ORIGINAL ARTICLE

What Glaucoma Surgical Rate could Serve as a Target for West Africa? A Systematic Review

Egbula N Eni[1], Winifred Nolan[2], Bassey Eval[3], John C Buchan[4]

Abstract

Aim and objective: This study aimed to use the available evidence to model a glaucoma surgical rate (GSR), which could serve as a target for West Africa.

Materials and methods: A comprehensive literature search was performed in Medline, Embase, Global Health, and CINAHL, and studies published between January 1, 2000, and June 19, 2020, were retrieved. Study selection, quality appraisal, and data extraction were performed and the results of individual studies aggregated and presented using a narrative synthesis. Using these data, we aimed to construct a target GSR per million population per year that is sufficient to offer trabeculectomy to most patients with glaucoma who are diagnosed, and for whom other treatment options are either ineffective or inappropriate. The findings were then used to develop a trabeculectomy target for West Africa.

Results: Initial searches returned 633 references, of which 33 unique studies were eligible for inclusion. The glaucoma prevalence population-based surveys identified, reported a wide range of prevalence of primary open-angle glaucoma (POAG) ranging from 1.0 to 8.4%. The studies on glaucoma medications reported intraocular pressure (IOP)-lowering effects ranging from 12.8% (beta-blockers) to 63.7% (Timolol–Latanoprost combinations). The adherence rate to antiglaucoma medications spanned from 10.3 to 82.3%. Regarding selective laser trabeculoplasty (SLT), only two studies were found. All the studies on trabeculectomy showed a significant reduction in IOPs at different follow-up periods with many reporting the absence of vision-threatening complications. From these available data, a GSR of 50 trabeculectomies was suggested for countries in West Africa.

Conclusion: This trabeculectomy target metric is expected to minimize POAG blindness in the West African subregion.

Clinical significance: The proposed GSR will enable eye care workers involved in glaucoma care in West Africa to assess their efforts compared with the proposed target. The gap will signal the potential for improvement.

Keywords: Glaucoma surgical rate, Primary open-angle glaucoma, Systematic review, Target, Trabeculectomy, West Africa.

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Background

West Africa is believed to have the highest prevalence of primary open-angle glaucoma (POAG) in the world.[1] Primary open-angle glaucoma accounted for 94.5% of glaucoma in a survey in Ghana,[2] and 86% of glaucoma in Nigeria.[3] Despite this huge burden, the treatment of glaucoma in West Africa is fraught with several challenges including late presentation and diagnosis,[4] poor compliance to medical therapy,[5,6] reluctance of ophthalmologists to treat glaucoma with surgery,[7] and refusal of glaucoma surgery by patients.[8]

The principal type of glaucoma surgery performed in West Africa is trabeculectomy.[9] It is superior to medical therapy. Burr et al. in a Cochrane study in which they reviewed the results of four randomized controlled trials (involving 188 participants) which had compared trabeculectomy and medical therapy in adult POAG patients concluded that primary trabeculectomy was more successful in reducing intraocular pressure (IOP).[10] Trabeculectomy is, therefore, considering the current evidence base, arguably the most appropriate first-line treatment to address glaucoma blindness in West Africa at the population level. However, glaucoma blindness prevention can only be achieved if sufficient trabeculectomies are performed each year per million population; this is termed glaucoma surgical rate (GSR). This study aimed to identify, appraise, and synthesize existing evidence on glaucoma prevalence, treatment efficacy/complications, and adherence to glaucoma treatment in West Africa to use the data to model a target GSR for the region.

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Materials and Methods

Study Design

The study is a systematic review of population-based prevalence and incidence studies as well as glaucoma treatment and adherence studies in West Africa.

Ethical Considerations

Ethical approval was not required for this study since only secondary data which were fully in the public domain already were used.

Additionally, living people cannot be directly or indirectly identified by the data involved in this study.

Eligibility Criteria

Inclusion Criteria

- Studies on the population-based prevalence and incidence surveys of POAG.
- Glaucoma treatment efficacy and adherence studies.
- Studies on the outcomes of trabeculectomy and selective laser trabeculoplasty (SLT), including complication rates.
- Included studies must report new primary data.
- Included studies must be studies on West African subjects.
- Studies published from January 2000 to June 2020.

Exclusion Criteria

- Studies not conducted on humans.
- Letters and editorials.

Data Sources and Search Strategy

A comprehensive search of electronic databases Medline, Embase, Global Health, and CINAHL was undertaken. The search was conducted first in Medline with a subsequent translation of the search strategies into the other databases. This was complemented with hand-searching of reference lists and citation tracking of included studies in Google Scholar and other search engines. A combination of synonyms and subject headings (where available) for the following search concepts: "glaucoma", "trabeculectomy", "selective laser trabeculoplasty", and "West Africa" was used to conduct the search. The search was put together using search tools like truncation, wildcards, proximity searching, and Boolean operators to combine the search concepts.

Given that West Africa comprises both English- and French-speaking countries, language-specific filters were not employed in the search. This strategy was to guarantee retrieval of articles published in both French and English Language. The searches were, however, limited to studies conducted in West Africa and published between January 1, 2000, and June 19, 2020, because the study aimed to access a relatively new body of evidence that addresses the research questions considering that glaucoma care services are gradually evolving fields.

A variety of study designs was anticipated, so study-specific filters were not applied to the search. This approach was to ensure that a comprehensive search with greater sensitivity than specificity was run.

References retrieved from the searches were exported to Endnote X9 (Clarivate Analytics, Philadelphia, USA) management software and duplicate articles were removed. Articles identified underwent screening of their titles and abstracts to remove those that were clearly ineligible or irrelevant. The full text was retrieved for all potentially eligible studies. Two reviewers independently undertook the titles/abstracts as well as the full-text screening activity. Discrepancies between selected articles were settled through discussion between the reviewers and referred to an arbiter, where necessary.

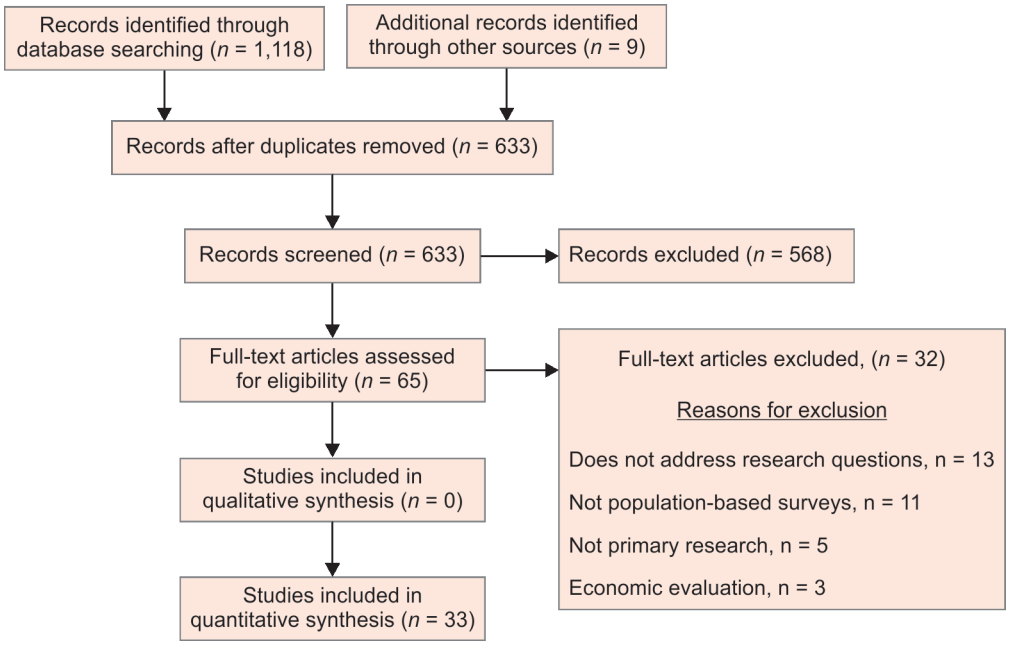
Articles that could not be retrieved online were obtained directly from the authors through requests sent by emails. This approach ensured that the full text of all the articles that were needed was obtained.

A summary of the literature searching and sifting procedure is presented in Flowchart 1.

Risk of Bias and Quality Assessment

The quality of eligible studies was appraised with the Mixed Methods Appraisal Tool 2018 version (MMAT).[11] MMAT was chosen because it is a valid tool that allows for quality assessment of quantitative, qualitative, and mixed methods study designs. It has been used in other systematic reviews.[12] MMAT permits the evaluation of each study through the use of several criteria specific to the individual study design. The ratings of each criterion were used to judge the quality of the included studies. During

Flowchart 1: Study selection process



the development of this study protocol, it was anticipated that studies of different designs may be encountered given that studies featuring different interventions and measures of outcomes were needed to address the research questions. A single appraisal tool that comprises specific sets for different study designs was therefore preferred over other appraisal tools such as the Critical Appraisal Skills Programme (CASP). The methodological quality criteria for quantitative descriptive studies were used to assess the quality of the included studies as all the included studies turned out to be quantitative descriptive studies. All studies that met the inclusion criteria were included in the review regardless of their risk of bias.[11] Therefore, even studies rated as "low quality" were included because such studies may still provide useful insight.[13]

Approach to Evidence Synthesis

Studies were categorized based on their outcome measures. Due to the considerable heterogeneity across the study designs and lack of consistent research questions, no opportunity for meta-analysis was found. The findings of each study within these groups were then summarized with frequencies and percentages for categorical variables. Quantitative variables, in contrast, were summarized using means and standard deviations for normally distributed data (such as IOP, a continuous variable) or median for skewed and/or data with outliers, such as age in some instances. Narrative synthesis involving the textual description of effects was then used to knit together the different findings including a summary of effect estimates, where available, based on the Synthesis Without Meta-analysis (SWiM) reporting guidelines.[14] The entire results were aggregated and used to develop a GSR target that is needed to minimize glaucoma blindness in West Africa.

Results

A search of the databases was conducted on June 19, 2020. After de-duplication, 633 items were generated. A preliminary screening of titles and abstracts, where available, against the inclusion and exclusion criteria, was undertaken to leave behind 65 articles whose full texts were obtained and reviewed.

Seven population-based prevalence studies, one study on the incidence of glaucoma, 10 studies on efficacy and adherence to medical therapy of glaucoma, 2 SLT efficacy studies, and 13 trabeculectomy outcome studies met the inclusion criteria. The remaining 32 out of 65 studies were excluded. Thus, overall, 33 studies were included in the review. The search process and results, including the excluded studies and the reasons for their exclusion, are depicted in Flowchart 1. Five articles were in French,[5,15–18] and they were all translated to English. The remaining 28 were all published in English.

The included studies differ remarkably in samples, interventions, and measures of outcomes. The population-based glaucoma survey studies included participants aged 30 years and above; the glaucoma medication efficacy and adherence studies involved participants aged over 18 years; while two of the trabeculectomy studies[19,20] included participants as young as 14 years. The methodological quality rating[11] of included studies is set out in Tables 1 to 4.

Prevalence of Glaucoma from Population-based Glaucoma Surveys

Published population-based glaucoma surveys conducted in West Africa between January 2000 and 19 June 2020 are summarized in Table 1. Eight studies were found which measured this outcome. One of the studies[21] measured the incidence of POAG in the Tema Eye Survey.[2] It reported an 8-year cumulative incidence of 4.6% (95% CI: 3.5–6.0) which translated to an annual crude incidence of 0.58 (95% CI: 0.4–0.8) and is not included in Table 1 which presents studies which all reported prevalence of glaucoma.

IOP-lowering Effects of Antiglaucoma Medications

Only 3 out of the 10 studies on glaucoma medications reported IOP lowering effects of antiglaucoma medications in POAG patients. The three studies were all conducted in eye facilities. Their findings are presented in Table 2.

Adherence to Antiglaucoma Medications

Six out of the 10 studies on glaucoma medications reported glaucoma medication adherence in POAG patients. The studies were all conducted in eye facilities. One study in the glaucoma medication category reported adherence to follow-up appointments in glaucoma patients diagnosed during a free eye screening in an eye facility. The findings of these seven studies are set out in Table 3.

IOP-lowering Effects of SLT

Only two studies that assessed the IOP-lowering effects of SLT were found. Both showed modest IOP-lowering effects.

IOP-lowering Effects of Trabeculectomy

Thirteen studies on the outcome of trabeculectomy for POAG were found. Twelve were retrospective patient record studies and one was a 1-year prospective longitudinal study which was conducted in a tertiary eye facility. The IOP-lowering effects of the trabeculectomies are shown in Table 4.

Table 1: Prevalence of glaucoma from population-based glaucoma surveys

First author (study score in parenthesis)	*Year*	*Area*	*Prevalence of all glaucoma in percent (95% CI)*	*Prevalence of POAG in percent (95% CI)*	*Age (years)*	*Sample size*
Murdoch (2)	2001	Kaduna, Nigeria	1.02 (0.12–3.64)	1.02 (0.12–3.64)	≥45	196
Ekwerekwu (2)	2002	Enugu, Nigeria	2.1	–	≥30	664
Ntim-Amponsah (3)	2004	Akwapim-South, Ghana	8.9	8.40 (7.74–9.06)	≥30	1.843
Guzek (4)	2005	Volta region, Ghana	7.6 (6.5–8.5)	–	≥40	2.298
Ashaye (4)	2013	Oyo, Nigeria	7.3 (5.5–9.1)	6.2 (4.5–7.8)	≥40	811
Budenz (5)	2013	Tema, Ghana	6.5 (5.8–7.1)	6.8 (6.2–7.4)	≥40	5.603
Kyari (5)	2015	Nigeria	5.02 (4.60–5.47)	1.53	≥40	13.591

95% CI = 95% confidence interval
Key to study score: 2 = low, 3 = moderate, 4 = good, 5 = high

Table 2: Glaucoma medication efficacy studies

First author (study score in parenthesis)	*Year*	*Area*	*Medications studied*	*IOP-lowering effect*	*Age (years)*	*Sample size*	*Research design*
Sounouvou (3)	2012	Cotonou, Bénin	Beta-blockers, Prostaglandin analogs	RE: 12.8% LE: 14.6% RE: 26.2% LE: 27.8%		224	Retrospective chart review
Koffuor (3)	2012	Pramso, Ghana	Latanoprost, Timolol, Timolol-Latanoprost combination	RE: 47.2 ± 21.6% LE: 48.8 ± 15.8% RE: 12.9 ± 22.5% LE: 19.6 ± 20.9% RE: 63.7 ± 1.6% LE: 61.4 ± 10.6%	30–100	141	Retrospective chart review
Gyasi (3)	2014	Accra, Ghana	No restrictions	Only 12.4% of IOP were controlled to < 16 mm Hg at 12 months from the initial mean IOP of 31.9 ± 8.9 mm Hg	>18	163	Retrospective chart review

RE, right eye; LE, left eye
Key to study score: 3 = moderate

Table 3: Rate of adherence to antiglaucoma medications among primary open-angle glaucoma patients

First author (study score in parenthesis)	*Year*	*Area*	*Adherence rate*	*Age (years)*	*Sample size*	*Method of determining adherence*
Omoti (3)	2005	Benin, Nigeria	33.9%	36–70	56	Self-reported
Tchabi (4)	2011	Cotonou, Bénin	53.3%	56.5 ± 11.9 (median age)	120	Self-reported
Omolase (3)	2013	Ondo, Nigeria	66.0%	22–88	100	Self-reported
Onkoya (3)	2016	Lagos, Nigeria	82.33%	≥40	114	Self-reported
Santos (3)	2016	Lomé, Togo	Good compliance (10.3%), fair (65.4%), poor (24.3%)	≥40	107	Self-reported
Kizor-Akaraiwe (2)	2019	Enugu, Nigeria	25.0% (adherence to follow-up appointments)	50 (median age)	116	Self-reported through telephone interview
Saka (2)	2020	Sagamu, Nigeria	81.6%	≥65	60	Retrospective chart review

Key to study score: 2 = low, 3 = moderate, 4 = good

Complications of Trabeculectomy

Twelve studies investigating complications of trabeculectomy as part of their outcomes in POAG patients were identified. These included a total of 1,288 eyes of POAG patients. Eleven were retrospective chart reviews, while one was a 1-year longitudinal study. Trabeculectomies were performed without adjunctive antimetabolites in three of the studies.[22–24]

Bekibele and Ashaye et al.[24,25] reported shallow anterior chamber (14.2 and 17.1%, respectively) as the commonest early postoperative complication observed in their studies. The trabeculectomies reported by Bekibele were performed without adjunctive antimetabolites in 56 eyes of 34 patients aged 18–80 years.[24] Ashaye et al. assessed the postoperative complications in 25 eyes that had trabeculectomy with adjunctive 5-fluorouracil (5-FU) and 51 eyes without 5-FU.[25]

One retrospective patient record study that investigated the complications of trabeculectomy in 40 eyes without adjunctive antimetabolite and 6 randomly selected eyes with 5-FU augmented trabeculectomy reported hyphema as the commonest early postoperative complication observed (15.3%).[26] Similarly, a 1-year longitudinal study of 5-FU augmented trabeculectomy in 45 POAG eyes reported hyphema as the most frequent complication (14.8%) in the early postoperative period.[19]

Most of the studies reported cataracts as a late complication with values ranging from 0.5%[22] to 23.4%.[20] Four studies[20,22,27,28] recorded endophthalmitis as complications with values ranging from 1.6%[22] to 4.5%.[27] Both Mielke and Ashaye and their respective colleagues[25,29] through retrospective chart review compared the complication rates between eyes that had 5-FU augmented trabeculectomy and eyes without adjunctive antimetabolite. They concluded that the complication rates were similar in both groups. Likewise, two retrospective patient record studies[28,30] compared primary trabeculectomy with 5-FU against primary trabeculectomy with mitomycin C and found that complications did not differ significantly between the two groups.

Estimation of Incidence

Mwanza et al.[21] reported a crude annual incidence of POAG of 0.58% in individuals aged 40 years and above in the Tema Eye Survey in Ghana. This is similar to the annual incidence that was obtained by Leske et al.[31] in an African-descent aged 40–84 years in Barbados. No other study which reported the incidence of glaucoma in West Africa was found, however, the Nigerian National Blindness and Visual Impairment Survey reported a glaucoma prevalence of 0.7 for all ages.[32] Incidence can be estimated to be 10% of the prevalence. Hence, the incidence of glaucoma in Nigeria is about 0.07% for all ages or 0.50% in individuals aged 40 years and above,[3] which is comparable to the incidence obtained in the Tema Eye survey.[21]

Table 4: Trabeculectomy studies—intraocular pressure (IOP)-lowering effects

First author (study score in parenthesis)	*Year*	*Area*	*Antimetabolite*	*IOP-lowering effects*[a]	*Age (years)*	*Sample size*	*Research design*
Agbeja-Baiyero-ju (3)	2001	Ibadan, Nigeria	None	IOP ≤ 21 mm Hg in 92%	48.1 (mean age)	264 POAG eyes	Retrospective chart review
Anand (3)	2001	Lagos, Nigeria	None	IOP < 22 mm Hg = 71% at 5 years, IOP < 16 mm Hg = 46% at 5 years	62 (mean age)	142 eyes of 100 patients	Retrospective chart review
Bekibele (3)	2001	Ago-Iwoye, Nigeria	None	IOP < 21 mm Hg = 74.1% at 2 months	18–80 (54 years mean age)	56 eyes of 34 patients	Retrospective chart review
Mielke (3)	2003	Lagos, Nigeria	5-FU in 76 eyes, No 5-FU 78 eyes (controls)	IOP ≤ 14 mm Hg = 64% (5-FU group) and 39% for the controls at 18 months	18–80, 62 (median age)	154 eyes of 101 glaucoma patients	Retrospective chart review
Gyasi (3)	2006	Bawku, Ghana	None	IOP < 18 mm Hg = 67.95% at 6 months.	17–85, 50.6 (mean age)	185 eyes of 164 patients	Retrospective chart review
Adegbehingbe (3)	2007	Osun, Nigeria	5-FU in only 6 eyes	IOP ≤ 20 mm Hg in 73.3% at 1 year in the 5-FU group, 61.8% in the rest	43.5 ± 3.5 (mean age)	46 eyes of 35 POAG patients	
Lawan (2)	2007	Kano, Nigeria	5-FU	IOP of 10-15 mm Hg was 82% at 6 months to 5 years	18–75	71 eyes of 63 patients	Retrospective chart review
Kim (3)	2008	Cape Coast, Ghana	5-FU in 38 eyes, MMC in 30 eyes	IOP < 21 mm Hg in 24.3% of eyes in the 5-FU group and 55.2% of eyes in the MMC group	65.9 (mean age for 5-FU group), 64.7 (mean age for MMC group)	68 eyes of 68 patients	Retrospective chart review
Ashaye (3)	2009	Ibadan, Nigeria	5-FU in 25 eyes	Mean IOP of 17.8 mm Hg at one year from a preoperative mean of 32.2 mm Hg	30–73, 49.4 (mean age)	70 eyes of POAG patients	Retrospective chart review
Komolafe (3)	2011	Ibadan, Nigeria	5-FU	Mean IOP of 16.9 mm Hg at 72 weeks from a preoperative mean of 27.7 mm Hg	49.8 ± 9.33 (mean age)	22 eyes of 17 patients	Retrospective chart review
Anand (3)	2012	Lagos, Nigeria	5-FU in 73 eyes, MMC in 59 eyes	IOP < 15 mm Hg at 3 years was 55% (95% CI: 44–70%) in 5-FU eyes and 76% (95% CI: 66–89%) in the MMC group	60.5 ± 11.8 and 57.4 ± 12.4 (mean ages)	132 eyes of 129 patients	Retrospective chart review
Olawoye (4)	2013	Ibadan, Nigeria	5-FU	Mean IOP at 1 year was 12.3 mm Hg from a preoperative mean of 31.9 mm Hg	14–77, 48.9 ± 19.6 (mean age)	47 eyes of 31 patients	One-year longitudinal study
Olawoye (3)	2017	Ibadan, Nigeria	5-FU	Mean IOP of 15.4 mm Hg at 43 months from a preoperative mean of 31.9 mm Hg	14–77, (52 years median age)	47 eyes of 31 patients	Retrospective chart review

[a]IOP with no additional antiglaucoma medication; 5-FU, 5-fluorouracil; MMC, mitomycin C
Key to study score: 2 = low, 3 = moderate, 4 = good

GSR Target for West Africa

The ideal GSR for West Africa was derived as shown in Flowchart 2 using available evidence from Nigeria as only this country reported the required data needed for such modeling. The Nigeria National Blindness and Visual Impairment Survey reported the prevalence of glaucoma for all ages[32] from which a glaucoma incidence of 0.07% as stated above was derived.

A GSR could be proposed that was equal to incidence, or even higher than the incidence to tackle the backlog of unoperated cases. However, such a target would be an overestimate as many cases remain undiagnosed and some patients will decline surgery or be managed by other means. Using these data, we aimed to construct a target GSR per million population per year that is sufficient to offer trabeculectomy to most patients with glaucoma

who are diagnosed, and for whom other treatment options are either ineffective or inappropriate.

Flowchart 2 presents a flowchart of effectiveness based on the reviewed evidence. It is a best-case scenario, hence, was developed from best effectiveness studies that were identified in this review. Two studies[33,34] were able to achieve 80% adherence which is the minimum regarded as good adherence to medications,[35] so this proportion of medication adherence was assumed in the best-case scenario model (Flowchart 2). Only 25% of patients are expected to have adequate control of IOP (mean IOP ≤ 18 mm Hg) on drops at 6 months,[36] and for our model, we, therefore, assigned 75% of diagnosed glaucoma cases as requiring trabeculectomy. The 75% cut-off also ensured that an achievable target is developed,[37] in addition to the fact that in practice not all POAG patients will be fit for surgery.

In a previous study, only 1.4% of patients offered trabeculectomy actually attended the surgery.[4] The best IOP-lowering effects from trabeculectomy in the present study using the findings of Advanced Glaucoma Intervention Study (AGIS) as stated above as benchmark for good IOP control was achieved in 82% of eyes at 6 months to 5 years.[38] The 18% of eyes with failed trabeculectomies may therefore require a redo trabeculectomy or glaucoma drainage device surgery where the latter is available (Flowchart 2).

Based on the incidence and treatment effectiveness data, the ideal minimum number of trabeculectomies that need to be performed each year in a district of one million population in West Africa to have any impact on the backlog of POAG patients yet to benefit from the surgery is 50 (Flowchart 2). The available current evidence suggests the highest number of trabeculectomies performed annually in a health district of one million population in West Africa is about 4 (Flowchart 2) leaving a gap of 46 which need to be addressed.

Discussion

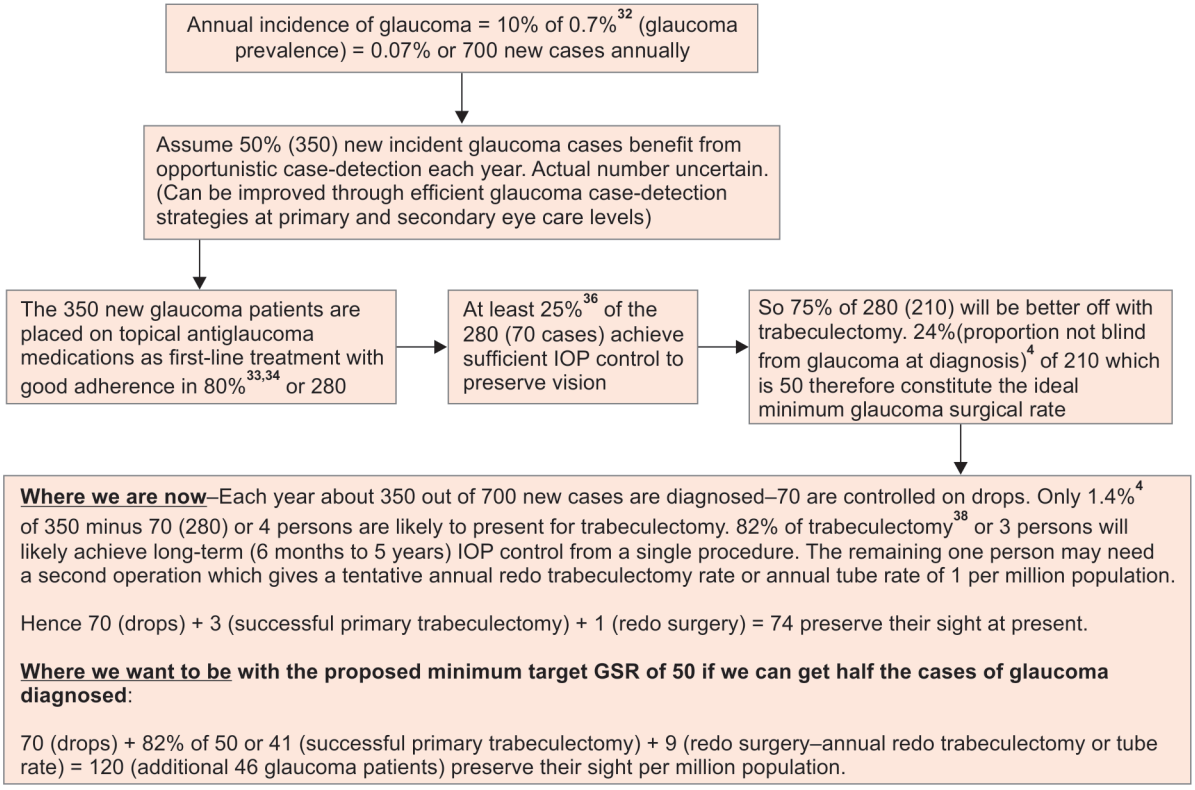
Minimizing blindness from glaucoma starts with planning for glaucoma service provision. The planning will be more effective if there is a target GSR. The prevalence and incidence of POAG as well as the outcomes of the different treatment modalities for this eye disease determine the GSR.

Considering that POAG constitutes the major type of glaucoma in West Africa and that some centers sometimes treat the other relatively rare types of glaucoma with trabeculectomy,[25] it appears plausible that estimating a GSR based on the prevalence of glaucoma for all ages will be more practical in the subregion. This will also reduce the underestimation that could result by not taking into consideration that a significant number of individuals aged <40 years also benefit from trabeculectomy, due to the relatively early onset of the disease in West Africa. For example, in Ghana, Ntim-Amponsah and colleagues[39] reported an age-specific prevalence of POAG of 6.0% in people aged 30–34 years, and 6.7% in individuals aged 35–39 years.

The IOP-lowering effects of antiglaucoma medications on POAG patients ranged from 12.8% with the use of beta-blockers[17] to 63.7% with the use of Timolol–Latanoprost combination[40] (Table 2). This evidence is, however, weak because all the three studies[17,36,40] that reported the IOP-lowering effects of medical treatment of glaucoma were retrospective patient record studies which are prone to selection and misclassification bias.

The six studies that reported glaucoma medication adherence in POAG patients presented a wide range of values that stretched

Flowchart 2: Glaucoma surgical rate target



from 10.3%[5] to 82.3%[33] (Table 3). While many studies reported compliance levels that were so low that it will be reasonable to conclude that medical therapy for glaucoma was inappropriate in this population, two studies achieved an acceptable 80% adherence[35] so we are working with this as an acceptable best-case scenario. Glaucoma patients who are found to exhibit poor adherence to their antiglaucoma medications could be good candidates for trabeculectomy. A key advantage of trabeculectomy over the medical treatment of glaucoma is the elimination of the adherence factor. From a cost perspective, trabeculectomy also has an edge over the medical treatment of glaucoma as it is cheaper in the long run given that it is often a one-off procedure for many patients.[41] This has led to the suggestion that glaucoma surgery could be a better approach to addressing the burden of glaucoma in developing countries.[42]

Only two studies[18,43] that examined SLT were found in this review. Although both studies reported a modest reduction in IOP, they are inadequate to allow plausible conclusions to be drawn, especially regarding its widespread use in West Africa. The paucity of studies on SLT in the sub-region might suggest that the procedure is not yet widely practiced. However, the procedure could be a useful treatment modality (where it is available) that may avoid some glaucoma patients from undergoing surgery.

The available evidence from this review suggests that among West African populations, trabeculectomy lowers IOP to an average level in the low[19,30,38] to mid-teens,[20,23,25,27,29] especially when augmented with either intraoperative mitomycin C or 5-FU both of which potentiate its IOP-lowering effect[19,20,26,28–30] (Table 4). This is particularly important because many glaucoma patients in the sub-region often present late in an advanced stage of the disease,[4] with the need for their IOPs to be controlled in the low to mid-teens. The AGIS showed that IOPs consistently <18 mm Hg following trabeculectomy in POAG patients aged between 35 and 80 years with failed medical therapy is associated with only minor deterioration of the visual field over 6 years.[44]

Studies that investigated the complications of trabeculectomy reported various types of complications. A few of the complications were vision-threatening. These included cataracts with a complication rate that ranged from 0.5%[22] to 23.4%,[20] and endophthalmitis, 1.6%[22] to 4.5%.[27] Since trabeculectomy like every other surgery has its own complications, a threshold for surgery will be justified based on the complication rates found in these studies. Such threshold for trabeculectomy will also depend on the life expectancy at birth, which for instance, is 61.49 years for Ghana and 53.05 years for Nigeria.[45]

The incidence of open-angle glaucoma increases with age,[31] but the life expectancy at birth of West African populations is relatively low.[45] These factors combined, create a pyramid of disease for POAG, where they are more people with early glaucoma (some of whom will die with the condition before it causes too much reduction in quality of life) than those with advanced disease. This creates a tipping point–if POAG patients are operated on at the very first sign of nerve damage that looks glaucomatous–there may be unnecessary complications that could have been avoided if the ophthalmic surgeon had waited as some of those people may die before the disease progresses too far.

In one of the reviewed studies,[20] almost one in every four POAG who had trabeculectomy developed visually significant cataracts after at least 2 years of follow-up. Thus, to prevent this complication and other complications associated with trabeculectomy, at least a quarter of POAG patients that could be managed successfully with medical therapy and/or SLT, where the latter is available, can be spared trabeculectomy. Deducing from this, the remaining 75% may benefit from trabeculectomy with minimal complications. Additionally, using the findings of AGIS[44] as a benchmark for successful IOP control, the best reported IOP control in this review (mean IOP consistently ≤18 mm Hg) for patients on topical glaucoma medications at 6 months was achieved in 25% of patients.[36] Based on these findings, a practical GSR is best computed from 75% of the population of POAG patients. This would be a GSR targeted at POAG patients with clearly progressive disease who are very likely to go blind without trabeculectomy. These assumptions were utilized in the calculation of the GSR.

The minimum number of trabeculectomies that need to be performed each year in West Africa, based on the available evidence is 50 in a health district with one million population. This should be the minimum target set by eye care workers involved in the management of POAG patients in the sub-region. Analogizing from the control of cataract blindness,[46] this is the minimal GSR that would reduce the trabeculectomy backlog and very likely reduce the rate of blindness from POAG in the sub-region.

A GSR of 7.0 and 2.9 was estimated for Ghana and Ivory Coast, respectively, in a previous study that was designed to estimate the global rates of glaucoma surgery.[9] A GSR of 7 is about 7 times lower than the minimum target of 50 proposed in this study. Similarly, a GSR of 2.9 is 17 times less than the trabeculectomy surgical rate of 50 modeled in this study. This suggests that the current GSR in West Africa is still abysmally low, especially when compared to rates obtained in the European region which ranged from 500 in Germany to 85.2 in the Netherlands.[9] These European studies considered a wide variety of glaucoma surgeries including trabeculectomy (77.7% of the entire glaucoma surgeries), glaucoma drainage device implantation, and cyclodestructive procedures, among others. However, 100% of the glaucoma surgery reported by Ivory Coast's National Prevention of Blindness Committee was trabeculectomy.[9]

The present study has estimated a GSR that could serve as a glaucoma surgery (trabeculectomy) target for West Africa. Analogous to cataract surgical rate (CSR) the metric GSR will allow easy comparison between West African countries and serve as a yardstick on which adequacy of surgical care of glaucoma patients in the region can be measured. The gap between the aspirational number of 50 trabeculectomies per million population per year and the actual number of trabeculectomies performed presently which is an average of 4 (an optimistic estimate of current GSR) (Flowchart 2) will signal the potential for improvement by ophthalmologists caring for POAG patients in West Africa.

Limitations

The current study is the first to present a target GSR (with trabeculectomy as the specific surgery) for West Africa taking into consideration medical treatment of glaucoma and the use of SLT as other viable treatment options. Consequently, it is likely to be fraught with assumptions and limitations. First, most of the studies reviewed are observational studies that are prone to bias. Second, no relevant unpublished studies could be assessed for inclusion in this study. There is therefore the possibility of publication bias.

Finally, most of the studies included in this review used insufficient standardization in reporting outcomes of the treatment of glaucoma. This hampered synthesis of findings across studies.

This particular limitation can be surmounted by using a standard outcome framework in research studies, such as proposed by the International Consortium for Health Outcomes Measurement (ICHOM).[47]

These limitations notwithstanding, this review provides a useful trabeculectomy target for West Africa. It highlights the need for eye care centers involved in glaucoma care in West Africa to start undertaking a routine audit of the numbers, outcomes, and complications of trabeculectomy in their centers. Such data could then be pooled nationally so that each West African country can assess how they stand compared to this proposed target.

Conclusion

Available evidence suggests that the prevalence of POAG is probably highest in West Africa. Most studies in West Africa rank glaucoma second to cataract as the commonest cause of blindness. This review found that medical treatment of POAG is inadequate to achieve the desired target IOP in most patients. This finding may be related to the poor adherence to antiglaucoma medications reported by most studies in the sub-region. Trabeculectomy, on the other hand, was found to be an effective surgical procedure for managing POAG in West Africa. With this in mind, a conservative estimate of the number of trabeculectomies needed to be performed in a year in a health district of one million population (GSR) in West Africa is a minimum of 50. This target metric is expected to minimize POAG blindness in the West African sub-region.

Available evidence suggests that SLT is not yet widely available as a treatment modality for POAG in West Africa. It is, however, a viable treatment option that could save some POAG patients from surgery, in centers where it is available.

Clinical Significance

The GSR target will provide eye care workers, program managers, and policymakers with a tool that will guide clinical and policy decision-making regarding the care of glaucoma patients in the region. It will provide a target for eye care providers to work toward while developing glaucoma services in West Africa.

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