Models of Open-Angle Glaucoma Prevalence and Incidence in the United States

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**Purpose.** To estimate the prevalence and incidence of open-angle glaucoma among black and white persons in the United States and to characterize quantitatively their life experience with glaucoma using a life table approach to estimate disease duration.

**Methods.** Review of published data on glaucoma combined with statistical models to estimate prevalence and incidence.

**Results.** The association of open-angle glaucoma with age was examined separately for white and black persons. By the year 2000, the number of persons in the United States with primary open-angle glaucoma is estimated to be 2.47 million (1.84 million white and 619,000 black Americans). A model using derived incidence rates for open-angle glaucoma (OAG) and United States mortality data indicated that the average black American has OAG 27% longer than the average white American (16.3 years compared to 12.8 years).

**Conclusions.** Meta-analysis to obtain pooled prevalence estimates for glaucoma provides useful information on length of disease and age distribution of those affected. It may assist in estimating treatment effects and associated costs to derive data that affect health care decisions. Invest Ophthalmol Vis Sci. 1997;38:83-91.

Although glaucoma is known to be a common visual disorder, the prevalence of its subtypes and the variations in its frequency have not been analyzed with precision. There are few detailed estimates of the number of persons affected by glaucoma, nor has the duration of disease been examined. Differences among populations in the incidence and prevalence of glaucoma may provide clues to its pathogenesis. For purposes of economic planning and for evaluations of therapeutic interventions, it would be helpful to know the rates of progressive atrophy and blindness, including an estimate of the average length of visual disability from glaucoma. A mathematical model that estimates the effect of glaucoma on populations might have explanatory and predictive value in answering some of these questions.

Our concept of open-angle glaucoma (OAG) has changed during the last 30 years. It is now defined as slowly progressive optic atrophy, characterized by midperipheral visual field loss and excavated appearance of the optic disc. The intraocular pressure (IOP) level is not a diagnostic criterion because a substantial minority of those with OAG have IOP levels within the normal range. However, IOP level is a confirmed risk factor for glaucoma. Screening for OAG requires either informed examination of the disc, functional testing of the visual field, or both. The cost and expertise required for glaucoma screening have been barriers to performing disease prevalence surveys that are population based.

This study uses standardized criteria to review the available literature on glaucoma prevalence as investigated in populations around the world. It has five specific aims: to estimate the prevalence of OAG, taking into account ethnic origin and age; to calculate incidence estimates from prevalence data; to apply age-specific incidence estimates and mortality figures to a hypothetical cohort of American adults at age 30, estimating their life experience with glaucoma; to calculate the number of incident cases, person-years of glaucoma, and mean duration of glaucoma using...
the model described; and to illustrate how these data can be used to provide estimates for public health purposes, such as determining the cost of glaucoma therapy.

METHODS

Literature Search and Criteria for Inclusion

We identified 111 published studies with data on the prevalence of glaucoma (OAG, angle-closure glaucoma, or secondary glaucoma) or on the prevalence of blindness when disease-specific causes were detailed. Among these, the reports that qualified for inclusion had all the following desirable study design features: random sampling of examined persons from a representative population; high rate of examination of the sample (>75%); clear definition of glaucoma that included either examination of the optic disc, functional test of the visual field, or both; and evidence that someone experienced in glaucoma evaluation performed or confirmed the diagnoses. Studies were not used for prevalence estimation if either IOP measurement or visual acuity was the only screening technique. Because we did not gather original information from individual patient data for this study, it was not necessary to follow human experimentation tenets or to obtain informed consent.

We did not estimate angle-closure glaucoma prevalence because of the small proportion of subjects identified with this disorder and because of the lack of gonioscopy or other screening methods in many studies. No study cited more than 32 prevalent cases. Most studies detected disc and field damage, then determined the type of glaucoma by ophthalmic examination. Angle-closure glaucoma was infrequent in white and black populations. Nine studies provide a median age-adjusted prevalence in white persons of 0.1% (range, 0.04% to 0.69%) in those older than 40 years of age. We noted a trend for angle-closure glaucoma to increase in frequency with age. Even fewer incidences of angle-closure glaucoma have been documented among black persons.

For this study, we summarized data from surveys that cited the age-specific OAG prevalence of populations in which persons classified their ethnic origin as either white or black. Studies among white persons were conducted in European countries or among subjects who identified themselves as not of African origin. Data were assumed to be appropriate for those of African origin when most of the subjects in a study group identified themselves as black. There is substantial heterogeneity among the populations so described, and, in generalizing to the United States population, references to white or black are inclusive of persons of mixed ethnic and other origins, particularly Hispanic and Asian. Although it would have been possible to use only the reports of prevalence in studies conducted in the United States, we decided to use prevalence estimates from all qualifying studies on white and black persons (excluding studies conducted in Asia). This seemed appropriate because by doing so, the generalizability of the estimates would be enhanced for those in the United States population. For example, the Beaver Dam, Wisconsin study evaluated a population whose ethnic origin was relatively uniform. The Baltimore Eye Survey evaluated a more diverse inner-city population. There is no reason to assume that either of these is ideally representative of the United States population. It seemed most appropriate to merge data for persons of European origin to generalize for the United States white population. Similarly, data from all studies, with prevalence estimates for those of African origin, were pooled for use with data for the United States black population. In another study, additional data were presented for other ethnogeographic groupings to propose a worldwide estimate of the number of persons with glaucoma. Simpler models were used in that study than in ours for the age–prevalence relationship of glaucoma in persons of European and African descent. To study this relationship with greater precision and with specific reference to the United States, the following methods were used.

Estimation of Prevalence of Open-Angle Glaucoma

To generate pooled estimates of the prevalence of OAG different ages, we combined the prevalence figures for each age and each study. For each race (black and white) separately, a mixed model, with age as a fixed effect and study as a random effect, was fitted to the prevalence rates using SAS Proc Mixed (SAS/STAT software, changes and enhancements through release 6.11 [1996]; SAS Institute, Cary NC). A variance components structure was used to model the correlation structure of the random effects. Observations were weighted by the denominator of the rate to account for differences in precision of prevalence estimates among studies and age groups. The random effects model represented a significant improvement in fit over the model with all fixed effects, as determined by a larger Akaike Information Criterion. In addition, the introduction of a quadratic (fixed-effect) term for age improved the fit of the model, as determined by chi-square tests of the difference of −2 log likelihoods. The improvement in fit produced by including the quadratic term was significant for the data obtained among black persons but not for the data obtained among white persons; however, for consistency, the quadratic term was retained for the final model for both data sets. A log prevalence model also
was examined; its fit was poorer than the linear model described above for the data sets of both white and black persons. Prevalence values predicted by the models for each age from 30 to 99 years were calculated, and data for ages 40 to 90 years are shown in Figure 1, along with their 95% confidence limits.

**Estimation of Incidence From Prevalence**

Predicted prevalence estimates were used to calculate incidence rates for white and black adults with the method proposed by Podgor et al. To do this, we entered the estimated prevalence for each age group into the formula of the type: \( (P_{x+1} - P_x)/(1 - P_x) \), where \( P_x \) is prevalence at year \( x \), and \( P_{x+1} \) denotes the corresponding figure for those 1 year older. Standard errors for the incidence estimates for each year were derived by using the delta method for functions of random variables. Estimated incidence rates for white and black persons and their confidence intervals are shown in Figure 2. Important assumptions for this generation of incidence from prevalence data are that the condition be irreversible, that mortality be the same in persons with and without the condition, and that the population composition be stable for the time interval studied. Open-angle glaucoma typically is irreversible. Mortality recently has been shown to be unaffected in white persons with OAG; there is no published information on differential mortality in black persons with OAG. Census bureau estimates were used for lower and upper limits in population data stratified by 5-year age group and ethnicity. Lower and upper 95% confidence bounds for prevalence were multiplied by these lower and higher population estimates to generate confidence limits for the numbers of persons with glaucoma.

**Projection of the Number of Persons With Open-Angle Glaucoma in the United States (Life Table Method)**

To estimate the cumulative incidence and prevalence of OAG in American adults, we used published data on national estimates of United States mortality rates (estimates specific to race and age) and the incidence rates derived as described above (Estimation of Incidence From Prevalence). An imaginary cohort of \( N_i \) persons was subjected to annual mortality rates and OAG incidence rates for ages 30 to 99 years. The cohort was assumed to have no in- or out-migration. Those in whom glaucoma developed in a given year were not at risk for death in that year. Persons in the cohort were assumed to enter the cohort at age 30 because reliable estimates of OAG prevalence were not available for ages younger than that and, hence, were assumed to be zero.

Calculations in the model were made as follows (Fig. 3): For an initial cohort \( (N) \), the number of incident cases in each year \( (i) \) equals \( N_i \times I_i \), where \( N_i \) = the number of persons at the start of year \( i \) who are alive and not affected by glaucoma, and \( I_i \) = age-specific incidence of OAG in year \( i \) \[ N_i = N_{i-1} \times (1 - I_{i-1} \times (1 - M_{i-1})) \]. Because the available data indicate that only a small proportion of those with glaucoma are younger than age 30, the calculations were...
FIGURE 3. Flow diagram of the model used to incorporate incidence and mortality data in the estimation of various parameters in a theoretical group of persons with open-angle glaucoma.

begun for persons at age 30; this is designated year 0 in the model (Fig. 3). The number of total deaths in year i equals $M_i \times (G_i + N_i[1 - I_i])$, and the number of deaths among persons who entered year i with glaucoma equals $M_i \times G_i$, where $M_i = \text{age-specific mortality rate in year } i$, and $G_i = \text{number alive at the start of year } i$ and already classified as having glaucoma at the start of the year. By convention, there were no persons in whom glaucoma developed and who died in the same year. The cumulative number of persons with glaucoma entering year i alive was $G_i = N_{i-1} \times I_{i-1} + G_{i-1} \times (1 - M_{i-1})$. The cumulative number of persons who did not have glaucoma and who were alive at the start of year i was $N_i = N_{i-1} \times (1 - I_{i-1}) \times (1 - M_{i-1})$. The cumulative number of persons alive at the start of year i was $(N_i + G_i)$.

We used this model to calculate the following data separately for white and black Americans: number of persons with incident glaucoma, number of deaths among persons with glaucoma and persons without it, proportion of the initial cohort affected, total number of person-years of glaucoma, and mean number of years affected with glaucoma per persons with glaucoma (calculated by dividing total person-years with glaucoma by number of persons with glaucoma).

RESULTS

Open-Angle Glaucoma in White Persons
The random effects model provided estimates of OAG prevalence for white persons (Fig. 1). As reported in the individual studies on which the model is based, prevalence increased with age. For white persons, 17 studies satisfied our criteria for inclusion of some data. In only a small number of reports did investigators attempt to perform visual field testing on all persons at screening. Even in these studies, some persons were classified as having glaucoma based on optic disc criteria alone. Hence, persons diagnosed with glaucoma had either abnormal discs alone or abnormal fields and discs. Criteria used to denote OAG typically included either functional loss by visual field testing or alterations of the optic disc severe enough for an assumption to be made that damage was present. Fourteen of these reports give age-specific estimates for prevalence of OAG. The median age-adjusted prevalence for their adult populations (older than age 40) was 1.55% (range, 0.49% to 8.34%). The population data of each study was used for age adjustment in this calculation. By region, three studies were conducted in the United States, three in the United Kingdom, one in New Zealand, and the remainder in other European countries. Some studies stratified cases into definite and probable OAG; all these categories were included in our study as OAG.

Gender-specific data were presented in 13 of these studies for OAG. Male-to-female ratios varied from 0.43 to 3.17, with a median of 1.0 (range, 0.43 to 3.17). Insufficient data were provided in most studies for age adjustment of the gender-specific rates. No difference in prevalence of OAG between men and women was assumed in this study.

Secondary Glaucoma
Few studies describe secondary glaucoma separately, and few investigators provide the criteria used in its definition. We have included those with pigmentary and exfoliation (or capsular) glaucoma as OAG. The median prevalence for secondary glaucoma in seven studies, including white and black persons, was 0.35% (range, 0.02 to 1.12%). This was approximately one fifth the median OAG prevalence in white persons. Because many persons with secondary glaucoma have unilateral conditions and are unlikely to suffer bilateral blindness, they are enumerated in this study but are not included in the models or in statistics on blindness.

Open-Angle Glaucoma in Black Persons
The relationship between OAG and age for black persons from the model (based on seven studies) is shown in Figure 1; as expected, prevalence rose with age. In addition, as demonstrated most directly in the Baltimore Eye Survey, glaucoma prevalence was higher in black persons, and its increase with age was greater than in white persons. The median age-adjusted prevalence for persons older than 40 years of age in seven
Open-Angle Glaucoma Prevalence and Incidence

TABLE 1. Number of People in the United States Estimated to Have Glaucoma in the Year 2000

<table>
<thead>
<tr>
<th>Group</th>
<th>Number (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White persons with OAG</td>
<td>1,846,948 (939,460, 2,834,413)</td>
</tr>
<tr>
<td>Black persons with OAG</td>
<td>619,181 (347,448, 948,733)</td>
</tr>
<tr>
<td>Total OAG</td>
<td>2,466,129</td>
</tr>
<tr>
<td>Secondary glaucoma</td>
<td>443,905</td>
</tr>
<tr>
<td>Overall total</td>
<td>2,910,034</td>
</tr>
</tbody>
</table>

CI = confidence interval; OAG = open-angle glaucoma.

studies was 4.62% (range, 1.39% to 8.76%). Large studies among black persons have been conducted in the Caribbean and in the United States; in two of these, visual field testing at screening was performed on all subjects. In other studies, methods and populations have varied widely.

Diagnosed Versus Undiagnosed Glaucoma

We enumerated the persons with previously diagnosed glaucoma and those detected during the surveys in each report. Most of these data were from studies conducted in developed countries. They varied from no previously known cases to 79% of patients who reported a previous diagnosis; the mean was 45% ± 25% known cases (mean ± standard deviation; number of studies = 14).

Number of Persons With Glaucoma in the United States

We applied the prevalence data from the random effects model for OAG to estimates of the number of white persons in the United States by the year 2000 among persons not designated as black in census bureau figures. The prevalence of OAG from studies among black persons were applied to the black American population estimated for the year 2000. The number of black American residents is estimated to be 35.5 million by 2000, of whom 619,181 will have OAG (Table 1). The portion of the population with OAG includes 3.5% of black persons older than 30 years and 5.2% of black persons older than 40 years of age. The remainder of the United States population (not designated as black; grouped here as white) is estimated to include 1.85 million persons with OAG. This represents 1.3% of the white population older than 30 years and 1.8% older than 40 years of age. The age distribution of black Americans with OAG is substantially different from that of white Americans (Fig. 4). Prevalence is relatively equal within each age group in black persons, whereas in white persons it is greater in the older age groups. Despite the fact that black persons comprise 14.7% of the United States population (35.5 of 241.2 million), they represent 25.1% of persons with OAG (619,181 of 2,466,129). Additionally, in the 40- to 59-year-old group, black persons comprise 43.4% of those with OAG (205,652 of 473,568). To describe the variability of our estimates for number of persons with OAG, we multiplied the upper and lower 95% confidence bounds for each age-specific prevalence estimate by the low and high bound for the age-specific population estimate given by the census bureau (Table 1).

The overall United States total for OAG for the year 2000 is estimated at 2.47 million (total population estimate = 276.6 million). If the prevalence of secondary glaucoma is one fifth the OAG value in white persons, 443,905 additional persons will be involved, totaling 2.91 million persons affected by glaucoma of both types.

Estimating the Number of Persons Blind From Glaucoma

It is important to estimate the number of those expected to be bilaterally blind from glaucoma. This allows specification of the disability–patient ratio. In surveys among white persons, the prevalence of those with glaucoma whose acuity in the better eye was equal to or worse than 20/200 because of glaucoma was 2.5% (Beaver Dam Study, Klein BEK, personal communication, 1996), 4.4% (Baltimore Eye Survey), and 6.2% (Roscommon, Ireland). For black persons,
estimates were higher: 7.9% (Baltimore Eye Survey). To estimate the expected number of blind persons, we multiplied the estimated number of those with glaucoma by 8% in black persons and by 4% in white persons. This suggests that 130,540 persons will be blind from primary glaucoma in the United States in 2000. More persons might be effectively blind from glaucoma because of small remaining central islands of vision, despite preserved visual acuity better than the blindness standard. No published study has enumerated these persons separately.

Incidence Estimates and the Glaucoma Model

Incidence estimates shown in Figure 2 were used in the life table model to yield life experience with respect to glaucoma for a theoretical cohort of Americans beginning at age 30 years. Estimates were generated by the incidence values from the model, whereas 95% confidence limit estimates were calculated by entering the 95% confidence limit values for incidence estimates into the life table model.

For white persons, the cumulative probability of OAG is 4.2%. For example, OAG would develop in 4,178 of an initial cohort of 100,000 persons at some point in their lifetimes (95% confidence limit = 3.01%, 5.01%). Of the total number of years lived to death or to age 100 by the cohort of 100,000, 1.1% of person-years would be affected by glaucoma (53,642 of 4,750,636 person-years; 95% confidence limit = 0.79%, 1.6%). The number of person-years of OAG per person with glaucoma would be 12.8 years (range, 12.5 to 14.7 years). Among those in whom OAG ever develops, it would develop in 25% by age 64, 50% by age 72, and 75% by age 81 years (Fig. 5).

In a cohort of the same initial size, more than twice as many black persons as white persons with OAG would be affected (cumulative probability, 10.3%, or 10,283 of 100,000 persons). Of even greater interest, 3.9% of the person-years of a black cohort of 100,000 would be affected by glaucoma, nearly four times as many as for a cohort of 100,000 white persons. The number of person-years per person with glaucoma among black persons is 16.5 years (95% confidence limit, 14.9; 19.3 years), a figure that is 25% higher than that for white persons. Furthermore, among those black persons in whom OAG ultimately would develop, it develops in 25% by age 54, 50% by age 65, and 75% by age 75 years. This is 6 to 10 years earlier than the comparable figures for white persons.

DISCUSSION

Our prevalence estimates are dependent on the assumptions used and on the quality of available data. There have been few previous attempts to estimate the number of persons with glaucoma, to characterize their distribution in various ethnic groups, or to estimate the lifetime experience with the disease among those affected. One reported point estimate of the number of white and black Americans with glaucoma in 1990 was published in a pamphlet (Tielsch JM (principal author). Vision Problems in the US. Schaumburg, IL: Prevent Blindness America; 1994:16). The estimated totals of white persons (1.48 million) and black persons (500,360) are similar to the totals presented here if the expected increase in the relevant population groups from 1990 to 2000 are taken into account. Other reports of glaucoma prevalence in the world were based largely on blindness surveys. In an earlier report, we estimated that 6.7 million persons worldwide will be blind from glaucoma by the year 2000. This suggests that glaucoma will soon be the second largest cause of bilateral blindness in the world. Only cataract represents a greater cause of severe visual loss.

There are difficulties inherent in estimating the number of those with glaucoma. Compared to the identification of visually significant cataract, screening for glaucoma involves the assessment of either the optic disc or peripheral visual function. There are no generally accepted criteria for glaucoma diagnosis. Studies such as those in Baltimore, Maryland or Beaver Dam, Wisconsin used multiple levels of diagnostic criteria. Despite a diversity of definitions, studies among white persons have yielded similar prevalence estimates. The use of blindness surveys to estimate glaucoma prevalence understates the number of persons with glaucoma because screening by visual acuity alone misses all but the most advanced glaucomatous eyes. In some studies, blindness is defined as visual...
acuity of 20/200 or worse (the United States standard), whereas others define it according to the World Health Organization standard of <20/400 (3/60). Re-evaluation of the Baltimore Eye Survey data does not suggest that blindness estimates for glaucoma are substantially different between the two standards (most persons with central visual loss were blind by both criteria). The vast majority of persons with glaucoma do not become functionally blind; however, the significant visual field loss before blindness and its potential effect on functional status is not accounted for by current statistics on blindness.

To judge by the proportion of patients in our surveys who reported that they were under care for glaucoma, only half of those with glaucoma in developed countries are known to the health care system. In developing countries, the proportion is almost surely lower; however, the number of surveys in developing countries is few. In part, the low rate of diagnosis results from the complexity and cost of screening for glaucoma. Lack of symptoms fails to alert patients or caregivers to the presence of glaucoma. The models presented here suggest that the appropriate age at which screening might be most effective is 6 to 10 years younger among those of African descent because of the earlier onset of disease. For white persons, it may be more cost effective to screen populations older than 50 years. By contrast, screening among black persons older than 30 years appears likely to be of value if the methodology is effective.

Our estimates of OAG incidence for white persons are similar to those generated by Podgor et al from Framingham Eye Study data. They reported 40/100,000 patients per year at age 55, and this rose to 220/100,000 patients per year at age 75. The model used here derived values of 59/100,000 patients per year at age 55 and increased to 201/100,000 patient per year at age 75. In a longitudinal follow-up study in Sweden, Bengtsson estimated OAG incidence at 190 to 240/100,000 patients per year for persons 55 to 85 years of age. By comparison, if one follows a selected population of glaucoma suspects rather than persons randomly examined from a population, the estimated incidence can be as much as 10 times higher. Studies of clinic-based populations typically overestimate the incidence of glaucomatous field loss. It would be interesting to compare the rates we calculated with estimated rates of glaucoma incidence from longitudinal studies now being conducted in Baltimore and Barbados. Estimates of OAG incidence for black persons differ from those for white persons. They are more than four times higher at age 55 (263/100,000 persons per year) and remain nearly three times higher at age 75 (541/100,000 persons per year).

Because approximately half the persons with glaucoma are known to the health care system, according to the estimates presented here, it is possible that the therapy some of these persons undergo delays the onset of glaucoma, decreasing prevalence and incidence estimates for white and black persons. Although many clinicians assume that there is some beneficial effect of treatment, its precise magnitude and variability are unknown; the effect of this factor on our estimates cannot be evaluated.

We combined United States data for population and mortality with our estimate of glaucoma incidence to provide estimates of cumulative incidence, duration of disease, and cumulative percent affected at various ages. Several major population studies have documented the higher prevalence of OAG among black persons. The model analysis extends these observations by providing estimates for age at onset. Fifty percent of black persons who will develop glaucoma have already done so by age 65. Among white Americans, this does not happen until after age 72. Because of the earlier age of onset in blacks, the average number of person-years of disease per affected person is greater for black persons than for white persons (16.3 years versus 12.8 years). This differential exposure may be a major factor in the poor outcome for black persons with glaucoma. It has been stated frequently that glaucoma lasts for many years after its onset, but the average duration of disease has not been estimated. For the average white person with OAG, the time from onset of OAG to death is approximately 13 years. This provides a time frame for the periods over which medical or surgical treatment is applicable. The proposed model may be useful in the prediction of the effects of treatment on OAG by the inclusion of modifying terms in the model.

The current estimates describe those persons with glaucoma damage (typically visual field loss) as defined in the studies reviewed. Glaucoma suspects were not included in these surveys, yet they represent a proportion of those who are observed and often treated. We did not attempt to estimate the duration of preglaucomatous, suspect status.

Results of this model might be useful in health evaluation and planning. For example, the calculated number of those with glaucoma in the United States can be multiplied by estimated annual cost for pressure-lowering eye drop treatment per person. Some assumptions that seem reasonable to estimate cost per year for eye drops include: 300 drops/10 ml bottle; a retail cost of $35/bottle of beta-adrenergic antagonist medication; 20% medicine wastage; and 80% patient compliance with bilateral, twice daily administration. This yields an estimated cost of $170/year per person. Using the total number of persons with OAG (2.47 million, treatment with eye drops for all these persons would cost $420 million/year. It has been suggested
that the average eye drop size (50 μl) could be substantially smaller with no loss in IOP-lowering potency.\textsuperscript{37} Modest decreases in the amount of medication used by patients with glaucoma could generate savings of many millions of dollars in the United States. Use of the data presented in these models can assist in such cost estimations. Another useful outcome of the model framework derives from the estimate that the average white patient with glaucoma requires almost 13 years of treatment. With delivery of one type of eye drop at the $170/year figure, the total for treatment from onset to death per patient would be approximately $2200. Of course, many persons with glaucoma take more than one type of medicine, whereas others undergo surgical treatment and require no medication. Many of those under treatment in the United States are glaucoma suspects who are not included in our OAG total. Furthermore, only half those with OAG have been diagnosed.

Data from the National Ambulatory Medical Care Survey\textsuperscript{38} indicate that office visits for glaucoma among those over 65 years of age for 1991 to 1992 represented the third most frequently reported reason for visits to physicians for a disease among all causes and were easily the most frequent diagnostic code for ophthalmic visits among the Medicare age group. At the reported visit rates, United States residents in 2000 would make 8.8 million office visits for glaucoma. This presumes no change in the proportion of those diagnosed with glaucoma. If the undiagnosed half of those with glaucoma were included, the number of visits clearly would increase. At 8.8 million visits/year, the estimated 1.2 million persons with known OAG would be making an average of 6.7 visits/year per person with OAG. This visit frequency is higher than the recommended standard of care for glaucoma. It is likely that many of the persons who are coded as having glaucoma are glaucoma suspects. If there are four suspects for every patient with OAG, the visit frequency per person among glaucoma suspects and patients with glaucoma is between one and two visits per year, a more probable figure. If the cost for a glaucoma visit is estimated at $50, the 8.8 million physician visits would cost $440 million. Changes in practice patterns, therefore, not only have potential therapeutic implications but economic implications of substantial magnitude as well. The model outcomes developed here can be used in estimating the impact of such change.

**Key Words**

glaucoma, incidence, meta-analysis, prevalence

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