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CAMBRIDGE OPHTHALMOLOGICAL SYMPOSIUM

The value of corneal transplantation in reducing blindness

P Garg[1], PV Krishna[1], AK Stratis[2] and U Gopinathan[3]

Abstract

Purpose **To analyse the role of keratoplasty in reducing world blindness due to corneal diseases.**

Methods **Review of published literature. We collected and analysed articles published in the English language literature related to the prevalence and causes of blindness in different parts of the world, causes of corneal blindness, and outcome of corneal transplantation for various corneal diseases.**

Results **A total of 80% of the world's blind live in developing countries. Retinal diseases are the most important causes of blindness (40–54%) in established economy nations while cataract (44–60%) and corneal diseases (8–25%) are the most common causes of blindness in countries with less developed economies. Keratitis during childhood, trauma, and keratitis during adulthood resulting in a vascularized corneal scar and adherent leucoma are the most frequent causes of corneal blindness in developing countries. Corneal diseases are responsible for 20% of childhood blindness. Nearly 80% of all corneal blindness is avoidable. The outcome of keratoplasty for vascularized corneal scar and adherent leucoma is unsatisfactory, necessitating repeat surgery in a high proportion of these cases. Other barriers for keratoplasty in these nations are suboptimal eye banking, lack of trained human resources, and infrastructure.**

Conclusions **Since the developing world carries most of the load of corneal blindness and the major causes of corneal blindness are corneal scar and active keratitis, development of corneal transplantation services need a comprehensive approach encompassing medical standards in eye banking, training of cornea specialists and eye banking personnel and exposure of ophthalmologists to care of corneal transplants for better follow-up care. However, concerted efforts should be made to develop and implement prevention strategies since most corneal blindness is preventable.**

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Keywords: blindness; corneal blindness; keratoplasty; survival of corneal grafts

[1]Cornea Service, LV Prasad Eye Institute, Hyderabad, India

[2]Dalhousie University, Halifax, Nova Scotia, Canada

[3]Ramayamma International Eye Bank, LV Prasad Eye Institute, Hyderabad, India

Correspondence: P Garg, Cornea Service, L V Prasad Eye Institute, L V Prasad Marg, Hyderabad 500034, India
Tel: +91 40 2354 8267; Fax: +91 40 2354 8271.
E-mail: prashant@lvpei.org

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Introduction

The number of blind persons in the world is not accurately known, but has been estimated at various points in time by the World Health Organization (WHO). The data available in 2000 suggests that there are approximately 50 million blind people in the world.[1] In addition, there are nearly 150 million people suffering from 'low vision' (as per the WHO definition of blindness and low vision).[2] The fact that there are 200 million people in the world today who are in some way severely visually disabled is a tragic, unacceptable situation in both social and economic terms. Furthermore, in the absence of more aggressive interventions blindness will continue to increase by nearly 2 million every year due to the increasing and ageing population and service delivery not keeping pace with the incidence.[1]

The global data identified three major causes of blindness in the world, namely cataract, trachoma, and glaucoma.[3] Thus, corneal diseases are the second most important cause of blindness today, apart from cataract. Visual rehabilitation in many of these cases is possible with corneal transplantation. However, a review of published reports on blindness clearly shows that (a) 80% of blind people live in the less developed world, countries where chronic economic deprivation is exacerbated by the added challenge of failing vision; (b) the diseases responsible for blindness varies among developed and less developed economies; and (c) most causes of corneal blindness in less developed nations are either treatable or preventable.[4–25] These realities call for

individualization of blindness control programes to different regions and optimal utilization of available resources. Therefore, it is important to evaluate the role of corneal transplantation in reducing blindness. In this article, we have tried to analyse the role of keratoplasty in reducing blindness, and problems associated with this option in countries where corneal blindness is a major problem. The published literature on epidemiology of corneal blindness, causes of corneal blindness, and indications and outcome of keratoplasty in different geographic locations formed the basis for this analysis.

Regional distribution of blindness

The global distribution of blindness by economic regions as published by WHO in 1995 is shown in Table 1.[2] To provide an easy mean of comparison the authors described what is known as regional burden of blindness (RBB) (Table 2).[2] The data clearly show that 75% of world blindness currently occurs in Asia and Africa.

Approximately 50% of all blindness is due to cataract, 15% due to trachoma, up to 10% due to uncorrected refractive error, 4% due to childhood blindness, and 1% due to onchocerciasis. These five diseases are responsible for up to 80% of the world's blindness.[1] Other causes of blindness include diabetic retinopathy, trauma, and age-related macular degeneration. The relative importance of diseases causing blindness varies greatly by region.[4] Table 3 shows regional estimates of the major causes of blindness. The Eye Diseases Prevalence Research Group estimated that the leading cause of blindness among white Americans older than 40 years is age-related macular degeneration accounting for 54% of all blindness, as opposed to 9% by cataract, the next most common cause.[5] Similar are the findings in Europe and Australia.[6–8] In India important causes of blindness are cataract (44–77.5%), uncorrected refractive error (15–16.3%), retinal diseases (5.9–10.9%), glaucoma (7.9–10.2%), and corneal diseases (1.2–7.1%).[9–11] Similar were the findings in other less developed countries.[12–15] In Saudi Arabia common causes of blindness are cataract (45.2%), trachoma and nontrachomatous corneal scar (25.7%), and glaucoma (5.7%).[12] The data clearly show that corneal diseases are important as a cause of blindness in nations with less developed economies; these are the nations that carry a major burden of blindness.

There is a strong correlation between ageing and blindness; approximately 58% of all blind persons are aged more than 60 years and only 3.8% of the global total are between 0 and 14 years.[16] However, this prevalence of blindness in children is an underestimate of the magnitude of the problem, because the mortality among blind children particularly in developing world is higher than their sighted counterparts and the prevalence takes into account only children who survive.[17] In addition, childhood blindness must be considered a priority because a blind child has many years of blindness ahead of them and the visual loss affects all aspects of the child's development. Current estimates suggest that

Table 1 Global magnitude of blindness by economic regions

World bank regions	*Prevalence of blindness (%)*	*Number of blind (million)*	*Major causes*
Established market economies	0.3	2.4	Cataract Glaucoma Retinal diseases
Former Socialist Economies of Europe	0.3	1.1	Retinal diseases Glaucoma Cataract
Latin America & the Caribbean	0.5	2.3	Cataract Glaucoma Corneal scar
Middle-Eastern Crescent	0.7	3.6	Cataract Glaucoma Corneal scar
China	0.6	6.7	Cataract Corneal scar Glaucoma
India	1.0	8.9	Cataract
Other Asia & Islands	0.8	5.8	Uncorrected refractive error Glaucoma/retinal diseases Corneal scar
Sub-Saharan Africa	1.4	7.1	Cataract Corneal scar Glaucoma

Data published by WHO in 1995.

Table 2 Regional burden of blindness (RBB)

World bank regions	*% Of global population (A)*	*% Of global blindness burden (B)*	*RRB (B/A)*
Established market Economies	15.1	6.3	0.41
Former Socialist Economies of Europe	6.6	2.9	0.44
Latin America & the Caribbean	8.4	6.1	0.72
Middle-Eastern Crescent	9.6	9.5	0.99
China	21.4	17.6	0.82
India	16.1	23.5	1.46
Other Asia & Islands	13	15.3	1.18
Sub-Saharan Africa	9.7	18.8	1.93

Data published by WHO in 1995.

Table 3 Regional variation in causes of blindness

	EME (%)	*FSE (%)*	*Latin America and Caribbean (%)*	*Middle Eastern Crescent (%)*	*China (%)*	*India (%)*	*OAI (%)*	*SSA (%)*
Cataract	3.50	8.30	57.60	45.20	32.40	51.20	39.80	43.60
Corneal scar (trachoma)	—	—	6.80	25.70	17.60	9.70	23.60	19.40
Glaucoma	7.50	6.80	8.00	5.70	22.70	12.80	16.70	12.00
Others	89.00	84.90	27.50	23.40	27.30	26.30	19.90	25.00

EME = Established Market Economies; OAI = Other Asia & Islands; FSE = Former Socialist Economies of Europe; SSA = sub-Saharan Africa.
Source—Data on Global Blindness WHO 1995.

Table 4 Estimates of the prevalence of childhood blindness by world bank regions

World bank regions	*Estimated regional prevalence*	*Estimated no. of blind children*	*% Of global childhood blindness*
Established market Economies	0.3	50 000	3.57
Former Socialist Economies	0.51	40 000	2.85
Latin America & the Caribbean	0.62	100 000	7.14
Middle-Eastern Crescent	0.8	190 000	13.5
China	0.5	210 000	15
India	0.8	270 000	19.3
Other Asia & Islands	0.83	220 000	15.7
Sub-Saharan Africa	1.24	320 000	22.9

Information based on prevalence data published in Tropical Doctor 2003 (October).

there are 1.4 million children blind globally.[16] The prevalence of blindness in children also varies according to socioeconomic status and under-5 mortality rates. In low-income countries with high under-5 mortality, the prevalence may be as high as 1.5 per 1000 children compared to 0.3 per 1000 children in high-income countries.[18] Nearly 22.9% blind children live in sub-Saharan Africa and approximately three-quarter of the world's blind children live in African and Asian continents (Table 4).[17]

Of the 1.4 million blind children worldwide an estimated 25% are blind from retinal diseases, 20% from corneal pathology, 13% due to cataract, 6% from glaucoma, and 17% due to anomalies affecting the whole globe.[19] The causes of childhood blindness are also different in developed countries and countries with less developed economies. In poor countries of the world, corneal scarring due to vitamin A deficiency, measles, ophthalmia neonatorum, and the effects of harmful traditional eye remedies predominate[20–25] while at the other end of socioeconomic spectrum, retinal diseases, optic nerve affections due to genetic or perinatal causes are important causes of blindness.[16,17] Corneal disease is responsible for less than 2% of blindness in children in industrialized countries while in the poorest areas of Africa and Asia corneal scarring accounts for 25–50% of childhood blindness.[19] Thus corneal disease is an important cause of blindness among children living in developing nations, which already carry a major burden of blindness.

These studies in adult and children clearly show that corneal diseases are important causes of blindness both

in adults and children and that the major burden of these diseases is in developing countries with less developed economies.

Causes of corneal blindness

The epidemiology of corneal blindness is diverse and highly dependent on the ocular diseases that are endemic in each geographical area. Traditionally, important diseases responsible for corneal blindness include trachoma, onchocerciasis, leprosy, ophthalmia neonatorum, and xerophthalmia.[26] Currently, trachoma is still the world's leading infectious cause of blindness and the leading cause of ocular morbidity. It often results in corneal scarring with dense vascularization, ocular surface problems, and invariable presence of entropion and trichiasis. It is estimated by WHO that at present there are about 4.9 million people blind from trachomatous corneal scarring and 10 million suffering from trichiasis and thus at risk of corneal blindness.[27] Onchocerciasis results in severe blinding keratitis resulting from an inflammatory response to dead and degenerating microfilaria in the corneal stroma. The end result is severe corneal scarring and vascularization. Although onchocerciasis is a major cause of blindness in the world, data from West Africa show that blindness rates due to onchocerciasis are below 1% in communities that had up to 10% blindness rates at the onset of onchocerciasis control programme. The incidence of the onchocerciasis-related blindness in West Africa is now zero.[28] Leprosy causes corneal scarring from exposure keratitis due to lagophthalmos, and loss of corneal sensation. These patients develop repeated corneal ulcers. Interstitial keratitis may also occur due to direct corneal infiltration by *M.laprae*. Although there has been remarkable progress in the treatment of leprosy in the past 20 years, corneal complications remain a significant cause of blindness, affecting 10–12 million people. A majority of those affected are in Africa and the southern part of India.[29] There are approximately 250 000 blind from the disease. Xerophthalmia and Ophthalmia neonatorum are important causes of blindness in children.

Although these diseases still remain important causes of blindness, the recent success of public health programmes in controlling onchocerciasis and leprosy as well as a gradual worldwide decline in the number of cases of trachoma has generated new interest in other causes of corneal blindness. These include corneal trauma, corneal ulceration, and complications from the use of traditional eye medicines. In 1992, Thylefors drew attention to the fact that trauma is often the most important cause of unilateral loss of vision in developing countries.[30,31] They estimated that approximately 1.6 million people are blind from injuries, 2.3 million had bilateral low vision, and 19 million are unilateral blind or had low vision. Corneal ulceration has been recognized as a silent epidemic in developing countries.[32] By extrapolating Indian estimates of the incidence of corneal ulcer, approximately 1.5–2 million people develop corneal ulcer annually in developing countries. The use of traditional eye medicines is a public health problem in many developing nations and an important risk factor for corneal blindness. These products are often contaminated and provide the vehicle for the spread of the pathogens. In Tanzania 25% of corneal ulcers were associated with traditional eye medicine use.[33]

The Andhra Pradesh Eye Disease Study estimated that the prevalence of corneal blindness in at least one eye was 0.66% (95% confidence interval (CI) 0.49–0.86). The most frequent causes of corneal blindness included keratitis in childhood (36.7%), trauma (28.6%), and keratitis during adulthood (17.7%).[34]

The diseases causing corneal blindness vary in Established Market Economies and countries with less developed economies. Since population-based data on causes of corneal blindness were not available particularly from developed nations, we decided to collect information on causes of corneal blindness using indications of keratoplasty in these geographic regions. Table 5 provides information on important indications for keratoplasty in different geographical locations.[35–44] As the table shows, the important causes of corneal blindness (based on indications of keratoplasty) in Established economies are pseudophakic bullous keratopathy, keratoconus, failed grafts, and corneal dystrophy. In contrast, in less developed economies corneal scar and active keratitis are the most common indications for penetrating keratoplasty.(PKP) Keratoconus and other dystrophies occur less often in these countries (4 *vs* 15%).

The data on repeat keratoplasty, an important indication of the procedure both in developed and developing countries, also show similar trends.[41,45,46] While the most common indication for initial PKP in cases with repeat keratoplasty was bullous keratopathy in developed nations, active keratitis and corneal scar were indications in developing nations. Even in the paediatric age group the indications for keratoplasty differ in developing and developed nations (Table 6). While congenital opacities are the most common indications for PKP in developed countries, acquired nontraumatic scars are most common indications in developing nations.[47–49]

Thus, we can conclude that corneal scar and active keratitis are the most frequent cause of corneal blindness and thus indications for PKP in developing countries while corneal oedema and keratoconus are the most

Table 5 Indications of penetrating keratoplasty in different countries

Indication	*USA*		*Canada*		*UK*	*France*	*India*	*Nepal*	*Taiwan*
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*
PBK +	27.2	19	28.5	15.29	7.6	9.9	10.6	6	17.6
Fuch's dystrophy	15.2	14.7	7.7	9.56	9.3	9.4	1.2	—	4.5
Keratoconus	15.4	15	10	16.04	15	28.8	6	4	2.5
Non-Fuch's dystrophy	1.3	19	—	3.12	3.6	—	7.2	—	1.6
Corneal scar	7.8	—	2.9	3.04	5.9[a]	7.7	28.1	37	27.9
Ulcerative keratitis	2.9	6.1	8.5	5.62	8.3	10.9[a]	12.2	9	17.9
Failed graft	18.1	12.9	22.3	18.01	40.9	9.9	17.1	13.3	21
Others	—	—	20.2	—	21.5	23.4	17.7	—	6.9

+ PBK = pseudophakic bullous keratopathy.
[a]Herpetic infections.
a = Cosar (2002)[35]; b = Dobbins (2000)[36]; c = Liu (1997)[37]; d = Maeno (2000)[38]; e = Al Yousuf (2004)[39]; f = Legeais (2001)[40]; g = Dandona (1997)[41]; h = Tabin (2004)[42]; I = Chen (2001).[43]

Table 6 Indications of keratoplasty in children

Causes of corneal opacity	*Dana et al (1995)*	*Dada et al (1999)*	*Aasuri et al (2000)*
Congenital	109 (66.46)	51 (12.28)	47 (30.54)
Acquired nontraumatic	28 (17.07)	296 (71.32)	85 (55.19)
Acquired traumatic	27 (16.46)	23 (5.54)	22 (14.28)
Regraft	27 (16.46)	45 (10.85)	8
Total	164	415	154

frequent causes of corneal blindness and thus the most common indications for PKP in developed nations. Since less developed countries carry most of the burden of corneal blindness this information is important while considering the role of keratoplasty for reducing world blindness.

Outcome of penetrating keratoplasty

Many of those currently blind from corneal diseases can be visually rehabilitated by corneal transplantation. PKP is the most effective and most often performed solid organ transplantation. In order to assess the role that corneal transplantation could play in visual rehabilitation of the corneal blind, a critical analysis of data on graft survival rate is necessary. Since a large percent of people blind due to corneal diseases live in the developing world, from a public health perspective it would be most useful to have the survival data from these nations for the most common corneal pathologies. The outcome of keratoplasty can be defined in two ways: from the surgeon's standpoint, graft clarity indicates technically a successful surgery, whereas from the patient's standpoint the recovery of useful vision is usually more important. Since visual recovery depends on many factors we looked at graft survival as an indicator of successful outcome. Table 7 shows the outcome of keratoplasty based on published reports from both established and less developed economies.[50–59]

Dandona and associates analysed 1-, 2-, and 5-year survival rates of 1725 corneal transplants performed at a tertiary eye care center in India.[58] The survival rates were 79.6% (95% CI 77.3–81.9%), 68.7% (65.7–71.7%) and 46.5% (41.7–51.3%) respectively. Preoperative diagnosis was the most significant variable affecting transplant survival in the multivariate Cox regression model. Keratoconus had the highest 1- and 5-year survival rate of 96.4% (93–99.8%) and 95.1% (84.8–100%) respectively. Five-year survival for other indications in that study were 56% (CI 45.2–66.8) for corneal dystrophies; 52.2% (CI 43.9–60.5) for corneal scar other than adherent leucoma, 44.1% (CI 28.8–59.4%) for pseudophakic bullous keratopathy; 31.5% (CI 16.1–46.8) for adherent leucoma; 21.5% (CI 8.5–34.5) for aphakic bullous keratopathy and 21.2% (CI 13.8–26.6%) for repeat transplants after failure of the first transplant. Other factors that affected graft survival in the study were socioeconomic status, age at surgery, vascularization of host cornea, and quality of donor cornea. The odds of the eye being blind after transplantation were high for indications such as adherent leucoma, failed graft, and aphakic bullous keratopathy, presence of deep vascularization, lower socioeconomic status, and age less than 10 years.[58]

Table 7 Graft survival (%)

	Overall (years)				*Keratoconus*	*PBK*	*Dystrophy*	*Adherent leucoma*	*Repeat Keratoplasty*
	1	2	5	10					
Dandona *et al* (1997)	79.6	68.7	46.5	—	95.1	44.1	56	31.5	21.2
Price *et al* (1993)	97	95	91	—	98	91	98	—	70
Thompson *et al* (2003)	—	—	—	82	92	74	90	—	41
Inove *et al* (2000)	—	—	—	72.2	98.8	51.1	76.9	—	61.8
Sit *et al* (2001)	—	78.8	64.5	—	95.9	50	85.2	73.5	—
Williams *et al* (1993)	90.8	84.1	72.2	59[a]	97.5	57.8	75.8	56.5	46.3
Ing *et al* (1998)[b]	—	—	—	78	96	76	81	46	—

PBK = pseudophakic bullous keratopathy.
[a]2000 data.
[b]10-year survival data.

Overall survival of corneal grafts is much better in developed countries (64.5–91% 5-year survival) than reported by Dandona *et al* (46.5%). One of the factors responsible for better outcome in some of these series is that the principal indications for keratoplasty (55–68%) namely, pseudophakic bullous keratopathy, keratoconus, and corneal dystrophies carry a much better prognosis than vascularized corneal scar, adherent leucoma and active keratitis, which are the most common indications of keratoplasty (40.3%) in developed countries. All the studies on corneal graft survival from both developing and developed nations identify presence of deep vascularization and active inflammation of eye at the time of surgery as risk factors for poor outcome.[50,59,60] In a study by Thompson and associates the presence of deep vessels in recipient cornea was associated with a low (65% 10-year survival) compared to those without vascularization (85% 10-year survival).[52] In Australian Graft Registry the eyes that were never inflamed had a better 5-year survival (91.3%) compared to 54.2% in eyes that were inflamed in the past.[60]

Keratoplasty is considered a high-risk procedure in the paediatric age group. In a multicentre study by Dana *et al* the overall survival rate was 80.2% (CI 72.9–87.4) at 1 year and 67.4% (CI 58.3–76.4) at 2 years.[47] In a study published from L V Prasad Eye Institute in India 66.2% eyes had clear graft at the last follow-up (mean follow-up 1.3 years).[49] Most other series also report success rates in the range of 50–60%, lower than survival rates in adult keratoplasty.[48,50,61,62] Even studies on paediatric keratoplasty suggest that preoperative corneal neovascularization is associated with a high risk of graft failure.

Extrapolation of the data from these studies clearly indicates that the outcome of corneal transplantation is likely to be poor in situations where corneal blindness is caused mainly by vascularized corneal scar and adherent leucoma, or where the socioeconomic status is poor, and where this form of blindness is in children. Such is the situation in a majority of countries that bear the major burden of corneal blindness.

Other factors that are critical for the success of corneal transplants are quality and efficiency of eye banking, availability of trained corneal surgeons, quality of clinical facilities for surgery, and availability of potent corticosteroids and other immunomodulatory agents at affordable cost. Follow-up care for corneal transplants is a life long commitment and access to care by ophthalmologists who have been exposed to the care of corneal transplants is also a major determinant of success.

In India with a population close to one billion only 20 514 donor corneas were procured in the year 2003.[63] Of these, only 8426 could be utilized for transplantation. The requirement for donor corneas per year in India is estimated to be 20 times the current procurement. This clearly shows that there is a huge gap between demand and supply of donor corneal tissues in India and probably in other countries where corneal blindness is most prevalent. Thus, there is lack of quality corneal tissues in these countries. This may not only affect number of transplants that can be performed but also graft outcome.

What is the role of keratoplasty in reducing blindness?

Previous sections suggest that a large number of people blind due to corneal diseases live in the economically less developed areas of the world; adherent leucoma and vascularized corneal scar secondary to trachoma, keratitis in childhood, trauma, and keratitis in adults are the main causes of corneal blindness; and existing eye bank facilities are not able to provide enough quality donor corneas. In addition, there are not enough trained corneal surgeons in these regions and financial constraints may limit accessibility to surgery and long-term care. These observations raise a serious concern regarding the role of keratoplasty in reducing world

blindness. Improving the outcome of relatively high-risk keratoplasty would require improvement in eye banking standards, high-quality training programmes in corneal subspecialty and eye banking, enhancement of the surgical infrastructure, improvement in postoperative care of corneal grafts, and availability of affordable corticosteroid eye drops and immunomodulatory agents in these regions. All these requirements involve a significant financial commitment and will take time to effect. It is clear that surgical intervention alone is not cost effective in eliminating corneal blindness in developing countries. Further, most causes of corneal blindness in these countries with most of the burden are either preventable or treatable. The avoidable causes of corneal blindness include keratitis in childhood (vitamin A deficiency, measles, ophthalmia neonatorum), trauma, keratitis in adulthood (trachoma, onchocerciasis, trauma, and corneal ulcer), and use of traditional eye medicines. Therefore, prevention and early treatment of causes that lead to blindness would be a preferred approach toward reducing world blindness. Prevention is obviously more cost effective in the long term as demonstrated by success stories from some parts of the world in terms of reducing corneal blindness due to vitamin A deficiency, onchocerciasis, and leprosy.[64,65] However, until preventive strategies become effective and make a significant difference, corneal transplantation is the only option for visual rehabilitation of those currently blind from corneal diseases. Thus a comprehensive approach involving both preventive and therapeutic interventions would be the most effective in reducing blindness due to corneal diseases. This will provide both immediate and long-term solution of the problem. A four-tier pyramidal eye care delivery system proposed by the L.V. Prasad Eye Institute and has formed the basis of Vision 2020 initiatives in the country (Figure 1)) would be a good model to achieve the goal. At the primary level the strategies for prevention of corneal blindness can be integrated with maternal and child health programme. At the secondary level ophthalmologists will have to be trained to handle diseases of public health importance such as management of corneal trauma, early diagnosis and management of corneal ulcer in children and adults, management of sequelae of trachoma, identification and management of complications of keratoplasty, and early referral of cases with sight-threatening disorders. We need to create a network of tertiary eye care centres in these countries to handle more complicated cases. These centres must be well equipped and ophthalmologists must be appropriately trained to handle complex corneal diseases. These centres would additionally support continued medical education and research related to diseases important in these regions. Efforts will have to be made to upgrade eye banking in these nations.

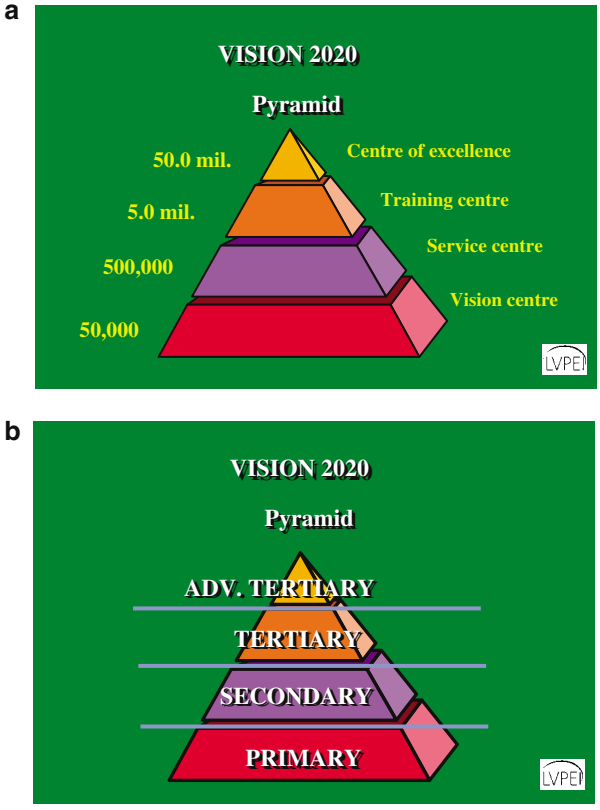

Figure 1 (a, b) Four-tier pyramidal eyecare delivery system with vision center at base and advanced tertiary eye care center at apex.

Conclusions

Eye diseases affecting the cornea are a major cause of blindness. Most of these blind persons live in countries with less developed economies. Common diseases that are responsible for corneal blindness viz. trachoma, onchocerciasis, leprosy, ophthalmia neonatorum, xerophthalmia, and corneal trauma results in vascularized corneal scar and adherent leucoma. The outcome of corneal transplantation in these disorders is not encouraging. Other barriers for the success of corneal transplantation in developing nations are lack of well-trained surgeons and nurses, poorly equipped clinical facilities, unreliable eye bank facilities, and inconsistent long-term care. Therefore, surgical intervention alone is not cost effective in eliminating blindness due to corneal diseases. A combined approach involving preventive steps and steps to improve management of corneal disorders must be designed for developing nations, which carry the most burden of corneal blindness. This approach will go a long way in reducing world corneal blindness.

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