

GLAUCOMA TREATMENT STRATEGIES FOR LOW-RESOURCE SETTINGS



An overview of resourceful approaches to glaucoma care in resource-limited contexts.

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Glaucoma is the leading cause of irreversible vision loss globally and the third most common cause of vision loss after cataracts and refractive error.^{1,2} The disease is estimated to affect roughly 3.5% of people aged 40 to 80 years worldwide.² In sub-Saharan African countries specifically, the prevalence of glaucoma is disproportionately high, with glaucoma being the first or second most common cause of vision loss.³

The economic impact of glaucoma is significant, and it increases with disease severity. Costs to the patient include direct expenses, such as examinations, consultations, and medical or surgical interventions, and indirect expenses, such as loss of income and caregiver support. Glaucoma also potentially creates indirect psychosocial burdens by decreasing patients' quality of life and contributing to psychological distress.^{4,5}

As a chronic disease with only noncurative treatment options, glaucoma is challenging to manage even in resource-rich settings. Brown and Krishna previously described in *Glaucoma Today* the challenge of providing quality, routine follow-up and access to care for underserved populations in the United States.⁶ In developing countries, the management of glaucoma is more challenging than the management of refractive error and cataracts due to the chronicity

and late symptom onset of the disease. Refractive error and cataracts, however, are typically the main focus of global public health campaigns to reduce visual impairment.⁷

Because the ability to manage glaucoma varies across the developing world, this article focuses on management principles that can be applied in various resource-limited settings to prevent visual impairment associated with glaucoma. These strategies should be evaluated by each locality to determine which course of action is best.

SECONDARY PREVENTION AS TREATMENT

Glaucoma treatment strategies are only as effective as the ability to diagnose the disease. Late presentation of glaucoma is more common in low-resource environments than in high-resource settings. In parts of West Africa, for example, up to 50% of patients with glaucoma present with blindness in one eye.⁸ This is particularly concerning because glaucomatous damage is irreversible and advanced disease requires more complex treatment modalities.

More effective screening is needed in low-resource areas to improve the detection of early-stage, asymptomatic glaucoma, specifically among patients younger than 40 years.⁹ This may entail conventional on-site diagnostic

testing, off-site interpretation of optic disc photos, or use of emerging deep learning analysis of the optic nerve and retinal ganglion cells. Earlier diagnosis and investment in secondary prevention measures can improve visual outcomes and lower the total lifetime cost of care.

In resource-limited settings, common barriers to glaucoma care include:

- The performance of basic diagnostics, such as vision tests and IOP measurements, by ophthalmic nurses in certain areas;
- Limited access to affordable, routine eye care such as refractive correction and low-cost cataract surgery, which require regular screening for ocular issues; and
- Low cultural awareness and acceptance of ophthalmic care, with many individuals unaware that blindness does not need to occur with age.

In such settings, devices for IOP measurement may be prohibitively expensive, poorly maintained, or utilized by undertrained staff. Technologies that have been found to often be unavailable include OCT, perimetry, and fundus photography.¹⁰ Advances in smartphone-based technology may expand access to fundus photography in the coming years.¹¹ However, even when eye care facilities in developing countries have access to these diagnostic devices, challenges related to

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the cost of care and patients’ awareness of the long-term progressive nature of the disease remain.

Advanced diagnostics are potentially helpful, but their utility is limited if at-risk populations are not adequately screened and if patients continue to present late in the disease process.

MEDICAL, SURGICAL, AND LASER APPROACHES TO TREATMENT

Consensus on the best approach to managing glaucoma in low-resource settings is lacking. Although ophthalmic medications are the most widely used treatment modality in these environments, they are often prohibitively expensive over the patient’s lifetime and therefore present issues with adherence and follow-up.¹² Surgery and laser therapy may overcome these limitations, but treatment complications, postoperative care, and patient expectations are all challenges associated with these approaches.¹³

Surgical Options

Surgery may be an attractive alternative to pharmaceutical therapy because of its long-term cost-effectiveness and sustainability. Trabeculectomy is typically the only procedure available in resource-limited settings. Although it is still considered by many to be the gold standard glaucoma surgery, trabeculectomy’s application in the developing world is variable due to its risk profile and inability to reverse vision loss. Consequently, eye surgeons in the developing world frequently shy away

from performing trabeculectomy for fear of poor patient satisfaction. Even when trabeculectomy is offered, patient acceptance rates can be low. Furthermore, considering that roughly half of the presenting patients may be monocular, trabeculectomy may pose an unacceptable risk to their remaining eye.

Trabeculectomy requires close peri- and postoperative follow-up, sometimes for several months. The procedure also carries a lifetime risk of sight-threatening infection, with estimates of postoperative blebitis ranging from 1% to 8% per patient-year.¹⁴ In developing countries, postoperative management is frequently complicated by limited follow-up by patients who must travel several hours for eye care. Low-cost interventions to improve follow-up rates, such as text message reminders and free medications, have shown promise in rural, resource-limited parts of China.¹⁵

The Aurolab Aqueous Drainage Implant (Aurolab) is a viable alternative to trabeculectomy that is similar to the Baerveldt Glaucoma Implant (Johnson & Johnson Vision).⁵ However, even at a relatively low cost of \$50, the Aurolab Aqueous Drainage Implant’s expense frequently limits its use in developing countries. Additionally, glaucoma drainage device surgery is fundamentally different than trabeculectomy, and glaucoma surgeons in resource-limited settings may lack training on how to place and manage these devices. When mentors lack procedural familiarity, it can be difficult for new techniques and technologies to be adopted by trainees.

A potentially safer and more cost-effective surgical option is MIGS. MIGS procedures that may be appropriate in resource-limited settings include goniotomy using a bent 25-gauge needle or 23-gauge straight cystotome and circumferential suture-based trabeculotomy.¹⁶⁻¹⁸ Barriers to the adoption of MIGS in these areas include:

- Cost and availability of stents;
- Cost and availability of direct gonioscopes;
- Unfamiliarity with procedural techniques due to lack of training in residency;
- Relatively low-quality microscopes that do not tilt and/or cannot appropriately magnify the view of the angle; and
- Decreased effectiveness of angle surgery in advanced glaucoma.

In resource-limited settings, MIGS is still in the early stages of investigation. However, these procedures may represent a cost-effective, safer alternative to trabeculectomy, particularly in patients with less advanced disease and the ability to follow up.¹³ As with traditional glaucoma drainage devices, MIGS devices require careful patient selection and surgical and postoperative training that may be difficult to obtain. Overall, high upfront costs and limited patient acceptance are the greatest barriers to widespread use of any glaucoma surgical intervention.

Laser Treatment

Selective laser trabeculoplasty (SLT) is the most commonly performed laser procedure in resource-limited contexts. This procedure can be used as a primary, replacement, or adjunctive therapy to medications at a much lower cost and with greater accessibility in areas such as sub-Saharan Africa. Additionally, SLT has a significantly better safety profile than surgery.¹⁹ The main limitation of SLT is that the procedure may need to be repeated to maintain its IOP-lowering effect, which is a challenge in populations with high

risk of loss to follow-up. Additional challenges of SLT include the cost of the laser, required device maintenance, and the procedure's limited efficacy in eyes with advanced disease.

For patients with advanced glaucoma and low vision potential, transscleral diode laser cyclophotocoagulation is an option where available, although this approach shares SLT's upfront cost and servicing challenges. MicroPulse cyclophotocoagulation (Iridex) uses a lower-power transscleral diode laser and thus carries a lower risk of vision loss and postoperative hypotony. However, the technology's cost, availability, and lack of physician familiarity currently limit its utility in resource-limited settings.

For angle closure spectrum glaucoma, a gonioscopy mirror may be available. However, due to underutilization, poor technique, and overreliance on the Van Herick method, physicians may misdiagnose angle closure glaucoma as open-angle glaucoma and therefore miss an opportunity to perform cataract extraction or laser peripheral iridotomy.^{20,21} Treatment of angle closure glaucoma can be initiated with an Nd:YAG laser, but this device is not as widely available in developing countries as in developed countries. In patients with more than 180° of synchial angle closure, trabeculectomy may still be more effective than laser peripheral iridotomy.

COMMUNITY-BASED OUTREACH AND COLLABORATION FOR FOLLOW-UP SUPPORT

A shortage of ophthalmic care providers often exists in resource-limited settings, especially for glaucoma care. In sub-Saharan Africa, for example, there is only one ophthalmologist for every 2.9 million people.³ Such issues of provision are generally true of all ophthalmic care professionals, including ophthalmic nurses, optometrists, and counselors.²² As a result, investment and innovation are needed to provide screening, diagnosis, and follow-up support. This

is especially important in rural settings, where ophthalmologists are less likely to reside. In sub-Saharan Africa, this divide is readily apparent, as 80% of the population lives in rural areas, whereas most ophthalmologists live in urban centers.³

The mobilization of local community health workers or primary care physicians to support eye care may improve glaucoma diagnosis, follow-up, and treatment adherence.²³ Additionally, harnessing existing primary care resources and ophthalmic intervention programs, such as those in place for cataract surgery, may reduce the cost of glaucoma care. For example, the African Glaucoma Consortium is seeking to integrate SLT across sub-Saharan African through existing multilevel infrastructures.²⁴

PATIENT-CENTERED TREATMENT APPROACHES

Additional focus on physician-patient communication in developing countries may improve long-term outcomes of glaucoma management. In a study of Nigerian ophthalmologists, investigators found that health care providers harbored significant concerns about patient satisfaction with glaucoma surgery, especially among individuals with low health literacy who may expect the treatment to restore their sight.¹⁰ Proper education combined with shared doctor-patient decision-making can improve patient adherence to and expectations of treatment.

Medical Management

In resource-limited settings, it is important for providers to educate patients on their medication treatment plan and to be aware of any potential side effects that could affect treatment adherence.¹⁰ For example, lack of access to air conditioning in some areas may limit the utility of drops. Strategies to improve adherence must be considered for each patient and should include tips for simplifying the medication regimen and education on the role of medicine in the lifelong course of

glaucoma.²⁵ Proper education on the risks and benefits of different treatment options allows patients to make the best decisions based on their values and circumstances and can thereby improve their satisfaction.

Discussing Alternatives

If there are concerns surrounding patients' ability to afford long-term medications or regularly obtain their medications, SLT can be considered as a first-line treatment option, provided a working laser is available. With SLT, affordability and accessibility barriers are reduced, systemic side effects are limited, and the treatment effects are comparable to early medical therapy. For surgical options that require long-term follow-up, physician-patient conversations (including discussion of the potential barriers to care) must occur to ensure postoperative care is accessible.

Many surgeons in developing countries still perform trabeculectomy on patients who lack the ability to follow up in an attempt to prevent further disease progression. In fact, a patient's inability to follow-up may compel surgeons to operate earlier in the disease course, particularly when medical management is not possible. Due to the scarcity of argon lasers to perform laser suture lysis of trabeculectomy sutures, releasable sutures are routinely employed in patients who can follow up reliably. Nonreleasable sutures are used more often in patients with limited follow-up ability to reduce the risk of postoperative hypotony.

When a patient who cannot properly follow up presents with both glaucoma and cataract, a common treatment strategy is combination superior small-incision cataract surgery (SICS) and trabeculectomy. Notably, many patients in developing countries present with advanced cataracts that make preoperative glaucoma staging impossible. Therefore, in patients with good follow-up potential who present with advanced cataract and elevated IOP, a reasonable approach is to

perform temporal SICS and preserve the superior ocular surface for subsequent trabeculectomy if needed.

Community Outreach

Targeted public health campaigns based on local community characteristics and values can promote treatment of and screening for glaucoma and other preventable forms of blindness. An epidemiological study of glaucoma prevalence at a tertiary referral site in Ghana highlighted potential approaches for glaucoma awareness campaigns. The focuses included offering glaucoma screenings during voluntary marriage counseling similar to the process used for sickle cell disease, and partnering with local religious leaders.²⁶ In some communities, public health measures may need to address misunderstandings and superstitions that discourage patients from seeking care.²⁷

FUTURE DIRECTIONS

Teleophthalmology has the potential to improve patient satisfaction and outcomes by saving time and costs.^{28,29} Its use will likely continue to grow as access to high-speed internet increases in the developing world, and it may ultimately help to improve patient follow-up.

Ongoing advances in smartphone applications, deep learning, and AI will likely benefit glaucoma management as well. Smartphones are readily accessible to most patients and health care professionals in low-resource environments and may minimize patients' need to travel to an eye care specialist.³⁰ Smartphone applications show potential to improve medication adherence by reminding patients about their eye drops or monitoring real-time use of eye drops through bottle holder devices.³¹ Smartphones can also be used by health care professionals for visual field testing and photography of the anterior segment, angle, fundus, and optic disc.^{11,32,33}

Deep learning and AI also hold promise in detecting early visual field loss from optic nerve damage and

determining disease progression.³⁴

These technological advances are in various stages of development but may become more accessible to the masses in the future. In addition, Orbis' virtual training platform, Cybersight, is an outstanding web-based educational resource for eye care professionals.

CONCLUSION

The high prevalence and late presentation of glaucoma in resource-limited settings require attention to be paid to secondary prevention measures. Targeted resource-specific treatment strategies should maximize sustainable vision-maintaining outcomes while minimizing barriers to access, such as distance, cost, and limited patient understanding. Telemedicine, smartphone applications, deep learning, and AI may address many of these issues as these emerging technologies become more accessible and effective. ■

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