meyer RF, Patel DI, Bruner WE, Cano DB et al. A randomized, prospective, double-masked clinical trial of Optisol vs DexSol corneal storage media. *Arch Ophthalmol* 1992; 110:1404-1408.
107. Summerlin WT, Miller GE, Harris JE, Good RA. The organ-cultured cornea: an in vitro study. *Invest Ophthalmol* 1973; 12:176-180.
108. Doughman DJ, Lindstrom RL, Singh G, Mindrup EA, Nelson JD. Long term organ culture for corneal storage. In: Brightbill FS (ed): *Corneal Surgery: Theory, Technique and Tissue*, ed 1. St Louis, Mosby Co; 1986:84-93.
109. Doughman DJ, van Horn D, Rodman WP, Byrnes P, Lindstrom RL. Human corneal endothelial layer repair during organ culture. *Arch Ophthalmol* 1976; 94:1791-1796.
110. Doughman DJ, Harris JE, Schmitt MK. Penetrating keratoplasty using 37 oC organ cultured corneas. *Trans Sect Ophthalmol Am Acad Ophthalmol Otolaryngol* 1976; 81:778-793.
111. Kolstad A. Organ cultured donor material for penetrating corneal grafts. A preliminary report. *Acta Ophthalmol* 1979; 57:742-749.
112. Bourne WM, Doughman DJ, Lindstrom RL, Kolb MJ, Mindrup E, Skelnik D. Increased endothelial cell loss after transplantation of corneas preserved by a modified organ-culture technique. *Ophthalmology* 1984 ; 91:285-289.
113. Sperling S. Human corneal endothelium in organ culture. The influence of temperature and medium of incubation. *Acta Ophthalmol* 1979; 57:269-276.
114. Ehlers H, Ehlers N, Hjortdal JO. Corneal transplantation with donor tissue kept in organ culture for 7 weeks. *Acta Ophthalmol* 1999; 77:277-278.

115. Van der Want HJ, Pels E, Schuchard Y, Olesen B, Sperling S. Electron microscopy of cultured human corneas. Osmotic hydration and the use of a dextran fraction (dextran T 500) in organ culture. *Arch Ophthalmol* 1983; 101:1920–1926.
116. Doughman DJ. Prolonged donor cornea preservation in organ culture: long-term clinical evaluation. *Trans Am Ophthalmol Soc.* 1980;78:567-628.
117. Pels E, Schuchard Y. Organ Culture preservation of human corneas. *Doc Ophthalmol.* 1983; 56:147-153.
118. Pels E, Schuchard Y. Organ Culture in the Netherlands. In Brightbill F (ed). *Corneal Surgery, Theory, Technique and Tissue*(ed 1). St Louis. Mosby 1986:93-101.
119. Sperling S, Gundersen HJ. The precision of unbiased estimates of numerical density of endothelial cells in donor cornea. *Acta Ophthalmol* 1978; 56:793-802.
120. Maas-Reijs J, Pels E, Tullo AB. Eye Banking in Europe 1991-1995. *Acta Ophthalmol* 1997; 75:541-543.
121. Claerhout I, Maas H, Pels E. Directory of the European Eye Bank Association. (ed 17), Amsterdam 2009.
122. Williams KA, Noack LM, Alferich SJ, Danz R, Erickson SA and Coster DJ. Assessment of the Dutch organ-culture system of corneal preservation within the Eye Bank of South Australia. *Aust N Z J Ophthalmol* 1988; 16:21-25.
123. Coster DJ, Williams KA (on behalf of all contributors). The Australian Corneal Graft Registry: 1990 to 1992 report. *Aust N Z J Ophthalmol* 1993; 21 (2 suppl):1-48.
124. Gandhi SS, Lamberts DW, Perry HD. Donor to host transmission of disease via corneal transplantation. *Surv Ophthalmol* 1981; 25:306-311.
125. Payne JW. Donor selection. In: Brightbill FS(ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 1. St Louis, Mosby Co; 1986:6-16.
126. Harrison DA, Hodge DO, Bourne WM. Outcome of corneal grafting with donor tissue from eyes with primary choroidal melanomas. A retrospective cohort comparison. *Arch Ophthalmol* 1995; 113:753-756.
127. McGeorge AJ, Vote BJ, Elliot DA, Polkinghorne PJ. Papillary adenocarcinoma of the iris transmitted by corneal transplantation. *Arch Ophthalmol* 2002; 120:1379-1383.
128. López-Navidad A, Soler N, Caballero F, Lerma E, Gris O. Corneal transplantation from donors with cancer. *Transplantation* 2007; 83:1345-1350.
129. Salame N, Viel JF, Arveux P, Delbosc B. Cancer transmission through corneal transplantation. *Cornea* 2001; 20:680-682.
130. Duffy P, Wolf J, Collins G et al. Possible person to person transmission of Creutzfeldt-Jakob disease. *N Engl J Med* 1974; 290:692-693.
131. Houff SA, Burton RC, Wilson RW, Henson TE, London WT, Baer GM, Anderson LJ, Winkler WG, Madden DL, Sever JL. Human-to-human transmission of rabies virus by corneal transplant. *N Engl J Med* 1979; 300:603-604.

132. Schwarz A, Hoffmann F, L' age-Stehr J, Tegzess AM, Offermann G. Human immunodeficiency virus transmission by organ donation: outcome in cornea and kidney recipients. *Transplantation* 1987; 44:21-24.
133. Glasser DB. Serologic testing of cornea donors. *Cornea* 1998; 17:123-128.
134. O'Day DM. Diseases potentially transmitted through corneal transplantation. *Ophthalmology* 1989; 96:1133-1137.
135. Eye Bank Association of America. Medical Standards. Version 2008. www.restoreight.org/standards0707.pdf
136. Williams KA, Lowe MT, Bartlett CM, Kelly L, Coster DJ. The Australian Graft registry 2007 report. Flinder University Press, 2007 <http://hdl.handle.net/2328/1002>.
137. Hoft RH, Pflugfelder SC, Forster RK, Ullman S, Polack FM, Schiff ER. Clinical evidence for hepatitis B transmission resulting from corneal transplantation. *Cornea* 1997; 16:132-137.
138. Lee HM, Naor J, Alhindi R, Chinfook T, Kraiden M, Mazzulli T, Rootman DS. Detection of hepatitis C virus in the corneas of seropositive donors. *Cornea* 2001; 20:37-40.
139. Sengler U, Reinhard T, Adams O, Gerlich W, Sundmacher R. Testing of corneoscleral discs and their culture media of seropositive donors for hepatitis B and C virus genomes. *Graefes Arch Clin Exp Ophthalmol* 2001; 239:783-787.
140. Merle H, Cabre P, Merle S, Gerard M, Smadja D. A description of human T-lymphotropic virus type I-related chronic interstitial keratitis in 20 patients. *Am J Ophthalmol* 2001; 131:305-308.
141. Castelo Branco B, Chamon W, Belfort R, Figueiredo Carneiro N, Brites C. New corneal findings in human T-cell lymphotropic virus type 1 infection. *Am J Ophthalmol* 2001; 132:950-951.
142. Goldberg MA, Laycock KA, Kinard S, Wang H, Pepose JS. Poor correlation between reactive syphilis serology and human immunodeficiency virus testing among potential cornea donors. *Am J Ophthalmol* 1995; 119:1-6.
143. Mascari MS, Norris SJ. OptiSol corneal storage medium and transmission of *Treponema pallidum*. *Cornea* 1995; 14:595-600.
144. Commission Directive 2004/23/EC of the European Parliament and of the Council of 31 March 2004 on setting standards for quality and safety in the donation, procurement, testing, processing, preservation, storage and distribution of human tissues and cells. *Official Journal of the European Union* L 102/48 07/04/2004:48-58. http://ec.europa.eu/health/ph_threats/human_substance/legal_tissues_cells_en.htm

145. Commission Directive 2006/17/EC of February 2006 implementing Directive 2004/23/EC of the European Parliament and of the Council as regards certain technical requirements for the donation, procurement and testing of human tissues and cells.
http://ec.europa.eu/health/ph_threats/human_substance/legal_tissues_cells_en.htm
146. Commission Directive 2006/86/EC of 24 October implementing Directive 2004/23/EC of the European Parliament and of the Council as regards traceability requirements, notification of serious adverse reactions and events, and certain technical requirements for the coding, processing, preservation, storage and distribution of human tissues and cells.
http://ec.europa.eu/health/ph_threats/human_substance/legal_tissues_cells_en.htm
147. Laycock KA, Wright TL, Pepose JS. Lack of evidence for hepatitis C virus in corneas of seropositive cadavers. *Am J Ophthalmol* 1994; 117:401-402.
148. Laycock KA, Essary LR, Delaney S, Kuhns MC, Pepose JS. A critical evaluation of hepatitis C testing of cadaveric corneal donors. *Cornea* 1997; 16:146-150.
149. Cahane M, Barak A, Goller O, Avni I. The incidence of hepatitis C virus positive serological test results among cornea donors. *Cell Tissue Bank* 2000; 1:81-85.
150. Anderson LJ, Williams LP, Layde JB, Dixon FR, Winkler WG. Nosocomial rabies: Investigation of contacts of human rabies cases associated with a corneal transplant. *Am J Public Health* 1984; 74:370-372.
151. Srinivasan A, Burton EC, Kuehnert MJ et al. Transmission of rabies virus from an organ donor to four transplant recipients. *The New Engl J Med* 2005; 352:1103-1111.
152. Hogan RN, Cavanagh HD. Transplantation of corneal tissue from donors with diseases of the central nervous system. *Cornea* 1995; 14:547-553.
153. Mehta JS, Franks WA. The sclera, the prion and the ophthalmologist. *Br J Ophthalmol* 2002; 86:587-592.
154. Maddox RA, Belay ED, Curns AT et al. Creutzfeldt-Jakob disease in recipients of corneal transplants. *Cornea* 2008; 27:851-854.
155. Head MW, Northcott V, Rennison K, et al. Prion protein accumulation in eyes of patients with sporadic and variant Creutzfeldt-Jakob disease. *Invest Ophthalmol Vis Sci* 2003; 44:342-346.
156. Tullo AB, Buckley RJ, Kelly T, Head MW, Bennett P, Armitage WJ, Ironside JW. Transplantation of ocular tissue from a donor with sporadic Creutzfeldt Jakob disease. *Clin Experiment Ophthalmol* 2006; 34:645-649.
157. Armitage WJ, Tullo AB, Ironside JW. Risk of Creutzfeldt-Jakob disease transmission by ocular surgery and tissue transplantation. *Eye* 2009 Jan 9.

158. Wehrly SR, Manning FJ, Proia AD, Burchette JL, Foulks GN. Cytomegalovirus keratitis after penetrating keratoplasty. *Cornea* 1995; 14:628-633.
159. Remeijer L, Maertzdorf J, Doornenbal P, Verjans GM, Osterhaus AD. Herpes simplex virus 1 transmission through corneal transplantation. *Lancet* 2001; 375:442.
160. Biswas S, Suresh P, Bonshek RE, Corbitt G, Tullo AB, Ridgeway AE. Graft failure in human donor corneas due to transmission of herpes simplex virus. *Br J Ophthalmol* 2000; 84:701-705.
161. Robert PY, Adenis JP, Denis F, Alain S, Ranger-Rogez S. Herpes simplex virus DNA in corneal transplants: prospective study of 38 recipients. *J Med Virol* 2003; 71:69-74.
162. Sengler U, Spelsberg H, Reinhard T et al. Herpes simplex virus (HSV-1) infection in a donor cornea. *Br J Ophthalmol* 1999; 83:1405.
163. Tullo AB, Marcyniuk B, Bonshek R, Dennett C, Cleator GM, Lewis AG, Klapper PE. Herpes virus in a corneal donor. *Eye* 1990; 4:766-777.
164. Sengler U, Reinhard T, Adams O, Krempe C, Sundmacher R. Herpes simplex virus infection in the media of donor corneas during organ culture: frequency and consequences. *Eye* 2001; 15:644-647.
165. Cockerham GC, Krafft AE, McLean IW. Herpes simplex virus in primary graft failure. *Arch Ophthalmol.* 1997; 115:586-589.
166. Cleator GM, Klapper PE, Dennett C, Sullivan AL, Bonshek RE, Marcyniuk B, Tullo AB. Corneal donor infection by herpes simplex virus: herpes simplex virus DNA in donor corneas. *Cornea* 1994; 13:294-304.
167. De Kesel RJ, Koppen C, Teven M, Zeyen T. Primary graft failure caused by herpes simplex virus type 1. *Cornea* 2001; 20:187-190.
168. Robert PY, Adenis JP, Pleyer U. How safe is corneal transplantation. A contribution on the risk of HSV-transmission due to corneal transplantation. *Klin Monatsbl Augenheilkd* 2005; 222:870-873.
169. Morris DJ, Cleator GM, Klapper PE, et al. Detection of herpes simplex virus DNA in donor cornea culture medium by polymerase chain reaction. *Br J Ophthalmol* 1996; 80:654-657.
170. Remeijer L. Human Herpes simplex virus keratitis: the pathogenesis revisited, Thesis, Erasmus University, Rotterdam, The Netherlands 2002.
171. Ehlers N, Corneal banking and grafting. The background to the Danish Eye Bank system, where corneas await their patients. *World Forum on Eye Banking. Acta Ophthalmol* 2002; 80:572-578.
172. Heim A, Wagner D, Rothämel T, Hartman U, Flik J, Verhagen W. Evaluation of serological screening of cadaveric sera for donor selection for cornea transplantation. *J Med Virol* 1999; 58:291-295.

173. Taban M, Behrens A, Newcomb RL, Nobe MY, McDonnell PJ. Incidence of acute endophthalmitis following penetrating keratoplasty: a systematic review. *Arch Ophthalmol* 2005; A:123:605-609.
174. Taban M, Behrens A, Newcomb RL, et al. Acute endophthalmitis following cataract surgery: a systematic review of the literature. *Arch Ophthalmol* 2005; B 123:613-620.
175. Polack FM, Locatcher-Khorazo D, Gutierrez E. Bacteriologic study of "donor eyes". Evaluation of antibacterial treatments prior to corneal grafting. *Arch Ophthalmol* 1967; 78:219-225.
176. Pardos GJ, Gallagher MA. Microbial contamination of donor eyes. A retrospective study. *Arch Ophthalmol* 1982; 100:1611-1613.
177. Robert PY, Camezind P, Drouet M, Ploy MC, Adenis JP. Internal and external contamination of donor corneas before in situ excision: bacterial risk factors in 93 donors. *Graefes Arch Clin Exp Ophthalmol* 2002; 240:265-270.
178. Sugar J, Liff J. Bacterial contamination of corneal donor tissue. *Ophthalmic Surg* 1980; 11:250-252.
179. Hassan SS, Wilhelmus KR, Dahl P, Davis GC, Roberts RT, Ross K, Varnum BH. Infectious disease risk factors of corneal graft donors. *Arch Ophthalmol* 2008; 126:235-239.
180. Rehany U, Balut G, Lefler E, Rumelt S. The prevalence and risk factors for donor corneal button contamination and its association with ocular infection after transplantation. *Cornea* 2004; 23 :649-654.
181. Nash RW, Lindquist LD, Kalina RE. An evaluation of saline irrigation and comparison of povidone-iodine and antibiotic in the surface decontamination of donor eyes. *Arch Ophthalmol* 1991; 109:869-872.
182. Builles N, Perraud M, Reverdy ME, Burillon C, Crova P, Brun F, Chapuis F, Damour O. Reducing contamination when removing and storing corneas: a multidisciplinary, transversal, and environmental approach. *Cornea* 2006; 25:185-192.
183. Bonner T, Doughman DJ, Mindrup E, Stroud D. Mortician Retrieval of Donor globes: The Minnesota Experience. *Minn Med* 1984; 67:449-454.
184. Borderie VM, Laroche L. Microbiologic study of organ-cultured donor corneas. *Transplantation* 1998; 66:120-123.
185. Lane SS, Mizener MW, Dubbel PA, Mindrup EA, Wick AA, Doughman DJ, Holland EJ. Whole globe enucleation versus in situ corneal excision: a study of tissue trauma and contamination. *Cornea* 1994; 13:305-309.
186. Garweg J, Hagenah M, Englmann K, Böhnke M. Corneoscleral discs excised from enucleated and non-enucleated eyes are equally suitable for transplantation. *Acta Ophthalmol* 1997; 75:483-486.

187. Jhanji V, Tandon R, Sharma N, Titiyal JS, Satpathy G, Vajpayee RB. Whole globe enucleation versus in situ excision for donor corneal retrieval -a prospective comparative study. *Cornea* 2008; 27:1103-1108.
188. Sperling S, Sørensen IG. Decontamination of cadaver corneas. *Acta Ophthalmol* 1981; 59:126-133.
189. Pels E, Vrensen GF. Microbial decontamination of human donor eyes with povidone-iodine: penetration, toxicity, and effectiveness. *Br J Ophthalmol* 1999; 83:1019-1026.
190. Baum J, Barza M, Kane A. Efficacy of penicillin G, cefazolin and gentamycin in M-K medium at 4 degrees C. *Arch Ophthalmol* 1978; 96:1262-1264.
191. Kapur R, Tu EY, Pendland SL et al. The effect of temperature on the antimicrobial activity of Optisol-GS. *Cornea* 2006; 25:319-324.
192. Yau CW, Busin M, Kaufman HE. Ocular concentration of gentamicin after penetrating keratoplasty. *Am J Ophthalmol* 1986; 101:44-48.
193. Nirankari VS, Dandona L, Rodrigues MM, Schwalbe RS. Antibiotic prophylaxis in corneal storage media. *Trans Am Ophthalmol Soc.* 1994; 92:181-196.
194. Albon J, Armstrong M, Tullo AB. Bacterial contamination of human organ-cultured corneas. *Cornea* 2001; 20:260-263.
195. Zanetti E, Bruni A, Mucignat G, Camposiero D, Chiara frigo A, Pozin D. Bacterial contamination of human organ-cultured corneas. *Cornea* 2005; 24:603-607.
196. Saini JS, Reddy MK, Sharma S, Wagh S. Donor corneal tissue evaluation. *Indian J Ophthalmol.* 1996; 44:3-13.
197. Keyhani K, Seedor JA, Shah MK, Terraciano AJ, Ritterband DC. The incidence of fungal keratitis and endophthalmitis following penetrating keratoplasty. *Cornea* 2005; 24:288-291.
198. Fontana L, Errani PG, Zerbinati A, Musacchi Y, Di Pede B, Tassinari G. Frequency of positive donor rim cultures after penetrating keratoplasty using hypothermic and organ-cultured donor corneas. *Cornea* 2007; 26:552-556.
199. Hagenah M, Böhnke M, Engelmann K, Winter R. Incidence of bacterial and fungal contamination of donor corneas preserved by organ culture. *Cornea* 1995; 14:423-426.
200. Larsen PA, Lindstrom RL, Doughman DJ. *Torulopsis glabrata* endophthalmitis after keratoplasty with an organ-cultured cornea. *Arch Ophthalmol* 1978; 96:1019-1022.
201. Al-Assiri A, Al-Jastaneiah S, Al-Khalaf A, Al-Fraikh H, Wagoner MD. Late-onset donor-to-host transmission of *Candida glabrata* following corneal transplantation. *Cornea* 2006; 25:123-125.

202. Tappeiner C, Goldblum D, Zimmerli S, Fux C, Frueh BE. Donor-to-host transmission of *Candida glabrata* to both recipients of corneal transplants from the same donor. *Cornea* 2009; 28:228-230.
203. Antonios SR, Cameron JA, Badr IA, et al. Contamination of donor cornea: Postpenetrating keratoplasty endophthalmitis. *Cornea* 1991; 10:217-220.
204. Kloess PM, Stulting D, Waring GO 3rd, Wilson LA. Bacterial and fungal endophthalmitis after penetrating keratoplasty. *Am J Ophthalmol* 1993; 115:309-316.
205. Cameron JA, Antonios SR, Cotter JB, Habash NR. Endophthalmitis from contaminated donor corneas following penetrating keratoplasty. *Arch Ophthalmol* 1991; 109:54-59.
206. Everts RJ, Fowler WC, Chang DH, Reller LB. Corneoscleral rim cultures: lack of utility and implications for clinical decision-making and infection prevention in the care of patients undergoing corneal transplantation. *Cornea* 2001;20: 586-589.
207. Leveille AS, McMullan FD, Cavanagh HD. Endophthalmitis following penetrating keratoplasty. *Ophthalmology* 1983; 90:38-39.
208. Stocker FW. The endothelium of the cornea and its clinical implications. *Trans Am Ophthalmol Soc* 1953; 5:165-173.
209. Bourne WM, O'Fallon WM. Endothelial cell loss during penetrating keratoplasty. *Am J Ophthalmol* 1978; 85:760-766.
210. Bourne WM, Hodge DO, Nelson LR. Corneal endothelium five years after transplantation. *Am J Ophthalmol* 1994; 118:185-196.
211. Bourne WM. Cellular changes in transplanted human corneas. *Cornea* 2001; 20:560-569.
212. Pels E, Schuchard Y (1986) Organ culture and endothelial evaluation as a preservation method for human corneas. In: Brightbill FS (ed). *Corneal Surgery* (ed3). Mosby Co, St Louis; 1993: 622-633.
213. Maurice DM. Cellular membrane activity in the corneal endothelium of the intact eye. *Experientia* 1968; 24:1094-1095.
214. Jalbert I, Stapleton F, Papas E, Sweeney DF, Coroneo M. In vivo confocal microscopy of the human cornea. *Br J Ophthalmol* 2003; 87:225-236.
215. Masters BR. David Maurice's contributions to optical ophthalmic instrumentation: roots of the scanning slit clinical confocal microscope. *Exp Eye Res* 2004; 78:315-326.
216. Rosenwasser GO, Nicholson WJ. Introduction to eye banking: a handbook and atlas. *Proforma* 2003; 106-117.
217. Thuret G, Manisolle C, Aquart S, Le Petit JC et al. Is manual counting of corneal endothelial cell density in eye banks still acceptable? The French experience. *Br J Ophthalmol* 2003; 87:1481-1486.

218. Dikstein S, Maurice DM. The metabolic basis to the fluid pump in the cornea. *J Physiol* 1972; 221:229.
219. Odenthal MT. In vivo studies on human corneal endothelial morphology and function. Thesis University of Amsterdam, The Netherlands, 2007.
220. Edelhauser HF, Van Horn DL, Hyndiuk RA, Schultz RO. Intraocular irrigating solutions. Their effect on the corneal endothelium. *Arch Ophthalmol* 1975; 93:648-657.
221. Geroski DH, Edelhauser HF. Quantitation of Na/K ATPase pump sites in the rabbit corneal endothelium. *Invest Ophthalmol Vis Sci* 1984; 25:1056-1060.
222. O'Donnell C, Maldonado-Codina C. Agreement and repeatability of central corneal thickness measurement in normal corneas using ultrasound pachymetry and the OCULUS Pentacam, *Cornea* 2005; 24:920-924.
223. Ehlers N. Graft thickness after penetrating keratoplasty. *Acta Ophthalmol* 1974; 56:412-416.
224. Forster RK, Fine M. Relation of donor age to success in penetrating keratoplasty. *Arch Ophthalmol* 1971; 85:42-47.
225. Williams KA, Roder D, Esterman A, et al. Factors predictive of corneal graft survival: Report from the Australian Corneal Graft Registry. *Ophthalmology* 1992; 99:403-414.
226. Williams KA, Muehlberg SM, Lewis RF, Coster DJ. Influence of advanced recipient and donor age on the outcome of corneal transplantation. Australian Corneal Graft Registry. *Br J Ophthalmol* 1997; 81:835-839.
227. Beck RW, Gal RL, Mannis MJ, et al. Is donor age an important determinant of graft survival? *Cornea* 1999; 18:503-510.
228. Völker-Dieben HJ, D'Amaro J, Kok-van Alphen CC. Hierarchy of prognostic factors for corneal allograft survival. *Aust N Z J Ophthalmol* 1987; 15:11-18.
229. Cornea Donor Study Investigator Group, Gal RL, Dontchev M, Beck RW, Mannis MJ, Holland EJ, Kollman C, Dunn SP, Heck EL, Lass JH, Montoya MM, Schultze RL, Stulting RD, Sugar A, Sugar J, Tennant B, Verdier DD. The effect of donor age on corneal transplantation outcome results of the cornea donor study. *Ophthalmology* 2008; 115:620-626.
230. Meyer CH. Can corneal grafts survive over 100 years? *An Inst Barraquer* 2000; 29:15-28.
231. Meyer CH, Muller MF, Meyer H. Can we trust elderly donor grafts for corneal transplantation. *BMJ* 2001; 322:108-109.
232. Culbertson WW, Abbott RL, Forster RK. Endothelial cell loss in penetrating keratoplasty. *Ophthalmology*. 1982; 89:600-604.
233. Armitage WJ, Easty DL. Factors influencing the suitability of organ cultured corneas for transplantation. *Invest Ophthalmol Vis Sci* 1997; 38:16-24.

234. Gain P, Thuret G, Chiquet C, et al. Cornea procurement from very old donors: post organ culture cornea outcome and recipient graft outcome. *Br J Ophthalmol* 2002; 86:404-411.
235. Pels E, Beekhuis WH, Völker-Dieben HJ. Long term tissue storage for keratoplasty. In: Brightbill FS, (ed) *Corneal Surgery. Theory, Technique and Tissue* ed 3. St Louis: Mosby, 1999; 879-901.
236. Maas H, Tullo AB, Pels E *Directory of the European Eye Bank Association*(ed 11) Antwerp, Belgium 2003.
237. Claerhout I, Maas H, Pels E. *Directory of the European Eye Bank Association* (ed 14) Venice, Italy 2006.
238. Koenig SB. Donor age. In Brightbill FS(ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 1. St Louis. Mosby Co; 1986:6-24.
239. Schimmelpfennig B. Tissue storage, short term-state of the art. In: Brightbill FS (ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 1. St Louis, Mosby Co; 1986:60-75.
240. Slettedal JK, Lyberg T, Ramstad H, Beraki K, Nicolaissen B. Regeneration of the epithelium in organ-cultured donor corneas with extended post-mortem time. *Acta Ophthalmol* 2007; 85:371-376.
241. Slettedal JK, Lyberg T, Røger M, Beraki K, Ramstad H, Nicolaissen B. Regeneration with proliferation of the endothelium of cultured human donor corneas with extended postmortem time. *Cornea*. 2008; 27:212-219.
242. Bigar F, Schimmelpfennig B, Hürzeler R. Cornea guttata in donor material. *Arch Ophthalmol* 1978; 96:653-655.
243. Shaw EI, Rao GN, Arthur EJ, Aquavella VJ. The functional reserve of corneal endothelium. *Trans Ophthalmology* 1978; 85:640-649.
244. Sobottka Ventura AC, Rodokanak-von Schrenk A, Hollstein K, Hagenah M, Böhnke M, Engelmann K. Endothelial cell death in organ-cultured donor corneae: the influence of traumatic versus nontraumatic cause of death. *Graefes Arch Clin Exp Ophthalmol* 1997; 235:230-233.
245. Pels L. Organ Culture: the method of choice for preservation of human donor corneas. *Br J Ophthalmol* 1997; 81:523-525.
246. Bourne WM. Examination and Photography of donor corneal endothelium. *Arch Ophthalmol* 1976; 94:1799-1800.
247. Schimmelpfennig B, Bigar F, Witmer R, Hürzeler R. Endothelial changes in human donor corneas. *Graefes Arch Klin Exp Ophthalmol* 1976; 200:201-210.
248. Brown N. Macrophotography of the anterior segment of the eye. *Br J Ophthalmol* 1970; 54: 697-701.
249. Bourne WM, Kaufman HE. Specular microscopy of human corneal endothelium in vivo. *Am J Ophthalmol* 1976; 81:319-323.

250. Sugar A. Clinical specular microscopy. *Surv Ophthalmol* 1979; 24:21-32.
251. Kirk AH, Hassard DT. Supravital staining of the corneal endothelium and evidence for a membrane on its surface. *Can J Ophthalmol* 1969; 4:405-415.
252. Sperling S. Evaluation of the endothelium of human donor corneas by induced dilation of intercellular spaces and trypan blue. *Graefes Arch Clin Exp Ophthalmol* 1986; 224:428-434.
253. Thuret G, Manissolle C, Herrag S, Deb N, Campos-Guyotat L, Gain P, Acquart S. Controlled study of the influence of storage medium type on endothelial assessment during corneal organ culture. *Br J Ophthalmol* 2004; 88:579-581.
254. Stocker FW, King EH, Lucas DO, Georgiade NA. Clinical test for evaluating donor corneas. *Arch Ophthalmol* 1970; 84:2-7.
255. Singh G, Böhnke M, von-Domarus D, et al. Vital staining of corneal endothelium. *Cornea* 1985-1986; 4:80-91.
256. Van Schaick W, van Dooren BT, Mulder PGH, Völker-Dieben HJ. Validity of endothelial cell analysis methods and recommendation for calibration in Topcon SP-2000P specular microscopy. *Cornea* 2005; 24:538-544.
257. Ohno K, Nelson LR, McLaren JW, Hodge DO, Bourne WM. Comparison of recording systems and analysis methods in specular microscopy. *Cornea* 1999; 18:416-423.
258. Gundersen HJ. Notes on the estimation of the numerical density of arbitrary profiles. The edge effect. *J microscopy* 1977; 111(II):219-223.
259. Gain P, Thuret G, Chiquet C et al (2002) Automated analyser of organ cultured corneal endothelial mosaic. *Fr J Ophthalmol* 2002; 25:462-472.
260. Lin RC, Li Y, Tang M, McLain M, Rollins AM, Izatt JA, Huang D. Screening for previous refractive surgery in eye bank corneas by using optical coherence tomography. *Cornea* 2007; 26:594-599.
261. Priglinger SG, Neubauer AS, May CA, Alge CS, Wolf AH, Mueller A, Ludwig K, Kampik A, Welge-Luessen U. Optical coherence tomography for the detection of laser in situ keratomileusis in donor corneas. *Cornea*. 2003; 22:46-50.
262. Mootha VV, Dawson D, Kumar A, Gleiser J, Qualls C, Albert DM. Slitlamp, specular, and light microscopic findings of human donor corneas after laser-assisted in situ keratomileusis. *Arch Ophthalmol* 2004; 122:686-692.
263. Armour RL, Ousley PJ, Wall J, Hoar K, Stoeger C, Terry MA. Endothelial keratoplasty using donor tissue not suitable for full-thickness penetrating keratoplasty. *Cornea* 2007; 26:515-519.
264. Terry MA. Precut tissue for Descemet stripping automated endothelial keratoplasty: complications are from technique, not tissue. *Cornea* 2008; 27:627-629.
265. Terry MA, Saad HA, Shamie N, Chen ES, Phillips PM, Friend DJ, Holiman JD, Stoeger C. Endothelial keratoplasty: the influence of insertion techniques and incision size on donor endothelial survival. *Cornea* 2009; 28:24-31.

266. Bourne WM. Corneal Preservation. In: Kaufman HE, Barron BA, Waltman SR, McDonald MB (eds) *The Cornea*. Oxford, Butterworth-Heinemann; 1988:713-724.
267. Basu PK, Hasany SM, Ranadive NS, Chipman M. Damage to corneal endothelial cells by lysosomal enzymes in stored human eyes. *Can J Ophthalmol* 1980; 15:137-140.
268. Hoefle FB, Maurice DM, Sibley R. Human corneal donor material: a method of examination before keratoplasty. *Arch Ophthalmol* 1970; 84:741-744.
269. Laing RA. Tissue evaluation: specular microscopy of donor corneas. In: Brightbill FS (ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 1. St Louis, Mosby Co; 1986:35-46.
270. Reinhart WJ. Tissue evaluation, gross and slitlamp examination of the donor eye. In: Brightbill FS(ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 1. St Louis, Mosby Co; 1986:30-35.
271. Basu PK. A review of methods for storage of corneas for keratoplasty. *Indian J Ophthalmol* 1995; 43:55-58.
272. Smith TM, Popplewell J, Nakamura T, Trousdale MD. Efficacy and safety of gentamicin and streptomycin in Optisol-GS, a preservation medium for donor corneas. *Cornea* 1995; 14:49-55.
273. Steinemann TL, Kaufmann HE, Lindstrom RL, Beuerman RW, Varnell ED. Intermediate-term storage media (K-Sol, Dextsol, Optisol. In: Brightbill FS (ed). *Corneal Surgery*, ed 2. St Louis, Mosby Co; 1993:609-613.
274. Nelson LR, Hodge DO, Bourne WM. In vitro comparison of Chen medium and Optisol-GS medium for human corneal storage. *Cornea* 2000; 19:782-787.
275. Friedland BR, Forster RK. Comparison of corneal storage in Mc Carey Kaufman medium, moist chamber, or standard eye-bank conditions. *Investigative Ophthalmol* 1975; 15:143-147.
276. Means TL, Geroski DH, Hadley A, et al. Viability of human corneal endothelium following Optisol-GS storage. *Arch Ophthalmol* 1995; 113:805-809.
277. Kim T, Palay DA, Lynn M. Donor factors associated with epithelial defects after penetrating keratoplasty. *Cornea* 1996; 15:451-456.
278. Pels E, Schuchard Y. The effects of high molecular weight dextran on the preservation of human corneas. *Cornea* 1984-1985; 3:219-227.
279. Müller LJ, Pels E, Vrensen GF. The effects of organ-culture on the density of keratocytes and collagen fibers in human corneas. *Cornea* 2001; 20:86-95.
280. Camposampiero D, Tiso R, Zanetti E et al. Improvement of human corneal endothelium in culture after prolonged hypothermic storage. *Eur J Ophthalmol* 2003; 13:745-751.

281. Böhnke M: Donor tissue for keratoplasty. Report of experiences by the Hamburg cornea bank The Hamburg system of corneal preservation. *Klin Mbl Augenheilk* 1991; 198:562-571.
282. Pels E, Beele H, Claerhout I. Eye bank issues: II. Preservation techniques: warm versus cold storage. *Int Ophthalmol*. 2008; 28:155-163.
283. Spelsberg H, Reinhard T, Sengler U, Daeubener W, Sundmacher R. Organ-cultured corneal grafts from septic donors: a retrospective study. *Eye* 2002; 16:622-627.
284. Frueh BE, Böhnke M. Corneal Grafting of Donor Tissue Preserved for Longer than 4 Weeks in Organ-Culture Medium. *Cornea* 1995; 14:463-466.
285. Kissam RS. Ceratoplastie in man. *NYJ Med* 1844; 2:281-282.
286. Reisinger F. Die keratoplastik ein Versuch zur Erweiterung der Augenheilkunst. *Bayerische Annalen* 1824; 1:207-215.
287. Rycroft B. The corneal graft- past, present and future. *Trans Ophthalmol Soc UK* 1965; 85:459-517.
288. Laibson PR. History of corneal transplantation. In: Brightbill FS(ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 4. St Louis, Mosby Elsevier; 2009:1-7.
289. Laibson PR, Rapuano CJ. 100 year review of cornea. *Ophthalmology* 1996; 103:17-28.
290. Casey TA, Mayer DJ. The history of corneal grafting. In: Casey TA, Mayer DJ, (eds). *Corneal Grafting: Principles and Practice*. London: W.B. Saunders; 1984:9-16.
291. Power H. Zur Transplantations rage der cornea. *Klin Mbl Augenheilk* 1878; 16: 35-39.
292. Elschmig A, Vorisek EA. Keratoplasty. *Arch Ophthalmol* 1930; 4:165-173.
293. Castroviejo R. Keratoplasty. A historical and experimental study, including a new method. *Am J Ophthalmol* 1932; 15:825-838.
294. Castroviejo R. Keratoplasty. Comments on techniques of corneal transplantation. Source and preservation of donor's material. Report of new instruments. *Am J Ophthalmol* 1941; 24:1-2, 139-155.
295. Barraquer JI Jr. Technique of penetrating keratoplasty. *Am J Ophthalmol* 1950; 33:6-17.
296. Stocker FW. Successful corneal graft in a case of endothelial and epithelial dystrophy. *Am J Ophthalmol* 1952; 35:349-352.
297. Vail D. The Eye bank for sight restoration. *Am J Ophthalmol* 1953; 36:723-725.
298. Maumenee AE. Clinical aspects of the corneal homograft reaction. *Invest Ophthalmol* 1962; 1:244-252.

299. Batchelor JR, Casey TA, Werb A, Gibbs DC, Prasad SS, Lloyd DF, James A. HLA matching and corneal grafting. *Lancet* 1976; 1:551-554.
300. Völker-Dieben HJ, Kok-van Alphen CC, Oosterhuis, van Dorp G, van Leeuwen A. First experiences with HLA-matched corneal grafts in high risk cases. *Doc Ophthalmol* 1977; 44:39-48.
301. Ehlers N, Kissmeyer-Nielsen F. Corneal transplantation and HLA histocompatibility. A preliminary communication. *Acta Ophthalmol* 1979; 57:738-741.
302. Völker-Dieben HJ, Kok-van Alphen CC, Lansbergen Q, Persijn GG. The effect of prospective HLA-A and -B matching on corneal graft survival. *Acta Ophthalmol* 1982; 60:203-212.
303. Völker-Dieben HJ, Claas FH, Schreuder GM, Schipper RF, Pels E, Persijn GG, Smits J, D'Amario J. Beneficial effect of HLA-DR matching on the survival of corneal allografts. *Transplantation* 2000 27; 70:640-648.
304. Vail A, Gore SM, Bradley BA, Easty DL, Rogers CA, Armitage WJ. Conclusions of the corneal transplant follow-up study. *Collaborating Surgeons. Br J Ophthalmol* 1997; 81:631-636.
305. Böhringer D, Reinhard T, Böhringer S, Enczmann J, Godehard E, Sundmacher R. Predicting time on the waiting list for HLA matched corneal grafts. *Tissue Antigens* 2002; 59:407-411.
306. Arentsen JJ, Morgan B, Green WR. Changing indications for keratoplasty. *Am J Ophthalmol* 1976; 81:313-318.
307. Smith RE, McDonald HR, Nesburn AB, Minckler DS. Penetrating keratoplasty, changing indications, 1947 to 1978. *Arch Ophthalmol* 1980; 98:1226-1229.
308. Ghosheh FR, Cremona FA, Rapuano CJ, Cohen EJ, Ayres BD, Hammersmith KM, Raber IM, Laibson PR. Trends in penetrating keratoplasty in the United States 1980-2005. *Int Ophthalmol* 2008; 28:147-153.
309. Sutphin JE. Indications and contraindications of penetrating keratoplasty. In: Brightbill FS(ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 4. St Louis. Mosby Elsevier; 2009:365-377.
310. Vail A, Gore SM, Bradley BA, Easty DL, Rogers CA. Corneal graft survival and visual outcome. A multicenter Study. *Corneal Transplant Follow-up Study Collaborators. Ophthalmology* 1994; 101:120-127.
311. Williams KA, Esterman AJ, Bartlett C, et al. How effective is corneal transplantation? Factors influencing long term outcome in multivariate analysis. *Transplantation* 2006; 81:896-901.
312. Claesson M, Armitage WJ, Fagerholm P, Stenevi U. Visual outcome in corneal grafts: a preliminary analysis of the Swedish Corneal Transplant Register. *Br J Ophthalmol*. 2002; 86:174-180.

313. Segal O, Barkana Y, Hourovitz D, Behrman S, Kamun Y, Avni I, Zadok D. Scleral contact lenses may help where other modalities fail. *Cornea* 2003; 22:308-310.
314. Geerards AJ, Vreugdenhil W, Khazen A. Incidence of rigid gas-permeable contact lens wear after keratoplasty for keratoconus. *Eye Contact Lens* 2006; 32:207-210.
315. Visser ES, Visser R, van Lier HJ, Otten HM. Modern scleral lenses part I: clinical features. *Eye Contact Lens* 2007; 33:13-20.
316. Tahzib NG, Cheng YY, Nuijts RM. Three-year follow-up analysis of Artisan toric lens implantation for correction of postkeratoplasty ametropia in phakic and pseudophakic eyes. *Ophthalmology* 2006; 113:976-984.
317. Malbran E. Lamellar keratoplasty in keratoconus. In: King JH, McTigue JW, eds. *Cornea World Congress 1965*. Washington DC: Butterworth Co; 1965:511-518.
318. Polack FM. Queratoplastia lamellar posterior. *Rev Peru Oftalmol* 1965; 2:62-64.
319. Barraquer JI. Two-level keratoplasty. *Int Ophthalmol Clin* 1963; 3:515-539.
320. Tan DT, Mehta JS. Future directions in lamellar corneal transplantation. *Cornea* 2007; 26(9 Suppl 1):S21-28.
321. Tan DT, Anshu A, Mehta JS. Paradigm shifts in corneal transplantation. *Ann Acad Med Singapore* 2009; 38:332-338.
322. Ko W, Freuh B, Shield C, et al. Experimental posterior lamellar transplantation of the rabbit cornea. *Invest Ophthalmol Vis Scie* 1993; 34:1102.
323. Melles GR, Eggink FA, Lander F, et al. A surgical technique for posterior lamellar keratoplasty. *Cornea* 1998; 17:618-626.
324. Melles GR, Wijdh RH, Nieuwendaal CP. A technique to excise the descemet membrane from a recipient cornea (descemetorhexis). *Cornea* 2004; 23:286-288.
325. Melles GR. Posterior lamellar keratoplasty: DLEK to DSEK to DMEK. *Cornea* 2006; 25:879-881.
326. Cheng YY, Pels E, Nuijts RM. Femtosecond-laser-assisted Descemet's stripping endothelial keratoplasty. *J Cataract Refract Surg* 2007; 33:152-155.
327. Terry MA. Endothelial keratoplasty): history, current state, and future directions. *Cornea* 2006; 25:873-878.
328. Cheng YY, Pels E, Cleutjens JP, van Suylen RJ, Hendrikse F, Nuijts RM. Corneal endothelial viability after femtosecond laser preparation of posterior lamellar discs for Descemet-stripping endothelial keratoplasty. *Cornea* 2007; 26:1118-1122.
329. Chen ES, Terry MA, Shamie N, et al. Pre-cut tissue in Descemet's stripping automated endothelial keratoplasty donor characteristics and early postoperative complications. *Ophthalmology* 2008; 115:497-502.
330. Terry MA, Shamie N, Chen ES, Phillips PM, Hoar KL, Friend DJ. Precut tissue for Descemet's stripping automated endothelial keratoplasty: vision, astigmatism, and endothelial survival. *Ophthalmology* 2009; 116:248-256.

331. Terry MA, Shamie N, Chen ES, Hoar KL, Phillips PM, Friend DJ. Endothelial keratoplasty: the influence of preoperative donor endothelial cell densities on dislocation, primary graft failure, and 1-year cell counts. *Cornea* 2008; 27:1131-1137.
332. Seitz B, Br nner H, Viestenz A, et al. Inverse mushroom-shaped nonmechanical penetrating keratoplasty using a femtosecond laser. *Am J Ophthalmol* 2005; 139:941-944.
333. Slade SG. Applications for the femtosecond laser in corneal surgery. *Curr Opin Ophthalmol* 2007; 18:338-341.
334. Kaufman HE, Insler MS, Ibrahim-Elzembely HA, Kaufman SC. Human fibrin tissue adhesive for sutureless lamellar keratoplasty and scleral patch adhesion: a pilot study. *Ophthalmology*. 2003; 110:2168-2172.
335. Yoo SH, Kymionis GD, Koreishi A, Ide T, Goldman D, Karp CL, O'Brien TP, Culbertson WW, Alfonso EC. Femtosecond laser-assisted sutureless anterior lamellar keratoplasty. *Ophthalmology* 2008; 115:1303-1307.
336. Ahmad O, Mian S, Sugar A. The future of keratoplasty. In: Brightbill FS, McDonnell PJ, McGhee CNJ, Farjo AA, Serdarevic ON (eds). *Corneal Surgery: Theory, Technique and Tissue*, ed 4. St Louis, Mosby Elsevier; 2009:597-603.
337. Uiters E, van den Borne B, van der Horst FG, Völker-Dieben HJ. Patient satisfaction after corneal transplantation. *Cornea* 2001; 20:687-694.
338. Coster DJ , Williams KA. Outcomes of penetrating keratoplasty. In: Brightbill FS (ed). *Corneal Surgery: Theory, Technique and Tissue*, ed 4. St Louis. Mosby Elsevier; 2009; 553-560.
339. De Boer, Moll AC, de Vet HC, Terwee CB, Völker-Dieben HJ, van Rens GH. Psychometric properties of vision-related quality of life questionnaires: a systematic review. *Ophthalmic Physiol Opt* 2004; 24:257-273.
340. Wet op de geneeskundige behandelingsovereenkomst. *Burgerlijk Wetboek*, afdeling 5, art 446 t/m 468. Ministerie van VWS. www.minvws.nl/dossiers/wet-op-de-geneeskundige-behandelingsovereenkomst.
341. Wilson SE, Kaufman HE. Graft failure after penetrating keratoplasty. *Surv Ophthalmol* 1991; 35:475-476.
342. Ing JJ, Ing HH, Nelson LR, Hodge DO, Bourne WM. Ten-year postoperative results of penetrating keratoplasty. *Ophthalmology* 1998; 105:1855-1865.
343. Waldock A, Cook SD. Corneal transplantation: how successful are we? *Br J Ophthalmol* 2000; 84:813-815.
344. Muraine M, Sanchez C, Watt L, Retout A, Brasseur G. Long-term results of penetrating keratoplasty. A 10-year-plus retrospective study. *Graefes Arch Clin Exp Ophthalmol* 2003; 241:571-576.

345. Thompson RW Jr, Price MO, Bowers PJ, Price FW Jr. Long-term graft survival after penetrating keratoplasty. *Ophthalmology* 2003; 110:1396-1402.
346. Nishimura JK, Hodge DO, Bourne WM. Initial endothelial cell density and chronic endothelial cell loss rate in corneal transplants with late endothelial failure. *Ophthalmology* 1999; 106:1962-1965.
347. Peto R, Pike MC, Armitage P, Breslow NE, Cox DR, Howard SV, Mantel N, McPherson K, Peto J and Smith PG. Design and analysis of randomized clinical trials requiring prolonged observation of each patient. Part I, Introduction and design. *J Cancer* 1976; 34:595-612.
348. Peto R, Pike MC, Armitage P, Breslow NE, Cox DR, Howard SV, Mantel N, McPherson K, Peto J and Smith PG. Design and analysis of randomized clinical trials requiring prolonged observation of each patient. Part II, Analysis and examples. *J Cancer* 1977; 35:1-39.
349. Matsuda M, Bourne WM. Long-term morphologic changes in the endothelium of transplanted corneas. *Arch Ophthalmol* 1985; 103:1343-1346.
350. Patel SV, Hodge DO, Bourne WM. Corneal endothelium and postoperative outcomes 15 years after penetrating keratoplasty. *Trans Am Ophthalmol Soc* 2004; 102:57-65.
351. McDonnell PJ, Enger C, Stark WJ, Stulting RD. Corneal thickness changes after high-risk penetrating keratoplasty. Collaborative Corneal Transplantation Study Group. *Arch Ophthalmol* 1993; 111:1374-1381.
352. Ehlers N, Hjortdal J. Corneal thickness: measurement and implications. *Exp Eye Res* 2004; 78:543-548.
353. Martola EL, Baum JL. Central and peripheral corneal thickness. A clinical study. *Arch Ophthalmol* 1968; 79:28-30.
354. Borderie VM, Touzeau O, Bourcier T, Allouch C, Zito E, Laroche L. Outcome of graft central thickness after penetrating keratoplasty. *Ophthalmology* 2005; 112:626-633.
355. Jensen LB, Hjortdal J, Ehlers N. Longterm follow-up after penetrating keratoplasty for keratoconus. *Acta Ophthalmol* 2009 Jun 26 (epub ahead of print).
356. Coster DJ. Evaluation of corneal transplantation. *Br J Ophthalmol* 1997; 81:618-619.
357. Maguire MG, Stark WJ, Gottsch JD, Stulting RD, Sugar A, Fink NE, Schwartz A. Risk factors for corneal graft failure and rejection in the collaborative corneal transplantation studies. *Ophthalmology* 1994; 101:1536-1547.
358. Hick S, Laliberté JF, Meunier J, Ousley PJ, Terry MA, Brunette I. Topographic screening of donor eyes for previous refractive surgery. *J Cataract Refract Surg* 2006; 32:309-317.

359. Wolf AH, Neubauer AS, Priglinger SG, Kampik A, Welge-Luessen UC. Detection of laser in situ keratomileusis in a postmortem eye using optical coherence tomography. *J Cataract Refract Surg* 2004; 30:491-495.
360. Lim-Bon-Siong R, Williams JM, Samapunphong S, Chuck RS, Pepose JS. Screening of myopic photorefractive keratectomy in eye bank eyes by computerized videokeratography. *Arch Ophthalmol* 1998; 116:617-623.
361. Ousley PJ, Terry MA. Objective screening methods for prior refractive surgery in donor tissue. *Cornea* 2002; 21:181-188.
362. Brown JS, Wang D, Li X, Baluyot F, Iliakis B, Lindquist TD, Shirakawa R, Shen TT, Li X. In situ ultrahigh-resolution optical coherence tomography characterization of eye bank corneal tissue processed for lamellar keratoplasty. *Cornea* 2008; 27:802-810.
363. Jones B.R. Ciba Foundation Symposium: Corneal graft Failure, Associated Scientific Publishers. Amsterdam / London/ New York; 1973:344.
364. Polack FM. Corneal Transplantation. New York: Grune & Stratton 1977; 163-175.
365. Casey TA, Mayer DJ. Corneal anatomy and pathophysiology. In: Casey TA, Mayer DJ (eds). *Corneal Grafting: Principles and Practice*. London: WB Saunders; 1984:17-26.
366. Pantanelli S, MacRae S, Jeong TM, Yoon G. Characterizing the wave aberration in eyes with keratoconus or penetrating keratoplasty using a high-dynamic range wavefront sensor. *Ophthalmology* 2007; 114:2013-2021.
367. Yagci A, Egrilmez S, Kaskaloglu M, Egrilmez ED. Quality of vision following clinically successful penetrating keratoplasty. *J Cataract Refract Surg* 2004; 30:1287-1294.
368. Pesudovs K, Schoneveld P, Seto RJ, Coster DJ. Contrast and glare testing in keratoconus and after penetrating keratoplasty. *Br J Ophthalmol* 2004; 88:653-657.
369. Fontaine N, Boisjoly H, Gresset J, Charest M, Brunette I, Le François M, Deschênes J, Ponomarenko S. Contrast and glare testing in the assessment of visual performance of candidate eyes for penetrating keratoplasty. *Cornea* 2000; 19:433-438.
370. Patel SV, McLaren JW, Hodge DO, Bourne WM. The effect of corneal light scatter on vision after penetrating keratoplasty. *Am J Ophthalmol* 2008; 146:913-919.
371. Patel SV, Baratz KH, Hodge DO, Maguire LJ, McLaren JW. The effect of corneal light scatter on vision after descemet stripping with endothelial keratoplasty. *Arch Ophthalmol* 2009; 127:153-160.
372. McLaren JW, Patel SV, Bourne WM, Baratz KH. Corneal wavefront errors 24 months after deep lamellar endothelial keratoplasty and penetrating keratoplasty. *Am J Ophthalmol* 2009; 147:959-965.

373. Boisjoly H, Gresset J, Fontaine N, Charest M, Brunette I, LeFrançois M, Deschênes J, Bazin R, Laughrea PA, Dubé I. The VF-14 index of functional visual impairment in candidates for a corneal graft. *Am J Ophthalmol* 1999; 128:38-44.
374. Brahma A, Ennis F, Harper R, Ridgway A, Tullo A. Visual function after penetrating keratoplasty for keratoconus: a prospective longitudinal evaluation. *Br J Ophthalmol* 2000; 84:60-66.
375. Mendes F, Schaumberg DA, Navon S, Steinert R, Sugar J, Holland EJ, Dana MR. Assessment of visual function after corneal transplantation: the quality of life and psychometric assessment after corneal transplantation (Q-PACT) study. *Am J Ophthalmol*. 2003; 135:785-793.
376. Williams KA, Ash JK, Pararajasegaram P, et al. Long term outcome after corneal transplantation. Visual result and patient perception of success. *Ophthalmology* 1991; 98:651-657.
377. Böhringer D, Schindler A, Reinhard T. Satisfaction with penetrating keratoplasty. Results of a questionnaire census. *Ophthalmologie*. 2006; 103:677-681.
378. Salamé N, Pitard A, Queguiner F, Boissier F, Delbosc B. Quality of life after corneal transplantation: a retrospective study. *J Fr Ophtalmol* 2003; 26:1016-1022.
379. Völker-Dieben HJ, D'Amaro J. Corneal transplanation: a single center experience 1976 to 1988. *Clin Transpl* 1988; 249-261.
380. Robin JB, Gindi JJ, Koh K, Schanzlin DJ, Rao NA, York KK, Smith RE. An update of the indications for penetrating keartyoplasty. 1979 through 1983. *Arch Ophthalmol* 1986; 104:87-89.
381. Sharif KW, Casey TA. Changing indications for penetrating keratoplasty, 1971-1990. *Eye* 1993; 7:485-488.
382. Lindquist TD, McNeil I JI, Wilhelmus KR. Indications for keratoplasty. *Cornea* 1994; 13:105-107.
383. Al-Yousuf N, Mavrikakis I, Mavrikakis E, Daya SM. Penetrating keratoplasty: indications over a 10 year period. *Br J Ophthalmol* 2004; 88:998-1001.
384. Hyman L, Wittpenn J, Yang C. Indications and techniques of penetrating keratoplasties, 1985-1988. *Cornea* 1992; 11:573-576.
385. Tan DT, Janardhanan P, Zhou H, Chan YH, Htoon HM, Ang LP, Lim LS. Penetrating keratoplasty in Asian eyes: the Singapore Corneal Transplant Study. *Ophthalmology* 2008; 115:975-982.
386. Chan CM, Wong TY, Yeong SM, Lim TH, Tan DTH. Penetrating keratoplasty in the Singapore National Eye Centre and donor cornea acquisition in the Singapore Eye Bank. *Ann Acad Med Singapore* 1997; 26:395-400.
387. Bradley BA, Vail A, Gore SM, et al. Penetrating keratoplasty in the United Kingdom: an interim analysis of the corneal transplant follow- up study. *Clin Transpl* 1993; 293-315.

388. TRIP = Transfusie Reacties in Patienten (The competent authority in the Netherlands to notify in case of serious adverse reactions or serious adverse events, according to Commission Directive 2006/86/EC.) www.tripnet.nl
389. European Union Standards and Training in the Inspection of Tissue Establishments (Eustite) www.eustite.org.