Glaucoma in developing countries

Ravi Thomas

Objective: To describe the background and strategy required for the prevention of blindness from glaucoma in developing countries. **Materials and Methods:** Extrapolation of existing data and experience in eye care delivery and teaching models in an unequally developed country (India) are used to make recommendations. **Results:** Parameters like population attributable risk percentage indicate that glaucoma is a public health problem but lack of simple diagnostic techniques and therapeutic interventions are barriers to any effective plan. Case detection rather than population-based screening is the recommended strategy for detection. Population awareness of the disease is low and most patients attending eye clinics do not receive a routine comprehensive eye examination that is required to detect glaucoma (and other potentially blinding eye diseases). Such a routine is not taught or practiced by the majority of training institutions either. Angle closure can be detected clinically and relatively simple interventions (including well performed cataract surgery) can prevent blindness from this condition. The strategy for open angle glaucoma should focus on those with established functional loss. Outcomes of this proposed strategy are not yet available. **Conclusions:** Glaucoma cannot be managed in isolation. The objective should be to detect and manage all potential causes of blindness and prevention of blindness from glaucoma should be integrated into existing programs. The original pyramidal model of eye care delivery incorporates this principle and provides an initial starting point. The routine of comprehensive eye examination in every clinic and its teaching (and use) in residency programs is mandatory for the detection and management of potentially preventable blinding pathology from any cause, including glaucoma. Programs for detection of glaucoma should not be initiated unless adequate facilities for diagnosis and surgical intervention are in place and their monitoring requires reporting of functional outcomes rather than number of operations performed.

Key words: Case detection, comprehensive eye examination, developing countries, glaucoma, integrated approach, training requirements

Access this article online

Website: www.ijo.in

DOI: 10.4103/0301-4738.100546

Quick Response Code:

The magnitude of the problem of glaucoma and its particular relevance to developing countries has been discussed numerous times and one wonders if it is worth summarizing yet again.[1-4] Glaucoma is the third most common cause of blindness and is responsible for 10% of blindness worldwide.[5] Recent estimates suggest that in 2010 approximately 60.5 million people were affected by glaucoma and about 8.4 million were blind from the disease.[2] Primary open angle glaucoma (POAG; 44.7 million cases worldwide) is considered more common than primary angle closure glaucoma (PACG; 15.7 million) but the latter is more likely to cause blindness among affected persons, and thus accounts for almost half of total glaucomatous vision loss. The projections for 2020 are that almost 80 million people will be affected by glaucoma.[2] While congenital glaucoma is a 'rare disease,' applying the concept of 'blind years' makes it an important cause of childhood blindness.

According to the World Bank, developing countries include those with low and low-middle income (< US$ 3975/-) as defined by the gross national income per capita.[6] If, as is correct, for all practical purposes, we include China (currently classified as high middle income) as a developing country, then the majority of the World's population (and those with glaucoma) reside in developing countries.[1,4,7,8] The majority of those affected in developing countries are unaware that they have the disease and visual impairment there is also more prevalent and severe.[1,9-12] The risk of blindness over a period of 12–20 years from POAG is estimated to range from 14.5% to 27% (unilateral) to 7–9% (bilateral).[13,14]

To compound the problem, the number of ophthalmologists available in developing countries is estimated at one per 500,000 people in Africa and one per 200,000 in Asia.[15] There are an estimated 12,000 ophthalmologists, (about one per 100,000 population including, depending on the definition, about 25 glaucoma specialists) in India and, as in the rest of the developing world, they are located mainly in the cities.[3,16] With an expected increase in and aging of the population, glaucoma is poised to become an even more important cause of ocular morbidity in the developing world.

These figures are already, depressingly, well known. The principles for a logical approach to the problem are also equally well known.[3,4,7,17,18] The required strategy was presented to the International Agency for the Prevention of Blindness (IAPB) at their general assembly in Beijing 1999.[19] Regrettably, they have not been pursued or implemented in any systematic manner that can make a tangible difference.

This article will again reiterate these principles and examine some reasons for difficulties in implementation. While accepting that all developing countries are different and require individualized solutions, a major assumption of this article is that the principles and lessons learnt in India may be useful in other developing nations.

Queensland Eye Institute and University of Queensland, Australia

Correspondence to: Prof. Ravi Thomas, Queensland Eye Institute, 41 Annerley Road, South Brisbane 4105, Queensland, Australia. E-mail: ravi.thomas@qei.org.au

Manuscript received: 12.06.12; Revision accepted: 25.07.12

Is Blindness From Glaucoma Worth Addressing In Developing Nations?

As glaucoma, especially the early stage of POAG, is a difficult disease to diagnose and even more difficult to treat, is it even worthwhile considering glaucoma programmatically in the developing world setting?

The decision to detect and treat glaucoma partly depends on the available resources and is inextricably linked to public health issues. Population attributable risk percentage (PAR%) helps address the issue of whether a disease is a public health problem. Using ocular hypertension (OH) as an example, PAR% addresses the question 'If we treat all the OH in the entire population, how much POAG in the population will we prevent?' Assuming a 3% prevalence of OH and the results of the OHTS study, we calculate the 'effective' PAR for the treatment of ocular hypertension as 8.5%.[20] This is lower than what would usually be considered for public health intervention and is unlikely to compete with opportunity costs in relation to treating cataract, other systemic diseases or issues like sanitation, clean drinking water, and immunization.[20] The PAR% makes it clear that developing nations are unlikely to try to screen for OH in a systematic way.

Depending on the assumptions of prevalence and relative risk, and using the Early Manifest Glaucoma Trial data, the 'effective' PAR% for prevention of progression of early POAG is around 20%.[20] This figure is more conducive to public health interventions, but given the slow progression of disease, low incidence of blindness, per capita income in developing countries and the logistical realities, it is unlikely to spur health policy makers into action, unless glaucoma detection can be easily piggybacked on to existing programs.

In contrast, in primary angle closure disease (PACD), the effective PAR% for prevention of progression to early PACG is 65%.[8] Such a high PAR% emphasizes the importance of PACG, especially in the developing countries in Asia. The effective PAR% and the consequence of untreated PACG is too high to ignore, especially as blindness from angle closure disease can potentially be prevented with early treatment such as peripheral iridectomy. PAC and early PACG must be identified and treated.[8]

Such considerations have led to the inclusion of glaucoma as one of the diseases targeted by Vision 2020: The Right To Sight. (Vision 2020 action plan 2007).

Options for Detection

Population-based screening of some sort, for eye disease, is popular among service and nongovernmental organizations. The publicity and numbers of people examined are no doubt a compelling argument to present to donors and do generate awareness. It is, however, clear that developing countries do not have the requisite infrastructure to categorize and follow up test positives on various screening tests, let alone treat the true positives and certainly not enough to repeat the process on a regular basis.[1,18,21] These facts, combined with the usually unappreciated but sometimes serious consequences of population-based screening, make it a poor choice for detection of glaucoma in most countries.[21]

Currently, the best approach to managing glaucoma in developing countries is case detection. This author views case detection in a broader perspective: when a patient presents to an eye clinic, we should take that opportunity to detect *any* potentially blinding disease, *including* glaucoma. If we are serious about prevention of blindness, as a policy, every new patient visiting an eye clinic, irrespective of presenting complaints must undergo a comprehensive eye examination. In addition to vision measurement, refraction and assessment of the pupil reflex, the components of such an examination include biomicroscopy, tonometry (preferably applanation), gonioscopy, and a dilated fundus examination with emphasis on the disc and posterior pole.

The objective is to detect at least all the 'in our face' glaucoma cases, that is those with established functional loss who are at high risk of blindness. Such cases are easily detected *if* a comprehensive eye examination is performed. For primary angle closure (PAC) or early primary angle closure glaucoma, case detection presents the unique opportunity to prevent blindness from glaucoma. In order to achieve that goal, detection of 'early' disease (PAC; early PACG) prior to functional loss is important in primary angle closure disease.

Given these obvious advantages, what are the barriers that preclude such an examination even in reputable institutions (including those involved in training) and in private clinics? The reasons are varied but predictable. Some, like excessive workload, are valid: the need to see a large number of cases is undeniable. Others are more difficult to accept and include the standard excuse of 'but we live in a poor developing country,' and cannot afford the 'cost of slit lamps, applanation tonometers, and diagnostic lenses.'[18] Such arguments are not uncommon even in the environs of otherwise (furniture-wise) well-appointed and well-attended outpatient clinics equipped with the latest excimer laser. Finances are indeed an issue, but at some stage priorities have to be set. Surely basic professional necessities like slit lamps, applanation tonometers, and diagnostic lenses ought to be acquired prior to excimer lasers?

The desire of funding agencies to provide the largest possible numbers as indicative of the biggest bang for the donated buck, is a contributing factor that detracts from addressing other causes of blindness.[4,17]

Finally, a subtle but dangerous reason for lack of appropriate attitude and examination relates to residency training.

Residency and Glaucoma Training in Developing Countries

As is possibly true of other developing countries, Indian residency programs vary from (a minority) comparable to the very best in the world to those that are charitably described as mediocre. Using fairly basic standards, the majority would not pass basic modern certification.[22]

A routine comprehensive eye examination that includes routine gonioscopy and dilated fundus examination is not taught, nor is it the norm even in reputable centers in India; some residency programs still use a flashlight examination as the routine.[22] It is therefore, not surprising that graduates follow the example of their teachers.

Surgical training in most residency programs is geared toward cataract surgery; even there, personal supervision using

beam splitters with microscopes is unusual and teaching of modern techniques by faculty (as opposed to senior trainees, who have in turn been taught by senior trainees) is rare.[22,23] The proliferation of fellowships in phacoemulsification is testimony to the lack of instruction in modern techniques of cataract surgery during residency. In this setting, teaching of glaucoma diagnosis, let alone surgery, is almost nonexistent. The situation is likely to be similar in other developing nations.

Fellowships in glaucoma are available in a few institutions, and some accept international students. However, those joining such programs are usually graduates of the residency training described. The glaucoma fellowship program at the L.V. Prasad Eye Institute was forced to set aside >3 months of the fellowship to teach basic ophthalmic skills that should have been learnt and mastered during residency.[18,22]

These constraints also compromise the research component in such fellowships. It is a rare residency/fellowship program that formally teaches research methodology, and this has implications for the collection and interpretation of research data required for future planning. The validity of findings obtained by field staff trained for only 2 weeks in techniques, such as gonioscopy, that they are unlikely to have used prior to recruitment for a research project are questionable.[18,22]

If our intention is to educate ophthalmologists in developing countries, with a view to the future, large numbers cannot be a pretext for short cuts that lead to shoddy training. A list of requirements used to assess residency training is the minimum such courses need, to produce good comprehensive ophthalmologists.[22]

Options for Management

All options available in the West are available to paying patients in many unequally developed countries such as India. The question is one of policy and preferred practice for the public and nongovernmental sector.

The cost of medical treatment, even the latest products marketed by multinationals, is cheap by Western standards, but must be viewed in the context of the country in question (Indian per capita annual income of $1170).[1,3,6] One danger is that patients prescribed these medications will use them only until the more basic demands of daily living re-assert themselves. Additionally, there is the problem of the uncertain effectiveness of some topical preparations, probably related to relatively lax regulations.[3,24] As a policy, routine medical treatment is currently not a feasible option for developing nations.

As far as surgery is concerned, the Collaborative Initial Glaucoma Treatment Study (CIGTS) has demonstrated that medical treatment is as effective as surgical treatment. This can also be interpreted to mean that surgical treatment is as effective as medical treatment: One *could* argue that if we had to fund a glaucoma management initiative in developing countries, it would have to be initial surgery, *provided* the diagnosis is made in a modern manner and surgery is performed by adequately trained ophthalmologists.[18,25,26] Considering the potential iatrogenic complications, we should insist on the demonstration of a functional defect in any patient being considered for incisional surgery. While an inexpensive Bjerrum's screen is likely sufficient for this purpose, the screening mode of an instrument like the Frequency Doubling Perimeter (FDP) is more likely to be used routinely.[27] The other major problem is that, as mentioned, glaucoma surgery is not taught routinely in residency programs and unlike cataract surgery, glaucoma management (or surgery) cannot be taught in a quick 1 month course.[18,22]

The use of laser trabeculoplasty as primary treatment is a safer option than surgery; the results, costs and requirements for repeat treatment need to be addressed by outcomes research.[26]

Laser iridotomy is usually the preferred initial procedure for PACD. In areas where laser is not available, surgical iridectomy is an option, but the skills required for this procedure in an otherwise normal eye make it far more difficult to undertake. Ophthalmic surgeons are more likely to have better cataract surgical skills, and if an eye has been diagnosed as PAC or early PACG an earlier intervention for visually significant cataract may be the preferred approach.[28] Results of a trial of clear lens extraction in this situation are awaited.[28,29] In the presence of a functional visual field defect, cataract surgery (for visually significant lens opacities) combined with trabeculectomy is a choice that is likely to be exercised without a preceding iridotomy.[26] The use of the manual small incision technique of cataract surgery in this situation seems to provide results similar to phacoemulsification.[30]

Suggested Approach to Detection and Management

Over the past 10 years, there have been tremendous inputs into combating cataract blindness, but disappointingly few efforts in developing countries to establish comprehensive eye care programs in the community that include management of glaucoma and other causes of blindness. Until data from outcomes research in developing nations is available to guide the management of glaucoma, we will have to rely on the available literature and the admittedly limited experience in developing countries. Any strategy has to address the issues detailed above.

1. The logistics of detection and management of glaucoma are complex and cannot be approached in isolation. The consensus of an expert panel on glaucoma under the aegis of the World Health Organization (WHO) was that training of staff and provision of basic instrumentation is required before setting up initiatives for detection and management.[7] In other words, do not try to incorporate glaucoma into a program unless facilities for diagnosis and especially treatment are available.
2. The panel also agreed that to achieve any degree of success glaucoma care must be integrated with the delivery of comprehensive eye care. As far as outcomes are concerned, the impact of a glaucoma program (as with any program to promote visual health including cataract surgical programs) should not be measured in terms of raw surgical numbers.[7] Integration requires a drastic change in philosophy that is difficult for glaucoma surgeons, other specialists, and funding agencies to accept. We should *no longer* be concerned with the detection of glaucoma, diabetic retinopathy, macular degeneration, childhood blindness or even cataract *in isolation*. The objective should be the detection and management of *any* potentially sight-threatening pathology. The silo-like mindset and the obsession with numerically

oriented cataract surgery (transported from wherever they can be found and screened) has to give way to a more holistic approach to blindness. Program interventions should occur in a geographically defined area where their impact can actually be measured. In fact, all prevention of blindness activities are best integrated with community health and development initiatives.

A pyramidal approach to eye care delivery has been advocated by the WHO for the South East Asia region.[31] Such a model integrates all eye care delivery. A vision technician at the vision center of such a model, armed with an FDP, can achieve a positive predictive value of about 50% for the detection of *any* significant ocular pathology that needs to be referred on to the secondary center.[27] The actual outcomes and cost effectiveness of this approach require further research. To be successfully replicated, the model will require ophthalmologists permanently stationed at the secondary level, not trainees on rotation as is currently the case. Also, the model is designed for countries with large populations, and will need modifications for less populous nations.

The pyramidal approach, as originally described, relies on detection of potentially blinding pathology at all levels. Even the vision technician at the bottom of the pyramid uses a slit lamp and performs tonometry as well as an undilated examination of the fundus. The technician is not trained in gonioscopy, but any high intra ocular pressure (including that associated with a low van Herick grade)[32] is referred to the secondary center. This approach requires significant resources in training and equipment, but will result in lasting human resources and infrastructure. There is an unfortunate tendency to utilize a watered down version of vision centers using only vision charts and a flashlight that does not fit in with the concept and objectives. Such a compromise, if used, should be recognized as a temporary 'band aid' with a strict timetable for up grading capacity. Experience in India suggests that such temporary fixes have a propensity to become permanent.[4]

3. As far as glaucoma is concerned, as a policy it may be best to concentrate on established disease. For POAG, the target population is those at high risk for blindness; that is those with established functional loss. It follows that the management policy in most developing countries is likely to be surgical. Incisional intervention for glaucoma carries a significant potential for morbidity. Therefore, prior to undertaking any widespread intervention, it is crucial to train personnel in the diagnosis of established disease and in safe filtering surgery. As a principle, filtering surgery should only be undertaken if a functional defect can be demonstrated or has a high probability of occurring, as is the case in patients with intra ocular pressures consistently in the 30s. The latter example should not be used as an excuse to avoid demonstrating or acquiring the capability to demonstrate a functional defect.

   While the above philosophy also holds for established PACD with functional loss, in the PACD spectrum relatively simple effective treatments for PAC and early PACG are available and can prevent progression. The strategy described can also detect PACD at a stage when blindness can be prevented.
4. Improvement in residency training programs is required to provide graduates with not just the training but also the attitude required to implement this holistic integrated approach. That change is likely to be even more difficult, requires teachers to lead by example, and may necessitate a 'Flexner' type report that transformed medical schools in the United States.[33,34] Given the well known 'chalta-hai' ('it's good enough') mentality, any resulting recommendations will need to have legislated teeth to them. As a temporary measure, some countries may opt for a 'trainer of trainers' approach that has been applied to cataract surgery, but it must be understood that such trainers will require longer and more intensive training than that required for cataract surgery.

Concluding Comments

It is easy for the informed insider to be pessimistic about prevention of blindness from glaucoma in developing countries. There is also the danger that solutions such as the integrated approach described above, that entail moving out of the 'but we work in a poor developing country' comfort zone, will elicit a natural reaction of resistance, if not downright hostility among some stakeholders (including funding agencies). As in the past, it is also likely that the messenger will be mistaken for the problem.

There are, however, several reasons to be cautiously hopeful. Data for the natural history, detection, and successful management of glaucoma are available, and the search for a simple and effective surgical intervention is gaining momentum. A relatively inexpensive frequency-doubling perimeter has shown promise in the detection of functional defects from any cause, and is also useful in the demonstration of visual field defects prior to surgical intervention for glaucoma.

Blindness from PACD, a major cause of glaucoma blindness in developing countries, can be prevented by laser iridotomy, or in appropriate cases by cataract surgery. Cataract surgical skills are already in place in many areas, and the laser required for iridotomy is the same as that used for posterior capsulotomy.

There are indications that low and middle-income countries have made progress with the development of blindness control programs. In Africa, where POAG is the main form of glaucoma, there have already been a small number of pilot studies.[35-37] China, which has a high prevalence of angle closure, is developing plans for the control of blindness (Wang Ningli; personal communication September 2009). Finally, the integrated approach exemplified in the pyramidal eye care model developed by Dr. Nag Rao at the L.V. Prasad Eye Institute can be modified for use in other developing nations.

Moving toward 2020 what we need to focus on is clear:[7]

- Integrate glaucoma care into existing eye care initiatives.
- Teach and practice routine comprehensive eye care examination.
- Diagnose all potentially blinding conditions by routine case detection.
- Rather than just the number of operations, report visual and IOP outcomes and complications of surgical interventions,
- Initiate glaucoma programs only once diagnostic skills and surgical training are in place.

Realistically, our efforts are unlikely to create a dent in glaucoma blindness in the near future but the suggested

strategy of integration has the potential for long-term results in overall prevention of blindness, including that from glaucoma.

References

1. Foster PJ, Thomas R. Glaucoma Care in Developing Countries. In: Grehn F, Stamper R, editors. Essentials in Glaucoma. Berlin: Springer; 2006.
2. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. Br J Ophthalmol 2006;90:262-7.
3. Thomas R, Paul P, Muliyil J. Glaucoma in India. J Glaucoma 2003;12:81-7.
4. Thomas R, Paul P, Rao GN, Muliyil JP, Mathai A. Present status of eye care in India. Surv Ophthalmol 2005;50:85-101.
5. Resnikoff S, Pascolini D, Mariotti SP, Pokharel GP. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. Bull World Health Organ 2008;86:63-70.
6. World Bank. How We Classify Countries. Available from: http://data.worldbank.org/about/country-classifications. [Last Accessed 2012 Jan].
7. Thomas R. Glaucoma: Problems in the Developing World. World Blindness and its Prevention. In: Pararajasegaram R, Rao GN, editors. Vol. 6. Proceedings of the Sixth General Assembly of the International Agency for the Prevention of Blindness, Beijing, September 5 - 10, 1999. p. 175-9.
8. Thomas R, Sekhar GC, Parikh R. Primary angle closure glaucoma: A developing world perspective. Clin Experiment Ophthalmol 2007;35:374-8.
9. Dandona L, Dandona R, Mandal P, Srinivas M, John RK, McCarty CA, *et al*. Angle-closure glaucoma in an urban population in southern India. The Andhra Pradesh eye disease study. Ophthalmology 2000;107:1710-6.
10. Dandona L, Dandona R, Srinivas M, Mandal P, John RK, McCarty CA, *et al*. Open-angle glaucoma in an urban population in southern India: The Andhra Pradesh eye disease study. Ophthalmology 2000;107:1702-9.
11. Ramakrishnan R, Nirmalan PK, Krishnadas R, Thulasiraj RD, Tielsch JM, Katz J, *et al*. Glaucoma in a rural population of southern India: The Aravind comprehensive eye survey. Ophthalmology 2003;110:1484-90.
12. Vijaya L, George R, Arvind H, Baskaran M, Paul PG, Ramesh SV, *et al*. Prevalence of angle-closure disease in a rural southern Indian population. Arch Ophthalmol 2006;124:403-9.
13. Chen PP. Blindness in patients with treated open-angle glaucoma. Ophthalmology 2003;110:726-33.
14. Hattenhauer MG, Johnson DH, Ing HH, Herman DC, Hodge DO, Yawn BP, *et al*. The probability of blindness from open-angle glaucoma. Ophthalmology 1998;105:2099-104.
15. Thylefors B. A global initiative for the elimination of avoidable blindness. Indian J Ophthalmol 1998;46:129-30.
16. Rao GN. Ophthalmology in India. Arch Ophthalmol 2000;118:1431-2.
17. Dandona L, Dandona R, Naduvilath TJ, McCarty CA, Nanda A, Srinivas M, *et al*. Is current eye-care-policy focus almost exclusively on cataract adequate to deal with blindness in India? Lancet 1998;351:1312-6.
18. Thomas R. Glaucoma in India: Current status and the road ahead. Indian J Ophthalmol 2011;59:3-4.
19. Thomas R. Glaucoma: Problems in the Developing World. In: Pararajasegaram R RG, editors. Sixth General Assembly of the International Agency for The Prevention of Blindness. Beijing, China: International Agency for the Prevention of Blindness; 1999. p. 6.
20. Thomas R, Kumar RS, Chandrasekhar G, Parikh R. Applying the recent clinical trials on primary open angle glaucoma: The developing world perspective. J Glaucoma 2005;14:324-7.
21. Thomas R, Parikh R, Paul P, Muliyil J. Population-based screening versus case detection. Indian J Ophthalmol 2002;50:233-7.
22. Thomas R, Dogra M. An evaluation of medical college departments of ophthalmology in India and change following provision of modern instrumentation and training. Indian J Ophthalmol 2008;56:9-16.
23. Thomas R. Role of small incision cataract surgery in the Indian scenario. Indian J Ophthalmol 2009;57:1-2.
24. Narayanaswamy A, Neog A, Baskaran M, George R, Lingam V, Desai C, *et al*. A randomized, crossover, open label pilot study to evaluate the efficacy and safety of Xalatan in comparison with generic Latanoprost (Latoprost) in subjects with primary open angle glaucoma or ocular hypertension. Indian J Ophthalmol 2007;55:127-31.
25. Lichter PR, Musch DC, Gillespie BW, Guire KE, Janz NK, Wren PA, *et al*. Interim clinical outcomes in the Collaborative Initial Glaucoma Treatment Study comparing initial treatment randomized to medications or surgery. Ophthalmology 2001;108:1943-53.
26. Thomas R, Sekhar GC, Kumar RS. Glaucoma management in developing countries: Medical, laser, and surgical options for glaucoma management in countries with limited resources. Curr Opin Ophthalmol 2004;15:127-31.
27. Thomas R, Naveen S, Nirmalan PK, Parikh R. Detection of Ocular Disease by a Vision Center Technician & The Role of Frequency Doubling Technology Perimetry in this Setting. Br J Ophthalmol 2010;94:214-8.
28. Walland M, Thomas R. Role of clear lens extraction in adult angle closure disease: A review. Clin Experiment Ophthalmol 2011;39:61-4.
29. Thomas R, Walland MJ, Parikh RS. Clear lens extraction in angle closure glaucoma. Curr Opin Ophthalmol 2011;22:110-4.
30. Thomas R, Parikh R, Muliyil J. Comparison between phacoemulsification and the Blumenthal technique of manual small-incision cataract surgery combined with trabeculectomy. J Glaucoma 2003;12:333-9.
31. Rao GN. An Infrastructure Model for the Implementation of VISION 2020: The Right to Sight. Can J Ophthalmol 2004;39:589-90.
32. Thomas R, George T, Braganza A, Muliyil J. The flashlight test and van Herick's test are poor predictors for occludable angles. Aust N Z J Ophthalmol 1996;24:251-6.
33. Beck AH. The Flexner report and the standardization of American medical education. JAMA 2004;291:2139-40.
34. Thomas R. Residency Training Programs in India. Indian J Ophthalmol 2009;56:525.
35. Kabiru J, Bowman R, Wood M, Mafwiri M. Audit of trabeculectomy at a tertiary referral hospital in East Africa. J Glaucoma 2005;14:432-34.
36. Mafwiri M, Bowman RJ, Wood M, Kabiru J. Primary open-angle glaucoma presentation at a tertiary unit in Africa: Intraocular pressure levels and visual status. Ophthalmic Epidemiol 2005;12:299-302.
37. Quigley HA, Buhrmann RR, West SK, Isseme I, Scudder M, Olivas MS. Long term results of glaucoma surgery among participants in an east African population survey. Br J Ophthalmol 2000;84:860-4.

Cite this article as: Thomas R. Glaucoma in developing countries. Indian J Ophthalmol 2012;60:446-50.

Source of Support: Nil. **Conflict of Interest:** None declared.