PROGRESSION OF VISUAL FIELD LOSS IN UNTREATED GLAUCOMA PATIENTS AND SUSPECTS IN ST LUCIA, WEST INDIES

BY *M. Roy Wilson, MD, MS*

ABSTRACT

Purpose: A 1986-1987 survey found an 8.8% prevalence of open-angle glaucoma in the black population of St Lucia, West Indies. This follow-up study assessed progression of visual field loss in untreated glaucoma patients and persons with suspected glaucoma 10 years later.

Methods: Subjects were 205 patients with or suspected of having glaucoma. The 1987 data included age, sex, visual acuity, and visual fields measured by automated threshold perimetry (Humphrey C-30-2 test). The 1997 data included intraocular pressure, visual acuity, and visual fields measured by the same test. Exclusion criteria included field unreliability, field improvement due to vision improvement, nonglaucomatous vision deterioration, glaucoma treatment since 1988, and scoring of a field as end-stage in 1987. Visual fields were scored by algorithms for the Advanced Glaucoma Intervention Study (AGIS) and Collaborative Initial Glaucoma Treatment Study (CIGTS).

Results: By AGIS criteria, 55% of 146 right eyes and 52% of 141 left eyes progressed. In linear regressions, progression severity was unassociated with male or female sex, intraocular pressure, or baseline visual field score, but was positively associated with age (P <.001, right; P = .002, left). By CIGTS criteria, more eyes progressed. The cumulative probability of reaching end-stage disease in 10 years in at least one eye was about 16% by AGIS criteria and was 35% by CIGTS criteria.

Conclusions: These data provide a unique opportunity to study progression of untreated glaucoma. A considerably larger percentage of eyes showed progression of visual field loss, and the rate of progression was greater than in studies of visual field loss in treated eyes.

Trans Am Ophthalmol Soc 2002;100:365-410

INTRODUCTION

Despite decades of experience in the treatment of open-angle glaucoma, the natural history of this disease remains an enigma. Among the inadequately answered questions are the following:

1. Which individuals with elevated intraocular pressure will develop open-angle glaucoma?
2. How does treatment of elevated intraocular pressure affect development of open-angle glaucoma?
3. Once glaucoma develops, at what rate does it progress?
4. How does treatment affect the rate of progression?

The first of these questions, and likely also the second, undoubtedly will be answered by the Ocular Hypertension Treatment Study,[1] a clinical trial designed to determine whether treatment to lower intraocular pressure prevents or delays the onset of open-angle glaucoma. Data from this study now are being analyzed. With respect to the third question, data on the rate of progression of treated open-angle glaucoma are conflicting.[2,3] Although widespread consensus is lacking, a few well-performed studies have reported visual field loss rates of about 2% to 3% per year.[4,5] Because the rate of progression of open-angle glaucoma is a topic of continuing investigation, it is likely that the progression rate estimates will soon become more precise.

Addressing the fourth question is problematic. Data are available on the progression of untreated normal-pressure glaucoma,[6] but no data have been reported describing the natural history of untreated open-angle glaucoma. The Early Manifest Glaucoma Trial,[7] a clinical trial to evaluate the effect of immediate intraocular pressure reduction in patients with early glaucoma and pressures not exceeding 30 mm Hg, potentially will provide information on the effect of treatment on progression in the very early stages. However, because it is generally agreed that open-angle glaucoma with elevated intraocular pres-

From the School of Medicine, Creighton University, Omaha, Nebraska. This study was supported in part by a grant from the Glaucoma Research Foundation and was conducted while the author was affiliated with the Jules Stein Eye Institute, University of California at Los Angeles.

sure must be treated, it would be unethical to conduct a trial to test the effect of treatment on the rate of progression of glaucoma with elevated pressures and various severity levels.

A study conducted in 1986-1987 assessed the prevalence of glaucoma and its risk factors in St Lucia, West Indies.[8] The high prevalence of glaucoma in this population (estimated to be 8.8%) and the availability of these baseline data (summarized below) appeared to present the opportunity for analysis of a "natural experiment" comparing the progression of open-angle glaucoma in treated and untreated eyes. At the time of the 1986-1987 survey, an infrastructure was in place to care for complicated ophthalmological disorders regardless of patients' ability to pay, with free transportation to clinics as needed. All subjects in the 1986-1987 survey with diagnoses of glaucoma or suspected glaucoma received referrals to Victoria Hospital, in Castries, or St Jude's Hospital, in Vieux Fort, where care was available from a faculty ophthalmologist and residents affiliated with the Massachusetts Eye and Ear Infirmary. Those with severe glaucoma received surgery; most of the others received at least one evaluation, and those requiring glaucoma medications received them at no charge. The findings of a feasibility study conducted in 1996 (described below) supported the feasibility of a follow-up study of glaucoma patients and suspects identified in the 1986-1987 survey.

Distressingly, the 1997 follow-up study showed that very few subjects were under active treatment, in part because the infrastructure for subsidized glaucoma care collapsed shortly after the Massachusetts Eye and Ear Infirmary resident rotation was discontinued, in 1988. In 1997, it was found that only a few patients had had surgery, and only a few who could afford medications had continued to receive them. Because few subjects had received treatment, the design of the follow-up study was changed to focus on the natural history and progression of untreated glaucoma.

ISSUES IN ANALYSIS OF GLAUCOMATOUS VISUAL FIELD LOSS PROGRESSION

Following the course of vision loss in glaucoma continues to be a major problem as more is learned about current visual field testing techniques and about the nature of the disease. No standard for identifying progression of glaucomatous visual field loss has been agreed upon. While one can be moderately certain that standard visual field tests will detect vision loss,[9] it still is unclear what constitutes a clinically significant, reproducible change for the worse. Visual fields may appear worse but then improve in subsequent tests. For example, the Advanced Glaucoma Intervention Study[10] reported that more than 30% of the fields classified as "progressed" at two follow-up examinations later failed to maintain this classification. Separating true progression from changes in visual fields due to learning effects, fatigue, and the long-term fluctuation inherent in the test is extremely difficult.[11,12] Each visual field measurement is influenced by a variety of factors, including test-subject performance, fixation losses, pupil size, refractive correction, and changes in degree of lens opacity. These factors combine with underlying physiological changes in visual sensitivity to produce significant long-term fluctuation in visual field test results even for healthy eyes, and this long-term fluctuation is larger for eyes with visual field loss.[11-15] In addition, progression of visual field loss is very slow in treated glaucoma. Changes of less than 1 dB per year are difficult to detect even with a series of visual fields spanning 6 years.[16]

The statistical methods most commonly employed to identify visual field loss progression are the Humphrey Statpac II glaucoma change probability analysis and linear regression. Analyses by these methods have shown that variability in visual field measurements is greater for some field test locations than others and that change in variable locations must be of greater magnitude than change in stable locations to be called true progression.[15,17] Other commonly used analysis methods employ visual field defect scoring algorithms developed for specific clinical trials.

Linear Regression Over Time

Linear regression analysis requires at least 5 and preferably 7 or more visual fields to determine whether visual field loss has progressed relative to the baseline measurement.[14,16,18] Variables that have been evaluated for their sensitivity to progression in linear analyses include mean deviation, corrected pattern standard deviation, thresholds within glaucoma hemifield test zones, and thresholds from each of the 52 test locations. Comparing these parameters for 191 subjects over a mean follow-up period of 7.1 years, Smith and colleagues[19] concluded that progression rates of between 1 and 5 dB per year could be detected. While this method of detecting progression looks promising, at least 5 years of data are required in order to detect significant change in any of these field parameters via linear regression analysis.[14,18]

The commercially available Progressor program[20] uses all of an individual subject's available visual field data in pointwise linear regression analysis for each test location from several visual fields against time of follow-up. The program produces a cumulative graphical output showing each test location as a bar graph, in which each bar represents one test. The length of the bar indicates the depth of the defect, and the color of the bar indicates the probability value of the regression slope relative to age-matched normal controls.[21,22] This technique is most

useful with a series of 7 visual fields.

Event Analyses

Glaucoma Change Probability. The glaucoma change probability analysis, included in Statpac II, looks for change by making a pointwise comparison of the standard visual field against the average of the first two reliable baseline visual fields. On the basis of the total deviation probability map, a change in sensitivity greater than the long-term fluctuation found in a reference population of stable glaucoma patients is required for deterioration to be detected at a given location.[23] Significant worsening of a test location is flagged with a black diamond and significant improvement with an open diamond. Because this analysis does not define cutoffs for visual field progression, the clinician must decide what number of changed points constitutes significant progression.

Clinical Trials and Progression. Because it often is necessary in clinical trials to determine whether progression is occurring before a series of 5 to 7 visual fields can be obtained, linear regression has not been the method of choice. Instead, the statistical methods provided by the Statpac II glaucoma change progression and global indices for identifying visual field loss progression relative to 2 baseline visual fields have been incorporated into the following large clinical trials: the Normal-Tension Glaucoma Study, the Early Manifest Glaucoma Trial, the Advanced Glaucoma Intervention Study, and the Collaborative Initial Glaucoma Treatment Study.

The Normal-Tension Glaucoma Study was designed to assess the effect of lowering intraocular pressure on the progression rate of normal-tension glaucoma. For subjects to be eligible for this study, their eyes had to show glaucomatous excavation of the optic disc and a field defect (measured by standard achromatic perimetry) consisting of a cluster of 3 nonedge points depressed by 5 dB, with 1 of the points also depressed by 10 dB. This defect had to be confirmed by two of three baseline visual field tests performed within a 4-week window. Progression was suspected if one of the following changes was observed: (1) at least 2 contiguous points within or adjacent to a baseline defect showed a reduction in sensitivity from baseline of ≥10 dB or three times the average baseline short-term fluctuation for that subject, whichever was greater, (2) the sensitivity of each suspected point was outside the range of values observed during baseline testing, or (3) a defect occurred in a previously normal part of the field. Confirmation of progression required agreement in the results of four tests.[24]

The Early Manifest Glaucoma Trial (EMGT) was designed to assess the effectiveness of reducing intraocular pressure in early, previously untreated open-angle glaucoma. Because visual field loss progression is used as a study end point, a progression algorithm was developed.[7] The Statpac glaucoma change progression analysis was modified so that scoring is based on the pattern deviation probability map instead of the total deviation probability map. The change in pattern deviation is thought to provide a more accurate assessment of visual field loss progression because this plot is less influenced by shifts in the global hill of vision due to cataract, pupil size changes, or refractive errors.[25] Enrollment in EMGT required an initial screening, two preintervention visual field tests, and two baseline examinations. At both baseline examinations, the glaucoma hemifield test results had to be either (1) "outside normal limits" because of defects in the same sectors or (2) "borderline," with obvious localized change to the optic disc. Progression requires that 3 or more points be flagged by the pattern deviation version of the glaucoma change progression analysis and confirmed in 2 subsequent visual fields; the points need not be contiguous.

The Advanced Glaucoma Intervention Study (AGIS) was designed to compare two surgical management strategies for patients with advanced glaucoma inadequately controlled by medications alone. To determine eligibility and to evaluate disease progression in patients with relatively advanced glaucomatous visual fields, the AGIS investigators developed an algorithm for scoring the visual field test based on reliability and the severity of glaucomatous visual field defects. The scoring system was based on the following concepts: (1) multiple defects can occur in the upper, lower, and nasal hemifields; (2) a defect requires 2 or more adjacent defective points; (3) the severity of depression must be greater than changes due to variability; and (4) the defect must be caused by glaucoma. The score increases with increasing numbers of depressed locations and with increasing depth of the defects, ranging from 0 (no defect) to 20 (all sites deeply depressed).[10] (The scoring procedure is described in the "Methods" section.) Subject eligibility was determined by the results of two preintervention field tests conducted less than 60 days apart. Enrollment required an AGIS score between 1 and 16 and a reliability score of <3 for the first visual field test. The second test was used as the baseline for subsequent tests. Progression is quantified as a score increase from baseline by ≥4 points in three consecutive reliable visual field tests.[26]

The Collaborative Initial Glaucoma Treatment Study (CIGTS) was designed to determine whether patients with newly diagnosed open-angle glaucoma are managed better by initial treatment with medications or by immediate filtration surgery. A primary outcome measure is the visual field score, determined by a modification of the AGIS scoring method described above. The CIGTS scoring system is based on these principles: (1) the total devi-

ation probability plot adjusts the total deviation values at each point relative to the most normal region in the visual field; (2) each abnormal test location must be accompanied by at least 2 adjacent abnormal points; and (3) each abnormal point is given a score from 1 to 4 based on the probability values (5% to 0.5%) for the 3 contiguous depressed points. (The scoring procedure is described in the "Methods" section.) For CIGTS, two preintervention field tests were conducted to determine subject eligibility. Enrollment required reliability scores of <4, glaucoma hemifield test results "outside normal limits," and at least 3 contiguous points on the total deviation plot with $P < .02$; if the points were in the nasal field, they could not cross the horizontal midline. The preintervention scores were averaged to create a baseline CIGTS score. If the baseline scores differed by >7, then a third field test was conducted and the three scores were used to compute a baseline CIGTS score. Progression is quantified as an increase in score from baseline reference by ≥3 points on three consecutive reliable visual field tests.[27]

Comparison of the Analysis Methods

Many specialists in glaucoma were involved in the development of the methods used in each of these studies. However, only a few studies have compared the various methods for identifying progression on the same series of visual fields.[28-30]

Comparing the AGIS, CIGTS, and EMGT methods, Katz and colleagues[29] evaluated the agreement among these methods and the judgment of two glaucoma specialists who graded the fields as "definite progression," "possible progression," "stable," "improved," or "too unreliable to assess." They found that the EMGT and CIGTS scoring methods and the glaucoma specialists identified similar incidences of progression, but not necessarily in the same eyes. Furthermore, the EMGT and CIGTS methods produced rates of apparent progression that were twice those obtained with the AGIS method. These results were corroborated by those of Lee and colleagues.[30] These studies indicate the difficulties resulting from the lack of a "gold standard" for progression of glaucoma independent of visual field test results. Until such a nonfield standard is established, only the agreement among different methods for grading progression can be determined and the sensitivity and specificity of the various techniques for determining progression will remain unknown.

DESCRIPTIONS AND MAJOR FINDINGS OF THE 1986-1987 ST LUCIA SURVEY

Introduction

Although glaucoma appears to be more prevalent among blacks than whites, little information on the epidemiology of glaucoma is available. Anecdotal reports of an unusually high prevalence of glaucoma in the relatively homogeneous black population of St Lucia, West Indies, made this an ideal site for an epidemiological study of glaucoma. A national survey of the prevalence of glaucoma in St Lucia, West Indies, was conducted in 1986-1987 by Howard University in collaboration with investigators from the Harvard Medical School.[8]

Methods

A cluster sampling design with systematic allocation of clusters was used to identify, from 1984 census data, a sample of 1,936 black subjects aged 30 years or older. The primary sampling units were electoral districts within St Lucia's 10 administrative areas, which were sampled with probability proportional to the size of the administrative area. A random starting point was chosen in each of the 42 districts (one per cluster), and consecutive households were listed until at least 50 subjects per cluster were recruited; all eligible individuals in a household were recruited.

All subjects underwent a screening examination, which included (1) a visual acuity test with a Snellen chart at 20 feet or a pinhole if visual acuity was 20/40 or less, (2) three measurements of intraocular pressure with a portable Perkins applanation tonometer, and (3) direct ophthalmoscopy, with clinical assessment of the horizontal and vertical cup-to-disc ratios. Height, weight, blood pressure, and pulse were measured and a risk-factor interview was completed. Screening for visual field loss by automated threshold perimetry with the Humphrey Field Analyzer full-field 120 test was attempted for every third subject and for every subject with any of the following conditions: intraocular pressure ≥21 mm Hg, cup-to-disc ratio ≥0.7, or cup-to-disc asymmetry ≥0.2. Some subjects could not be tested because they could not understand or comply with the testing procedure.

All subjects with elevated intraocular pressure, an abnormal cup-to-disc ratio, or 17 or more visual field defects were referred for a comprehensive glaucoma evaluation, including a slit-lamp examination, gonioscopy, and dilated direct and indirect ophthalmoscopy performed by a glaucoma subspecialist, as well as threshold visual field measurement with the Humphrey Field Analyzer (central 30-2 test). Glaucomatous visual field loss was detected by the mirror-image method.[31]

The primary definition of glaucoma conservatively included only visual fields with fixation loss of less than 20% and false-positive and false-negative error rates of less than 33%. All abnormal threshold visual fields were independently evaluated by two glaucoma subspecialists to confirm typical glaucomatous visual field loss. By the primary definition, cases were excluded if glaucomatous

etiology of the fields was considered questionable, regardless of the results obtained with the mirror-image method. Some referred subjects did not undergo threshold testing; these cases also were excluded by the primary definition. A more comprehensive secondary definition of glaucoma included (1) cases with unreliable visual field test results that met all other visual field criteria and (2) cases of referred subjects who did not undergo threshold visual field testing but whose examination results could not be explained by anisometropia or other ocular disease.

Results and Conclusions

Publicity for the survey by the Ministry of Health and aggressive follow-up by the survey team resulted in screening of 1,679 subjects, for a participation rate of 87% (77% for men and 92% for women). Of those screened, 520 subjects were referred for a definitive examination: 306 with elevated intraocular pressure, 207 with abnormal cup-to-disc ratios, and 252 with abnormal screening visual fields. Of the 520 subjects referred, 364 (70%) underwent threshold visual field testing; visual fields were obtained for a total of 699 eyes. By the primary definition of glaucoma, 147 subjects (31% of those referred; 45 men and 102 women) were diagnosed as having glaucoma, for a prevalence of 8.8%. The remainder (217) either were diagnosed as having glaucoma by a more liberal secondary definition or were considered glaucoma suspects.

This study differed from previous glaucoma prevalence surveys in that it was based on a representative national sample and used stringent visual field criteria to diagnose glaucoma. It found much higher prevalence than had been reported in many previous surveys, leading the authors to conclude that glaucoma was a major problem in this population.

DESCRIPTION AND FINDINGS OF THE 1996 FEASIBILITY STUDY

A trip to St Lucia was undertaken in December 1996 to determine the feasibility of a follow-up study of glaucoma patients and suspects identified in the 1986-1987 survey. Meetings were held with officials in the Ministry of Health and with nurses who had been trained as glaucoma diagnosticians for the initial survey. To test the feasibility of locating survey subjects and their medical records, three clusters from the 1986-1987 survey were chosen randomly, providing a sample of 37 subjects. A visit was made to each cluster to locate subjects, and medical records for the surviving subjects were sought in the Victoria Hospital medical records department.

The Ministry of Health officials and nurses expressed strong interest in and support of the proposed follow-up study. They also expressed interest in refresher training in glaucoma identification, diagnosis, and treatment.

Of the 37 subjects, 21 were interviewed, 8 had died, 3 were not home at the time of the visit, and 4 had moved to other clusters; the whereabouts of the remaining subject were unknown. Medical records were retrieved for the 28 living subjects who were located. It took 5 hours to find the 28 records. Each record provided the subject's name and address, the date of the last visit to the clinic, a summary of the ophthalmic examination, and the diagnosis and treatment plan. Thus, it was estimated that about 75% of the subjects in the 1986-1987 survey could be located to participate in the follow-up study, and that it might take about 2 weeks to retrieve their medical records. It was concluded that the follow-up study was feasible.

METHODS

LOCATION AND EXAMINATION OF SUBJECTS

The survey was approved by the responsible Institutional Review Board, and all subjects signed an informed consent form before participating in any part of the study.

Before the survey team arrived in St Lucia, the Ministry of Health generated national attention for the study through personal contacts, radio announcements, local newspapers, and other print media. Nurses and other contracted health care providers made multiple attempts to contact each of the 364 subjects identified in the 1986-1987 survey as having glaucoma or as being glaucoma suspects, and they filled out a "Record of Contacts" form (Appendix 1). Reports that subjects were deceased were verified through the national death registry. Subjects who were located were asked to report to a specific location for an eye examination and administration of a questionnaire.

The survey team consisted of an ophthalmologist and two nurses. One nurse measured visual acuity and administered the questionnaire, and the other administered the visual field tests.

The examination consisted of the following assessments: (1) measurement of visual acuity without correction, with correction (if available), and with pinhole, (2) refraction if visual acuity was less than 20/40, (3) threshold visual field measurement with the Humphrey Field Analyzer model 610 (Zeiss Humphrey Systems, Dublin, California) central 30-2 test and stimulus III, with near correction as appropriate, (4) slit-lamp biomicroscopy, (5) measurement of intraocular pressure with a portable applanation tonometer, (6) gonioscopy with a Zeiss-type lens, (7) optic nerve assessment by direct ophthalmoscopy and/or with a 90-diopter lens through dilated pupils, and (8) retina assessment by indirect ophthalmoscopy through dilated pupils. All examination findings were recorded on a standardized form (Appendix 2). If the best corrected visual acuity was less than 20/30, the ophthalmologist indi-

cated the most likely primary and secondary causes for the decreased vision.

Subjects who were not physically able to visit the examination site were examined in their homes. The modified examination consisted of measurement of visual acuity with and without correction and with pinhole, a penlight examination with loupes, intraocular pressure measurement with a portable applanation tonometer, and dilated funduscopic assessment.

All subjects completed the questionnaire (Appendix 3), which consisted of questions relating to demographic information, ocular and general medical history, eye care and general health services, medication use, and tobacco and alcohol use. To assess health-related quality of life, the National Eye Institute Visual Functioning Questionnaire 25, modified to be culturally appropriate to St Lucia, was administered. (The data unrelated to visual field loss progression, such as data on medical resource use and health-related quality of life, are not presented here but will be the subject of future analyses.)

Glaucoma progression typically is documented as changes in the optic nerve and/or progression of visual field defects. In the absence of photographic documentation, optic nerve assessment suffers from subjectivity and lack of reproducibility.[32] Therefore, visual field loss progression was used as a proxy for glaucoma progression.

SELECTION OF THE SAMPLE

Of the 364 potential subjects from 1987, 90 had died, 11 refused to participate, 21 were known to have moved from St Lucia, and 37 could not be located. Thus, data were obtained for both eyes of 205 subjects (56% of the 364 potential subjects). Among the living subjects the team was able to locate in St Lucia, the participation rate was 95%.

For each eye, 2 visual fields obtained 10 years apart were available for review. Visual fields were evaluated for reliability and excluded by the following criteria: (1) either the false-positive or the false-negative rate was 40% or greater, (2) both the false-positive and the false negative rate was 33% or greater, or (3) fixation loss was 33% or greater. Additionally, visual fields with obvious nonglaucomatous scotoma, such as near-correction lens rim artifact, were excluded.

Any eye with an improvement of vision by halving of the visual angle or deterioration of vision by doubling of the visual angle was individually considered for exclusion. An eye was excluded if it showed (1) an improvement of visual field attributable to improvement in vision or (2) a decrease in vision attributable to a cause other than glaucoma, as noted by the examining ophthalmologist. Eyes for which a Snellen acuity measurement was not available (ie, with acuity <20/400) were included in the sample but excluded from the visual acuity analysis.

If a subject had not undergone visual field testing because of blindness, the cause was determined; if it was glaucoma, the eye was included and given the highest-severity visual field score (20) for purposes of analysis. Eyes that in 1987 had experienced end-stage glaucoma, defined as an AGIS visual field score of 17 to 20, were excluded.

A few subjects had had glaucoma surgery, and a few were receiving glaucoma medication; their eyes were excluded. Some subjects reported past use of medications. If the subjects had used medications only while they were available at no cost and had not used medications since the subsidized eye-care program ended in 1988, their eyes were included. Otherwise, the eyes of subjects who reported past use of glaucoma medications were excluded.

VISUAL FIELD GRADING

Visual fields were graded by methods used in two multicenter clinical trials sponsored by the National Eye Institute: the Advanced Glaucoma Intervention Study[33] and the Collaborative Initial Glaucoma Treatment Study.[34] These studies were designed to assess glaucoma at different stages of the disease.

The Advanced Glaucoma Intervention Study

An outcome measure in this trial is a score based on the 52 test locations from the Humphrey 24-2 standard full threshold visual field test (excluding the two locations nearest the blind spot). As discussed above, the AGIS algorithm for scoring visual field defects is based on reliability, the number of adjacent test locations with depressed sensitivity, and the depth of the depression (relative to normal, based on the total deviation plot of the Statpac II single-field analysis), and the region of the field affected.[10] The scoring procedure is described in Table I. For AGIS, progression of visual field loss is defined by worsening of the score from the baseline value by 4 points or more in three consecutive 6-month follow-up tests.[26]

The Collaborative Initial Glaucoma Treatment Study

The overall visual field defect score is generated from the total deviation probability plot values (rather than their corresponding decibel cut offs, used by AGIS). Any of the 52 locations on this plot (excluding the two blind spot locations) for which the probability value is ≤.05 and which is accompanied by at least 2 adjacent abnormal points is considered defective and is scored. The score for each location is weighted by the depth of its defect and the depths of the defects of the two most defective neighboring locations (for which $P \leq .05$).[35] The scoring procedure is described in Table II.

For CIGTS, progression of visual field loss is defined

TABLE I: STEPS IN SCORING VISUAL FIELD DEFECT IN AGIS

STEP AND CRITERION		SCORE
1. Score the nasal area (step or defect):		Max = 2
≥1 depressed location in nasal area and only in 1 hemifield		
or		
3 clustered depressed locations of 6 possible nasal sites		1
4 to 6 clustered locations depressed ≥12 dB		1
2. Score each hemifield (defect):		Max = 9
≥1 cluster of 2 locations with 1 depressed by ≥12 dB		1
≥1 cluster of 3 to 5 depressed locations		1
≥1 cluster of 6 to 12 depressed locations		2
≥1 cluster of 13 to 20 depressed locations		3
≥1 cluster of >20 depressed locations		4
If 50% of depressed hemifield locations are depressed by		
	≥12 dB	+1
	≥16 dB	+2
	≥20 dB	+3
	≥24 dB	+4
	≥28 dB	+5
3. Sum the scores for each hemifield and for the nasal area		Max = 20

AGIS, Advanced Glaucoma Intervention Study.

TABLE II: STEPS IN SCORING VISUAL FIELD DEFECT IN CIGTS

1. Score each of the 52 test locations:		
Cluster probability	Neighboring locations	Score
≥.10		0
≤.05	0 or 1 at ≤.05	0
≤.05	2 to 8 at ≤.05	1
≤.02	2 to 8 at ≤.02	2
≤.01	2 to 8 at ≤.01	3
≤.005	2 to 8 at ≤.005	4
2. Add the scores for all 52 test locations		Max= 208
3. Divide by 10.4		Max= 20

CIGTS, Collaborative Initial Glaucoma Treatment Study.

by worsening of the score from the baseline value by ≥3 points in three consecutive separate tests.

The threshold level in decibels for each test location of the Humphrey 30-2 standard full threshold program was available for each visual field. However, many of the 1987 visual fields did not have the Statpac II indices necessary for calculation of AGIS and CIGTS scores. Conversion of the threshold decibel data into the requisite Statpac indices required the normative database from which the Statpac program was generated, and this information has not been made available by the manufacturer. The normative database developed by Drs Pamela Sample and Chris Johnson for the short-wavelength automated perimetry ancillary arm of the Ocular Hypertension Treatment Study was used instead. This normative database consists of data for one eye from each of the same 348 normal subjects between the ages of 20 and 85 tested with both standard automated perimetry (SAP) and short-wavelength automated perimetry. The normative data were collected at five centers by means of a standardized test protocol. To be included in the normative database, subjects had to have a normal eye examination, 20/30 or better visual acuity, normal color vision, no history of ocular or neurologic disease or surgery, refractive errors of less than 5 diopters spherical equivalent and 3 diopters cylinder, no diabetes mellitus, and normal optic nerve appearance, and subjects could not be taking any medications known to affect visual fields or color vision (Pamela Sample, PhD, electronic mail communication).

A Statpac-like SAP analysis package using these normative data was developed by Sample and Johnson. After age-correction for each of the 52 test locations of the Humphrey standard full-threshold 24-2 test (excluding

the two blind spot locations), the total deviation plot, the pattern deviation plot, and their associated probability cut offs and probability plots were computed. The package then computes cut off values at specific probabilities for global indices, mean deviation, and pattern standard deviation, along with an asymmetry analysis patterned after the glaucoma hemifield test analysis.[36] The values obtained are practically identical to values obtained from the Statpac II program (Chris Johnson, PhD, oral communication). All the visual field raw threshold values from the St Lucia study were run through the SAP analysis package to generate the information needed to perform the AGIS and CIGTS analyses for visual field loss progression.

ANALYTICAL METHODS

The subjects' demographic information, examination results, and questionnaire data were recorded by pencil on standardized forms and later entered into Corel Paradox database files. Snellen visual acuity measurements were converted to decimal values by division of the numerator by the denominator (eg, 20/20 = 1.0, 20/25 = 0.8, 20/30 = 0.67). Visual acuities worse than 20/400 were not given decimal values. The electronic data files were cross-checked with the raw data. Data that were considered out of range were eliminated.

The data then were transferred to a SAS 8.2 (SAS Institute, Cary, North Carolina) file for analysis. Multivariate linear regression was used to investigate the association between predictor variables and visual field loss progression based on AGIS and CITGS scores. Logistic regression also was performed, with progression versus no progression treated as a categorical response variable. The assumptions of linear and logistic regression analysis were verified. Cross-tabulations were made between the various predictor variables and severity of visual field loss progression, and chi-square tests were used to test for associations.

RESULTS

SAMPLE SELECTION, DEMOGRAPHICS, AND EXAMINATION RESULTS

Of the 410 eyes for which data were obtained, 59 right eyes and 64 left eyes were excluded. The reasons for exclusion were as follows:

- No 1987 visual field, 4 right eyes, 6 left eyes
- No 1997 visual field because of inadequate vision due to a cause other than glaucoma, 1 right eye
- Unreliable visual field for 1987 or 1997, 20 right eyes, 21 left eyes
- Substantially improved visual field due to better vision from cataract surgery, 3 right and 3 left eyes
- Substantial worsening of vision due to a cause other than glaucoma, 11 right and 11 left eyes
- Past or present glaucoma treatment, 26 right and 26 left eyes

Some eyes satisfied more than one of the above exclusion criteria. An additional five right eyes and nine left eyes were excluded because their 1987 visual fields satisfied the AGIS criterion for end-stage glaucoma (visual field score ≥17). Though CIGTS score was not used as an exclusion criterion, the CIGTS scores for these eyes all were ≥17. The final sample consisted of 146 right and 141 left eyes of 155 subjects.

The 155 subjects included 47 men and 108 women. The age distribution at baseline was as follows: 21 to 30 years, 2 patients; 31 to 40 years, 21 patients; 41 to 50 years, 57 patients; 51 to 60 years, 32 patients; 61 to 70 years, 31 patients; 71 to 80 years, 11 patients; older than 80, 1 patient.

The mean age was 52.3 years (range, 26-85 years). (Although the 1986-1987 survey was not intended to include subjects under the age of 30 years, two such subjects were found and have been included in this sample for consistency with the earlier study.) The mean intraocular pressures from the 1997 examination were 21.0 mm Hg (SD, 4.3; range, 10-39) for the right eye and 21.0 mm Hg (SD, 4.2; range, 12-43) for the left eye. Of the 155 subjects, 81 (52%) had definite visual field defects at the initial survey and had been diagnosed as having glaucoma, and 74 (48%) had either normal or inconclusive visual field test results and had been diagnosed as glaucoma suspects.

Among the eyes for which acuity measurements were available for both 1987 and 1997, vision deteriorated only minimally. The mean changes in visual acuity were -0.07 for the right eye and -0.10 for the left eye. For the subset of these eyes with visual field loss progression, the mean change in acuity was still only -0.06 for the right eye and -0.13 for the left eye. Table III summarizes the Snellen visual acuity measurements.

PROGRESSION OF VISUAL FIELD LOSS BY AGIS CRITERIA

AGIS visual field defect scores are summarized in Table IV. The 1987 mean scores were 3.5 for right eyes and 3.9 for left eyes, and the 1997 mean scores were 9.1 for right eyes and 9.0 for left eyes. By the AGIS criterion for definite change (score change of ≥4), 80 right eyes and 73 left eyes worsened, 5 right eyes and 8 left eyes improved, and 61 right eyes and 60 left eyes were unchanged. Among the eyes in which visual field loss had progressed by AGIS criteria, the 1987 mean scores were 3.3 for right eyes and 4.5 for left eyes, and the 1997 mean scores were 13.5 for right eyes and 13.1 for left eyes. The severity of progression was distributed as follows: mild progression (AGIS score

TABLE III: MEAN VISUAL ACUITY AND CHANGE IN ACUITY FROM 1987 TO 1997*

		ALL EYES			EYES PROGRESSED BY AGIS CRITERIA†		
	EYE	N	MEAN	SD	N	MEAN	SD
1987	R	130	0.74	0.27	67	0.68	0.27
	L	124	0.76	0.26	60	0.73	0.24
1997	R	130	0.66	0.25	67	0.62	0.27
	L	124	0.66	0.26	60	0.60	0.27
Change	R	130	-0.07	-	67	-0.06	-
	L	124	-0.10	-	60	-0.13	-

*Visual acuity is numerator divided by denominator of Snellen acuity measurement. Only eyes with Snellen acuity measurements for both 1987 and 1997 were included.
†Progression means that AGIS visual field defect score increased by ≥4.

TABLE IV: MEAN AGIS VISUAL FIELD DEFECT SCORE AND CHANGE FROM 1987 TO 1997

		ALL EYES			EYES PROGRESSED BY AGIS CRITERIA*		
	EYE	N	MEAN	SD	N	MEAN	SD
1987	R	146	3.5	3.7	80	3.3	3.3
	L	141	3.9	4.1	73	4.5	4.4
1997	R	146	9.1	6.9	80	13.5	5.4
	L	141	9.0	6.8	73	13.1	5.5
Change	R	146	5.6	-	80	10.2	-
	L	141	5.1	-	73	8.6	-

*Progression means that AGIS visual field defect score increased by ≥4.

increase of 4-7), 26 right eyes (N = 80), 27 left eyes (N = 73); moderate progression (score increase of 8-11), 24 right eyes, 19 left eyes; extensive progression (score increase of 12-15), 16 right and 16 left eyes; severe progression (score increase of ≥16), 14 right and 11 left eyes.

In the AGIS scoring system, end-stage glaucoma is defined by a score ≥18. Of the 80 right eyes that showed progression, 24 (30%) had progressed to end-stage glaucoma; for the 73 left eyes, the figure was 21 (29%). In 14 subjects, visual field loss had progressed to end-stage disease in both eyes. Of the eyes that had progressed to end-stage glaucoma, 14 of 24 right eyes (58%) and 13 of 21 left eyes (62%) had baseline AGIS scores of 0 to 5 (no to minimal visual field loss).

The following factors were investigated for possible association with progression of visual field loss: sex, age, intraocular pressure (1997), and baseline AGIS visual field defect score. For multiple linear regression, progression score (change in visual field score from 1987 to 1997), age, and intraocular pressure were continuous variables and sex was categorical. In this analysis, progression was not significantly associated with intraocular pressure (P = .91, right; P = .63, left) or with sex (P = .20, right; P = .33, left), but showed a significant positive association with age (P <.001, right; P = .002, left). The linear regression models for the right and left eyes were as follows, where y = progression severity and x = age:

Right: $y = -6.24 + 0.21885x$;
$r^2 = 0.20$;
slope 95% CI = 0.14 to 0.29

Left: $y = -3.9 + 0.1727x$;
$r^2 = 0.13$;
slope 95% CI = 0.09 to 0.25

Visual field loss in an eye with a high baseline score cannot progress but to a certain extent (eg, an eye with a baseline visual field score of 0 could receive a progression score of 20, whereas for an eye with a baseline score of 15, the maximum progression score would be 5). Therefore, a logistic regression was performed in which the baseline visual field score was treated as a continuous variable and the response variable was dichotomous (progression, defined as an AGIS score increase of ≥4, versus no progression). Again, progression was significantly associated only with age (P = .001, right; P = .003, left). Progression was not significantly associated with intraocular pressure (P

= .99, right; P = .84, left), sex (P = .14, right; P = .42, left), or baseline visual field score (P = .08, right; P = .21, left). The probability of progression, p, was modeled as follows, where x_1 = age and x_2 = baseline AGIS visual field score:

Right: $\log[p/(1-p)] = -2.3204 + 0.0545x_1 - 0.0902x_2$
Left: $\log[p/(1-p)] = -2.2454 + 0.0445x_1$

These relationships also were tested separately, with age, intraocular pressure, and baseline visual field status treated as categorical variables in chi-square tests of association with progression severity, summarized in Tables V through VII. In the analysis of baseline visual field score, the response variable was dichotomous (progression versus no progression). Again, the only significant association was between progression and age, for right eyes only (P = .01; for left eyes, P = .13).

PROGRESSION OF VISUAL FIELD LOSS BY CIGTS CRITERIA

The analyses described above also were performed with the CIGTS scores, which are summarized in Table VIII. The mean 1987 CIGTS scores were 5.6 for right eyes and 5.9 for left eyes, and the mean 1997 scores were 12.9 for right eyes and 13.6 for left eyes. By the CIGTS criterion for definite change (score change of ≥ 3), 107 right eyes and 101 left eyes worsened, 14 right eyes and 13 left eyes improved, and 25 right eyes and 27 left eyes were unchanged. Among the eyes in which visual field loss had progressed by CIGTS criteria, the 1987 mean scores were 4.6 for both right and left eyes, and the 1997 mean scores were 15.7 for right eyes and 16.2 for left eyes. The severity of progression was distributed as follows: mild progression (CIGTS score increase of 3-7), 32 right eyes (N = 107), 28 left eyes (N = 101); moderate progression (score increase of 8-11), 27 right eyes, 20 left eyes; extensive progression (score increase of 12-15), 17 right eyes, 24 left eyes; severe progression (score increase of ≥16), 31 right eyes, 29 left eyes.

The CIGTS system does not define end-stage glaucoma, but by the AGIS definition (score ≥18), many eyes had reached end-stage disease. Of the 107 right eyes that showed visual field loss progression, 53 (50%) had progressed to end-stage glaucoma; of the 101 left eyes, 54 (53%) had reached end-stage. In 39 subjects, visual field loss had progressed to end-stage disease in both eyes. Of the eyes that had progressed to end-stage glaucoma, 24 of 53 right eyes (45%) and 27 of 54 left eyes (50%) had baseline CIGTS scores of 0 to 5.

In the linear regression analysis, progression of visual field loss was not significantly associated with intraocular pressure (P = .76, right; P = .92, left), sex (P = .67, right; P = .72, left), or age (P = .14, right; P = .19, left). In the logistic regression analysis, the likelihood of progression was not significantly associated with intraocular pressure (P = .44, right; P = .64, left) or sex (P = .65, right; P = .81, left), but it was significantly associated with age (P = .001, right; P = .008, left) and baseline visual field score (P <.001 for both eyes); visual fields less severely affected at baseline were more likely to have progressed. The probability of progression, p, was modeled as follows, where x_1 = age and x_2 = baseline CIGTS visual field score:

Right: $\log[p/(1-p)] = -1.1479 + 0.0588\ x_1 - 0.1348\ x_2$
Left: $\log[p/(1-p)] = -0.5173 + 0.0475\ x_1 - 0.1507\ x_2$

The association between progression and baseline visual field status also was tested in a chi-square test, with baseline field status as a categorical variable, as shown in Table IX. In this analysis, progression was significantly associated with baseline CIGTS score (P <.001 for both eyes).

COMPARISON OF PROGRESSION BY AGIS AND CIGTS CRITERIA

As described above, the results obtained with the AGIS and CIGTS algorithms differed. Many more eyes progressed by CIGTS than by AGIS criteria. Identification of eyes as having progressed in visual field loss by the two scoring systems differed as follows: AGIS total, 80 right eyes and 73 left eyes progressed; CIGTS total, 107 right eyes and 101 left eyes progressed; both AGIS and CIGTS, 71 right eyes and 65 left eyes progressed; AGIS only, 9 right eyes and 8 left eyes progressed; CIGTS only, 36 right eyes and 36 left eyes progressed.

The Pearson product-moment correlation coefficients for progression by the AGIS and CIGTS criteria were 0.49 for right eyes and 0.59 for left eyes (P <.001 for both eyes).

PROGRESSION BY OTHER STATPAC INDICES

As discussed above, inadequate vision prevented some subjects from undergoing visual field testing in 1997. Because 1997 values for mean defect and corrected pattern standard deviation (CPSD) were not available for these subjects, their eyes were excluded from these analyses.

Table X summarizes the mean defect and CPSD measurements. In 1987, the mean scores for mean defect and corrected pattern standard deviation were -5.8 and 5.1, respectively, for right eyes and -6.8 and 5.9 for left eyes. In 1997, the mean scores for mean defect and CPSD were -10.3 and 7.0 for right eyes and -10.9 and 7.8 for left eyes. Among the subset of eyes that progressed by the AGIS criterion, the 1987 mean scores for mean deviation and CPSD were -6.2 and 5.4 for right eyes and -7.2 and 6.3 for left eyes. The 1997 mean scores for progressed eyes were -14.5 and 8.5 for right eyes and -16.3 and 8.7 for left eyes.

TABLE V: ASSOCIATION OF VISUAL FIELD LOSS PROGRESSION WITH INTRAOCULAR PRESSURE

INTRAOCULAR PRESSURE (MM HG)	VISUAL FIELD PROGRESSION SEVERITY* <4	4-7	8-11	12-15	≥16
			Right Eyes (N); *P* = .55		
≤21	48	21	18	8	10
22-28	14	3	3	5	3
≥29	4	2	3	3	1
			Left Eyes (N); *P* = .98		
≤21	52	17	14	11	8
22-28	11	7	3	3	2
≥29	5	3	2	2	1

*Progression severity = increase in AGIS visual field defect score.

TABLE VI: ASSOCIATION OF VISUAL FIELD LOSS PROGRESSION WITH AGE

AGE (YR)	VISUAL FIELD PROGRESSION SEVERITY* <4	4-7	8-11	12-15	≥16
			Right Eyes (N); *P* = .01		
21-30	0	1	0	0	1
31-40	9	6	3	0	1
41-50	34	6	7	4	4
51-60	13	6	6	5	0
61-70	9	6	5	4	5
71-80	1	1	3	2	3
>80	0	0	0	1	0
			Left Eyes (N); *P* = .15		
21-30	0	0	0	0	0
31-40	14	4	0	2	1
41-50	29	8	9	3	4
51-60	13	7	5	2	1
61-70	9	7	3	5	4
71-80	3	1	2	3	1
>80	0	0	0	1	0

*Progression severity = AGIS visual field defect score increased by ≥4.

TABLE VII: ASSOCIATION OF VISUAL FIELD LOSS PROGRESSION WITH BASELINE AGIS SCORE*

BASELINE SCORE	RIGHT EYES (N) NO	YES	LEFT EYES (N) NO	YES
0 (none)	16	16	16	21
1-5 (mild)	32	47	31	31
6-11 (moderate)	13	16	15	17
12-17 (severe)	5	1	6	4
	P = .21		*P* = .80	

*Progression = AGIS visual field defect score increased by ≥4.

DISCUSSION

LIMITATIONS AND ADVANTAGES OF THIS STUDY FOR IDENTIFYING VISUAL FIELD LOSS PROGRESSION

In the present study, only 1 baseline visual field and 1 follow-up field, taken 10 years apart, were available for each eye. None of the current algorithms or protocols for assessing progression of visual field loss allows for evaluation with only 2 visual fields; they are considered to require a series of 5 to 7 visual fields. However, the value of a sample of this size with 10 years of untreated glaucoma outweighs the disadvantage of having only 2 fields for comparison.

Normally, at least 2 baseline visual fields are required

TABLE VIII: MEAN CIGTS VISUAL FIELD DEFECT SCORE AND CHANGE FROM 1987 TO 1997

		ALL EYES			EYES PROGRESSED BY CIGTS CRITERIA*		
	EYE	N	MEAN	SD	N	MEAN	SD
1987	R	146	5.6	5.8	107	4.6	4.7
	L	141	5.9	5.3	101	4.6	4.7
1997	R	146	12.9	7.1	107	15.7	4.8
	L	141	13.6	6.8	101	16.2	4.3
Change	R	146	7.3	--	107	11.1	-
	L	141	7.7	--	101	11.6	-

*Progression = CIGTS visual field defect score increased by ≥3.

TABLE IX: ASSOCIATION OF VISUAL FIELD LOSS PROGRESSION WITH BASELINE CIGTS SCORE*

	RIGHT EYES (N)		LEFT EYES (N)	
BASELINE SCORE	NO	YES	NO	YES
0 (none)	7	30	4	21
1-5 (mild)	13	38	13	45
6-11 (moderate)	5	26	7	25
12-17 (severe)	14	13	16	10
	P <.001		*P* <.001	

*Progression = CIGTS visual field defect score increased by ≥3.

TABLE X: : MEAN SCORES FOR MEAN DEFECT AND CORRECTED PATTERN STANDARD DEVIATION AND CHANGE FROM 1987 TO 1997

		ALL EYES			EYES PROGRESSED BY AGIS CRITERIA*		
	EYE	N	MEAN	SD	N	MEAN	SD
				Mean Defect			
1987	R	121	-5.8	4.9	63	-6.2	4.8
	L	118	-6.8	7.5	58	-7.2	9.1
1997	R	121	-10.3	8.7	63	-14.5	8.7
	L	118	-10.9	8.5	58	-16.3	7.0
Change	R	121	-4.4	-	63	-8.3	-
	L	118	-4.3	-	58	-9.0	-
				Corrected Pattern Standard Deviation			
1987	R	121	5.1	2.8	63	5.4	3.0
	L	118	5.9	5.6	58	6.3	7.4
1997	R	121	7.0	3.5	63	8.5	3.1
	L	118	7.8	8.2	58	8.7	3.0
Change	R	121	1.9	-	63	3.0	-
	L	118	1.9	-	58	2.4	-

*Progression = AGIS visual field defect score increased by ≥4.

for comparison with subsequent fields. Ideally, these would be obtained after training of subjects inexperienced with visual field testing. This approach reduces the effects of learning and verifies the baseline defect. It has been shown that in standard full threshold visual field tests, thresholds usually improve until the third test.[4] It can be assumed that most participants in the present study had never had a visual field test before the 1986-1987 survey. In that study, they had only one screening visual field test before undergoing the visual field test that provided the baseline scores for the current study. Thus, their initial results likely were poorer than they would have been after training. On the other hand, none of the subjects had had a visual field test during the 10 years between the two studies. Therefore, it can be assumed that even on retesting, the subjects were inexperienced with visual field test-

ing. Thus, the effect of learning probably was negligible.

Another consideration is the lack of additional fields to confirm visual field loss progression. For a definitive determination of progression, many clinical trials require that 3 successive fields show a definite change from baseline. To facilitate confirmation, these trials schedule testing at 6-month intervals. In the present study, the lack of repeated evaluation for a given individual remains a limitation; however, for group statistics it might be less problematic, for several reasons. The 10-year interval in this study greatly exceeds the minimum of 5 years needed to show progression of visual field loss with serial fields.[13] Furthermore, the same scoring algorithms were used in both studies, as well as the same standards for inclusion and exclusion of eyes. This consistency was possible because the work of Drs Sample and Johnson enabled the use of the AGIS and CIGTS algorithms to score the baseline visual field tests.

Because eyes with improvement in vision by halving of the visual angle were excluded from this study, and because damage from chronic glaucoma is not reversible, no visual field theoretically should have improved over the 10-year period. However, in practice, intertest fluctuations not infrequently result in a better second visual field. By the AGIS criteria, the visual fields of 5 right eyes (3.4%) and 8 left eyes (5.7%) improved in this study. By the CIGTS criteria, the corresponding numbers were 14 right eyes (9.6%) and 13 left eyes (9.2%). AGIS found apparent improvement of the visual field (score decreased by ≥4 points) in 11% of eyes and deterioration (score increased by ≥4 points) in 5% of eyes retested within 6 weeks.[10] In a study comparing the two scoring systems, Katz and associates[28] found improved AGIS scores (by ≥4 points) in 11.9% of eyes and improved CIGTS scores (by ≥3 points) in 20.9% of eyes when the second visual field was obtained a year after the baseline field. In the present study, the proportion of eyes that improved (4.5%) is much lower. Although the study by Katz and associates attempted to minimize the possible effect of learning, such an effect on retesting would be greater after a year than after 10 years. Furthermore, the effect of age on visual fields is biased toward worsening rather than improvement, and the subjects in the present study were 10 years older when their second visual fields were obtained.

Although the effect of long-term fluctuation could not be measured directly, the fact that some visual fields improved implies that the visual field scores for some eyes worsened as a result of long-term fluctuation, rather than true worsening due to glaucoma. Variability alone should produce some fields showing poorer sensitivity relative to baseline and a comparable number of fields showing improved sensitivity relative to baseline. Thus, it is likely that similar percentages of eyes worsened and improved due to long-term fluctuation. Relatively few eyes showed visual field improvement, which suggests that the effect of fluctuation on the results of this study probably was minor.

In this study, the criteria for exclusion based on the reliability measures of fixation loss (≥33%) and false-positive and false-negative error rates (≥40%) were slightly less conservative than the manufacturer's suggested reliability criteria (fixation loss ≥20% and false-positive or false-negative error rate ≥ 33%).[37,38] Because most of the subjects were inexperienced with visual field testing, many more eyes would have been excluded had the manufacturer's criteria been used. It can be argued that the manufacturer's criteria may not be optimal, particularly for fixation loss; for example, Bickler-Bluth and colleagues[39] suggested that the fixation loss criterion for unreliability be increased to ≥33%. One strength of the present study was the large number of untreated subjects for whom visual field data were available. These data are unique; for this reason, the importance of visual field reliability was balanced against the importance of using as many of these data as possible.

A potential problem for determination of visual field loss progression with fields obtained 10 years apart is that vision typically deteriorates with time, usually because of cataracts, and decreased vision may in turn affect the visual field. This study excluded eyes with a decrease in vision by doubling of the visual angle not attributable to glaucoma. Eyes that had progressed to end-stage glaucoma for which a Snellen acuity measurement could not be obtained were not included in the visual acuity analysis. Had they been included, deterioration of vision over the 10-year period would have been more pronounced than what is shown in Table III. Nonetheless, the vast majority of the eyes upon which the visual field loss progression analysis was based had Snellen acuity measurements at both examination times, and the change in vision was minimal. Decreased vision thus does not appear to have appreciably affected the visual field loss progression data obtained in this study.

VISUAL FIELD LOSS PROGRESSION IN TREATED GLAUCOMA

A number of studies have estimated progression of visual field loss from glaucoma.[2,4,5,14,16,19,40] In all of these studies, most, if not all, of the patients were receiving medical treatment or had undergone surgery for glaucoma. In these studies, the design, the perimeters used, the method of assessing progression, and the length of follow-up varied greatly; therefore, these results must be compared with caution.

Studies have reported the following percentages of subjects experiencing a statistically significant visual field

decline during the following average follow-up time periods: 68% (14 years),[5] 73% (10 years),[41] 76% (7.6 years),[42] 38% (9 years),[4] 27% (7 years),[19] 28% (6.3 years),[14] and 25% (3.7 years).[43] The rate of visual field loss in primary open-angle glaucoma has been reported as percent loss, as well as decibel loss, per unit time. In a retrospective cohort study of 40 eyes of 40 subjects with primary open-angle glaucoma, Kwon and associates[5] reported annual rates of visual field loss of 1.5% for the entire cohort and 2.1% for the subset of 27 eyes that progressed. For a prospective cohort of subjects with normal-pressure glaucoma, primary open-angle glaucoma, and ocular hypertension, Rasker and associates[4] reported a similar annual progression rate of 1.3% for the entire cohort but a slightly higher rate of 2.9% for the subgroup whose eyes progressed. Based on their conversion factor equating 4% loss of total visual field to -1 dB, these annual progression rates would be -0.30 dB for the entire cohort and -0.73 dB for the subgroup whose eyes progressed. The corresponding annual rates in Kwon's study would be -0.35 dB for the entire group and -0.48 dB for the subgroup with progression.

In a retrospective trend analysis of 40 eyes of 40 patients with primary open-angle glaucoma, O'Brien and associates[43] reported a remarkably consistent annual visual field loss of -0.35 dB for the entire cohort. However, the annual rate was much higher (-1.39 dB) for the subgroup of eyes that showed visual field loss progression. Higher annual loss rates also were reported by Katz and colleagues (-0.96 dB)[14] and by Smith and colleagues (-1.25 dB).[19]

Among black subjects, AGIS found that the "average % with decrease of visual field" (score increased by ≥4) at 84 months (7 years) was approximately 30% (obtained from Table IV by averaging of the scores for the two surgical treatment groups).[26] In another AGIS study with follow-up periods ranging from 7 to 11 years, the percentage of black subjects with "sustained decrease of visual field" (score decreased at three consecutive examinations) was approximately 28%.[44]

The interim results of CIGTS, with follow-up completed through 4 years and partially completed through 5 years, showed relatively minimal visual field loss progression in both the medically and surgically treated groups.[45] The mean visual field score for the surgically treated group was 5.0 (SD = 4.3) at baseline and remained essentially unchanged. For the medically treated group, the baseline mean was 4.6 (SD = 4.2), and the score had increased to 5.0 by 5 years. Visual field loss progression (score increase by ≥3) was observed in 10.7% of visits of medically treated and 13.5% of visits of surgically treated subjects visits during the 5 years.

Studies have yielded conflicting results with respect to association of various factors with likelihood or rate of progression of visual field loss. The patient's sex has not been reported to be associated with progression likelihood or rate. Some studies have found age to be positively associated with progression in subjects with glaucoma.[14,45] For example, CIGTS found that every 10-year increment in age increased the risk of progression by 40%. The present study corroborates the finding of greater progression with advancing age. However, other studies have reported finding no significant association between age and likelihood of progression,[4,43] and Kwon and associates[5] found no significant association between age and progression rate.

Similarly, investigations of the association between the severity of baseline visual field loss and the likelihood or rate of progression have yielded mixed results. Katz and associates[14] found baseline visual field loss severity to be similar in eyes that were stable and those that progressed. However, CIGTS found that eyes with higher baseline visual field scores were more likely to progress.[45] Wilson and associates[46] and Mikelberg and associates[42] found that the more advanced the loss of visual field at baseline, the greater the rate of further field loss. Mikelberg hypothesized that up to a certain point, axons may be lost slowly in the optic nerve, with minimal change in visual field as measured with current techniques, but that once a certain quantity of axons is lost, further loss of visual field is more linear and rapid, because very little functional nerve remains intact. However, several studies investigating this relationship found no correlation between initial visual field loss severity and subsequent rate of field loss.[4,5,19,43] In the present study, no statistically significant relationship between baseline severity and progression was found with the AGIS scoring system. However, with the CIGTS scoring system, better baseline visual fields were significantly associated with a greater likelihood of progression. An explanation for this finding is not obvious, and further confirmatory studies are necessary.

Intraocular pressure has long been established as a major risk factor for development of glaucoma,[47] as well as a prognostic factor for glaucoma progression.[48] It therefore logically follows that intraocular pressure would be predictive of both likelihood and rate of progression of visual field loss, and most studies that have investigated these relationships have found the likelihood and rate of progression to be positively associated with intraocular pressure.[2,43,48-50] However, some studies, including the present one, have not found this relationship between intraocular pressure and visual field progression.[5] The most likely explanation is that in the absence of diurnal intraocular pressure measurements (or at least multiple measurements), the intraocular pressure measurement obtained at a single point in time does not adequately represent the intraocular pressure throughout the duration of the study period.

IMPLICATIONS FOR THE NATURAL HISTORY OF UNTREATED GLAUCOMA

In a cross-sectional study, Quigley and associates[2] estimated a low probability of becoming blind from glaucoma, whereas Hattenhauer and associates,[3] in a community-based retrospective record review, found a 20-year cumulative probability of unilateral blindness of 54% in glaucoma patients and 27% in patients with glaucoma and/or ocular hypertension. The latter study did not distinguish between blindness from glaucoma and other causes, and it is likely that many of the eyes that became blind could have had conditions other than glaucoma. In the study by Kwon and associates,[5] 5 of 40 eyes became legally blind from glaucoma, which would extrapolate to a cumulative unilateral blindness rate of 19% at 22 years.

Using data from the Glasgow glaucoma trial for eyes having intraocular pressure greater than 25 mm Hg at diagnosis, Jay and Allan[51] estimated that it would take 38 years from the first detectable field loss to end-stage disease for opti-mally treated eyes and 10 years for unsatisfactorily treated eyes. In a cross-sectional record review, Jay and Murdoch[49] estimated that it would take 3.6 years to reach the same end point for untreated eyes with comparable intraocular pressure at diagnosis. The difference in estimated time to end-stage disease based on treatment status is striking, but it must be emphasized that the estimate for the untreated eyes was based on cross-sectional data.

The only available prospective data on untreated glaucoma are from the Normal-Tension Glaucoma Study.[6] The results of that study can provide only limited understanding of the natural history of untreated glaucoma, for several reasons. First, the study was limited to glaucomatous eyes with low to average intraocular pressures. Second, for obvious safety reasons, eyes were excluded once they reached a clearly defined progression end point. Nonetheless, the Normal-Tension Glaucoma Study established the beneficial effect of treatment on visual field loss progression, particularly when the impact of cataract, which was more prevalent in the treated eyes, was removed.[52]

Although the data vary considerably, most studies of visual field loss in treated glaucomatous eyes suggest that among eyes that progress, the average annual decline in mean defect is approximately -1.0 dB ± -0.4 dB.[4,5,14,43] Although mean defect was not the primary means of assessing progression in the present study, it is interesting that among eyes that progressed, the average annual decline of mean defect was in the same range, at approximately -0.8 to -0.9 dB per year. However, it should be noted that in this study, unlike the others cited, eyes with decreased vision due to cataract (which would have had a substantial decline in mean defect) were excluded.

The best comparison of visual field loss progression in treated versus untreated glaucomatous eyes is made by comparing the results of the present study with a study that used the same definition of progression. Although the comparison is not ideal, AGIS had subjects with varying levels of glaucoma severity, all the subjects were treated, the same visual field scoring algorithm was used, and the data allowed comparison with black subjects only.[44,45]

Extrapolating from the percentage of black subjects with visual field loss at 7 years in AGIS (30%)[10] (assuming that the percentage increases linearly), the percentage of subjects with visual field loss at 10 years would be approximately 43%. In the present study, a considerably larger percentage of eyes progressed (53%). This comparison is particularly relevant, since race is believed to be a factor in visual field progression, with blacks at greater risk of progression than whites.

CIGTS has not yet had a long follow-up period, but visual field loss progression thus far has been minimal. The visual field score from baseline to the last examination, with most subjects having 5 years of follow-up, barely changed.[45] The surgically treated group had a mean baseline score of 5.0 (SD = 4.3), and this group's score remained essentially unchanged; the medically treated group had a mean baseline score of 4.6 (SD = 4.2), and the score increased to about 5.0. In contrast, the mean scores in the present study changed from 5.6 in right eyes and 5.9 in left eyes in 1987 to 12.9 in right eyes and 13.6 in left eyes in 1997. Because CIGTS reported percentage of visits, rather than eyes, that showed progression, it is difficult to make a direct comparison with this study. Presumably, percentage of visits would yield a higher number than percentage of eyes, particularly if subjects who reached an end point for visual field loss were seen more frequently. Worsening of visual field was noted in 12% of visits (10.7% of medically treated and 13.5% of surgically treated subjects). Even if this is taken to represent the percentage of eyes worsening, the extrapolated percentage of eyes progressing in 10 years would be only 24%. Of the CIGTS subjects, 55.5% were white,[34] and nonwhites had a 50% greater risk of progression than whites.[45] Even so, if the extrapolation is adjusted for this race differential, the percentage of eyes that progressed at 10 years would still be markedly lower than the 72% found in the present study. It should be kept in mind, however, that CIGTS is a well-monitored clinical trial, and the experiences reported for this trial may not reflect what occurs in practice.

Using subjects enrolled in a natural history study of risk factors for glaucoma at the Johns Hopkins School of Medicine, Katz and associates[29] found visual field loss progression by the CIGTS criteria in 22% of the subjects over 6 years. This would extrapolate to about 37% progression over 10 years. This also was a well-monitored group of

subjects, and only 45% were black. It is possible that the progression rate would be slightly higher in a normal clinic environment and with an exclusively black population.

In the present study, 24 of 146 right eyes (16.4%) and 21 of 141 left eyes (14.9%) progressed to AGIS scores of 18 or greater, which is considered to indicate end-stage disease. Based on CIGTS scores, the corresponding numbers were 53 of 146 (36.3%) and 54 of 141 (38.3%). For purposes of comparison, if end-stage glaucoma can be considered blindness, then the cumulative probability of at least one eye becoming blind in 10 years based on AGIS score can be estimated at approximately 16%. The corresponding estimate based on CIGTS score is 35% in 10 years. These estimates can be compared with a cumulative blindness rate of 19% at 22 years reported by Kwon and associates.[5] Such a direct comparison is, of course, problematic. One major issue is that the definition of blindness differs. Kwon used a legal definition based on measurement of the central field with a Goldmann perimeter. By that definition, the greatest diameter of the central field must be less than 20º. Such a definition would be consistent with the AGIS and CIGTS definitions of end-stage glaucoma but would not necessarily agree with them for any given eye. Nonetheless, given that Kwon's sample consisted of confirmed primary open-angle glaucoma patients, whereas the present study included a substantial number of glaucoma suspects, the percentage of eyes reaching end-stage disease in this untreated cohort seems disproportionately high compared with the percentage among Kwon's treated patients.

Because estimation of visual field loss progression depends on how progression is defined, this study used two tested visual field scoring algorithms. The number of eyes that progressed by the CIGTS algorithm (208, or 72%) was substantially larger than the number that progressed by the AGIS algorithm (153, or 53%). Such a difference between these two scoring algorithms is consistent with the results reported by Katz and associates[29] in their study of glaucoma patients followed for 6 years. They reported that 11% of their subjects progressed based on AGIS score and 22% based on CIGTS score. They also reported that the CIGTS scores were systematically higher and were more likely to incorrectly identify visual field improvement than the AGIS scores. Both of these observations are confirmed by the present study.

LIMITATIONS ON THE INTERPRETATION AND GENERALIZATION OF THE RESULTS

The major limitation of this study is the inability to directly compare visual field loss progression in treated versus untreated eyes. Comparison of progression in this untreated cohort with progression reported in published studies of treated eyes is problematic. Inferences about the influence of treatment must be based on the magnitude of the differences between the progression found in this study and that found in other studies with similar methodology. However, no published study has many methodological similarities to this one. The most valid comparisons are probably with the AGIS and CIGTS results, since the same methods of defining progression were used. However, caution must be used in comparing the results of these very well performed clinical trials with those of this essentially observational study.

Another limiting factor is that this sample is generalizable to a select population. The sample was entirely black, and blacks are known to have a higher prevalence of glaucoma and experience a more aggressive clinical course. It is possible that Caribbean blacks have an even higher prevalence of glaucoma, with a more aggressive course, thus further limiting the generalizability of these findings.

Further information on the clinical course of untreated glaucoma may become available with publication of the results of the Early Manifest Glaucoma Trial, which randomized subjects with glaucoma to medical treatment versus no treatment. However, the sample in that study consists of subjects with early glaucoma only, and they will not be allowed to progress indefinitely without treatment.

Despite these limitations, the current data set is unique and not likely to be replicated. It is desirable to learn as much as possible about the natural history of glaucoma from this data set. In future analyses, statistical techniques to compensate for the small number of treated eyes will be explored to allow for direct comparison of visual field loss progression between treated and untreated eyes with glaucoma.

REFERENCES

1. Gordon MO, Kass MA. The Ocular Hypertension Treatment Study: design and baseline description of the participants. *Arch Ophthalmol* 1999;117:573-583.
2. Quigley HA, Tielsch JM, Katz J, et al. Rate of progression in open-angle glaucoma estimated from cross-sectional prevalence of visual field damage. *Am J Ophthalmol* 1996;122:355-363.
3. Hattenhauer MG, Johnson DH, Ing HH, et al. The probability of blindness from open-angle glaucoma. *Ophthalmology* 1998;105:2099-2104.
4. Rasker MT, van den Enden A, Bakker D, et al. Rate of visual field loss in progressive glaucoma. *Arch Ophthalmol* 2000;118:481-488.
5. Kwon YH, Kim CS, Zimmerman MB, et al. Rate of visual field loss and long-term visual outcome in primary open-angle glaucoma. *Am J Ophthalmol* 2001;132:47-56.
6. Collaborative Normal-Tension Glaucoma Study Group. Comparison of glaucomatous progression between untreated patients with normal-tension glaucoma and patients with therapeutically reduced intraocular pressures. *Am J Ophthalmol* 1998;126:487-497.

7. Leske MC, Heijl A, Hyman L, et al. Early Manifest Glaucoma Trial: design and baseline data. *Ophthalmology* 1999;106:2144-2153.
8. Mason RP, Kosoko O, Wilson MR, et al. National survey of the prevalence and risk factors of glaucoma in St Lucia, West Indies. *Ophthalmology* 1989;96:1363-1368.
9. Kass M. The Ocular Hypertension Treatment Study. *J Glaucoma* 1994;3:97-100.
10. Advanced Glaucoma Intervention Study: 2. Visual field test scoring and reliability. *Ophthalmology* 1994;101:1445-1455.
11. Flammer J, Drance SM, Zulauf M. Differential light threshold. Short- and long-term fluctuation in patients with glaucoma, normal controls, and patients with suspected glaucoma. *Arch Ophthalmol* 1984;102:704-706.
12. Wild JM, Searle AE, Dengler-Harles M, et al. Long-term follow-up of baseline learning and fatigue effects in the automated perimetry of glaucoma and ocular hypertensive patients. *Acta Ophthalmol* (Copenh) 1991;69:210-216.
13. Birch MK, Wishart PK, O'Donnell NP. Determining progressive visual field loss in serial Humphrey visual fields. *Ophthalmology* 1995;102:1227-1234.
14. Katz J, Gilbert D, Quigley HA, et al. Estimating progression of visual field loss in glaucoma. *Ophthalmology* 1997;104:1017-1025.
15. Heijl A, Lindgren A, Lindgren G. Test-retest variability in glaucomatous visual fields. *Am J Ophthalmol* 1989;108:130-135.
16. O'Brien C, Schwartz B. The visual field in chronic open angle glaucoma: the rate of change in different regions of the field. *Eye* 1990;4:557-562.
17. Heijl A, Lindgren G, Olsson J. Normal variability of static perimetric threshold values across the central visual field. *Arch Ophthalmol* 1987;105:1544-1549.
18. McNaught AI, Crabb DP, Fitzke FW, et al. Visual field progression: comparison of Humphrey Statpac2 and pointwise linear regression analysis. *Graefes Arch Clin Exp Ophthalmol* 1996;234:411-418.
19. Smith SD, Katz J, Quigley HA. Analysis of progressive change in automated visual fields in glaucoma. *Invest Ophthalmol Vis Sci* 1996;37:1419-1428.
20. Fitzke FW, Hitchings RA, Poinoosawmy D, et al. Analysis of visual field progression in glaucoma. *Br J Ophthalmol* 1996;80:40-48.
21. Noureddin BN, Poinoosawmy D, Fitzke FW, et al. Regression analysis of visual field progression in low tension glaucoma. *Br J Ophthalmol* 1991;75:493-495.
22. Viswanathan AC, Fitzke FW, Hitchings RA. Early detection of visual field progression in glaucoma: a comparison of PROGRESSOR and STATPAC 2. *Br J Ophthalmol* 1997;81:1037-1042.
23. Heijl A. *Extended Empirical Statistical Package for Evaluation of Single and Multiple Fields in Glaucoma: Statpac 2 in Perimetry Update*. Amsterdam: Kugler and Ghedini; 1991:303-315.
24. Schulzer M. Errors in the diagnosis of visual field progression in normal-tension glaucoma. *Ophthalmology* 1994;101:1589-1594.
25. Bengtsson B, Lindgren A, Heijl A, et al. Perimetric probability maps to separate change caused by glaucoma from that caused by cataract. *Acta Ophthalmol Scand* 1997;75:184-188.
26. The Advanced Glaucoma Intervention Study (AGIS): 4. Comparison of treatment outcomes within race. seven-year results. *Ophthalmology* 1998;105:1146-1164.
27. Lichter P. Quality of life study—determination of progression. In: Anderson DM, Drance SM, eds. [*Encounters in Glaucoma Research 3: How To Ascertain Progression and Outcome*]. Amsterdam: Kugler; 1996:149-163.
28. Katz J. Scoring systems for measuring progression of visual field loss in clinical trials of glaucoma treatment. *Ophthalmology* 1999;106:391-395.
29. Katz J, Congdon N, Friedman DS. Methodological variations in estimating apparent progressive visual field loss in clinical trials of glaucoma treatment. *Arch Ophthalmol* 1999;117:1137-1142.
30. Lee A, Sample P, Blumental EZ, et al. Infrequent confirmation of visual field progression. *Ophthalmology* (in press).
31. Sommer A, Enger C, Witt K. Screening for glaucomatous visual field loss with automated threshold perimetry. *Am J Ophthalmol* 1987;103:681-684.
32. Coleman AL, Sommer A, Enger C, et al. Interobserver and intraobserver variability in the detection of glaucomatous progression of the optic disc. *J Glaucoma* 1996;5:384-389.
33. The Advanced Glaucoma Intervention Study (AGIS): 1. Study design and methods and baseline characteristics of study patients. *Control Clin Trials* 1994;5:299-325.
34. Musch DC, Lichter PR, Guire KE, et al. The Collaborative Initial Glaucoma Treatment Study: study design, methods, and baseline characteristics of enrolled patients. *Ophthalmology* 1999;106:653-662.
35. Mills RP, Janz NK, Wren PA, et al. Correlation of visual field with quality-of-life measures at diagnosis in the Collaborative Initial Glaucoma Treatment Study (CIGTS). *J Glaucoma* 2001;10:192-198.
36. Asman P, Heijl A. Glaucoma hemifield test: automated visual field analysis. *Arch Ophthalmol* 1992;110:812-819.
37. *The Humphrey Field Analyzer Owner's Manual*. San Leandro, Calif: Allergan Humphrey; 1983.
38. *STATPAC User's Guide*. San Leandro, Calif: Allergan Humphrey; 1986.
39. Bickler-Bluth M, Trick GL, Kolker AE, et al. Assessing the utility of reliability indices for automated visual fields. *Ophthalmology* 1989;96:616-619.
40. Kidd MN, O'Connor M. Progression of field loss after trabeculectomy: a five-year follow-up. *Br J Ophthalmol* 1985;69:827-831.
41. Hart WM Jr, Becker B. The onset and evolution of glaucomatous visual field defects. *Ophthalmology* 1982;89:268-279.
42. Mikelberg FS, Schulzer M, Drance SM, et al. The rate of progression of scotomas in glaucoma. *Am J Ophthalmol* 1986;101:1-6.
43. O'Brien C, Schwartz B, Takamoto T, et al. Intraocular pressure and the rate of visual field loss in chronic open-angle glaucoma. *Am J Ophthalmol* 1991;111:491-500.
44. The Advanced Glaucoma Intervention Study (AGIS): 9. Comparison of glaucoma outcomes in black and white patients within treatment groups. *Am J Ophthalmol* 2001;132:311-320.

45. Lichter PR, Musch DC, Gillespie BW, et al. Interim clinical outcomes in the Collaborative Initial Glaucoma Treatment Study comparing initial treatment randomized to medications or surgery. *Ophthalmology* 2001;108:1943-1953.
46. Wilson R, Walker AM, Dueker DK, et al. Risk factors for rate of progression of glaucomatous visual field loss: a computer-based analysis. *Arch Ophthalmol* 1982;100:737-741.
47. Armaly MF, Krueger DE, Maunder L, et al. Biostatistical analysis of the collaborative glaucoma study. I. Summary report of the risk factors for glaucomatous visual-field defects. *Arch Ophthalmol* 1980;98:2163-2171.
48. Mao LK, Stewart WC, Shields MB. Correlation between intraocular pressure control and progressive glaucomatous damage in primary open-angle glaucoma. *Am J Ophthalmol* 1991;111:51-55.
49. Jay JL, Murdoch JR. The rate of visual field loss in untreated primary open angle glaucoma. *Br J Ophthalmol* 1993;77:176-178.
50. Shirakashi M, Iwata K, Sawaguchi S, et al. Intraocular pressure-dependent progression of visual field loss in advanced primary open-angle glaucoma: a 15-year follow-up. *Ophthalmologica* 1993;207:1-5.
51. Jay JL, Allan D. The benefit of early trabeculectomy versus conventional management in primary open angle glaucoma relative to severity of disease. *Eye* 1989;3:528-535.
52. Collaborative Normal-Tension Glaucoma Study Group. The effectiveness of intraocular pressure reduction in the treatment of normal-tension glaucoma. *Am J Ophthalmol* 1998;126:498-505.

APPENDIX 1

ID _ _ - _ _ _ - _ _ _ - _ _

RECORD OF CONTACTS

ATT #	DATE	TIME	WEEKEND = 1 EVENING = 2 WEEKDAY = 3	IN-PER = 1 TELE = 2	INIT	REMARKS/OUTCOME/COMMENTS
			1 2 3	1 2		
			1 2 3	1 2		
			1 2 3	1 2		
			1 2 3	1 2		
			1 2 3	1 2		
			1 2 3	1 2		
			1 2 3	1 2		
			1 2 3	1 2		
			1 2 3	1 2		
			1 2 3	1 2		

DISPOSITION AREA

COMPLETE, NO CONVERSION 01
COMPLETE 02
BREAKOFF/REFUSAL ..... (EXPLAIN)..... 03
ILL, MEDICALLY INCAPABLE..... (EXPLAIN) ... 04
OUT OF AREA ..... (EXPLAIN) 05
NO LOCATE .....(EXPLAIN) 06
DECEASED ..... (SPECIFY DATE) ..07
OTHER .....(EXPLAIN) 08

EXPLAIN : _____

FINAL DISP .....
INTERVIEWER # .....
DATE (MM DD YY) .....
OF CONTACT ATTEMPTS .....
OF MINUTES IF COMPLETE .....
COMPLETED: RESP .... 1 IN PERSON 1
PROXY ... 2 BY PHONE 2

APPENDIX 2

1 of 6

Date: __ __/ __ __/ __ __

Examiner: __ __ __

ST. LUCIA GLAUCOMA EYE SURVEY FOLLOW-UP

Definitive Examination Form

ID: __ __ - __ __ __ __ - __ __ - __ __

		Right Eye			Left Eye		
		intact	pthisis	enucleation	intact	pthisis	enucleation
1.	Status of globe	(0)	(1)	(2)	(0)	(1)	(2)
2.	Pupil	no		yes	no		yes
	Afferent defect	(0)		(1)	(0)		(1)
	Other	(0)		(1)	(0)		(1)
	Specify:	_____			_____		
3.	Cornea						
	Pigment spindle	(0)		(1)	(0)		(1)
	KP	(0)		(1)	(0)		(1)
	Edema	(0)		(1)	(0)		(1)
	Scar	(0)		(1)	(0)		(1)
	Dystrophy	(0)		(1)	(0)		(1)
	Specify:	_____			_____		
4.	Iris						
	Transillumination	(0)		(1)	(0)		(1)
	Posterior synechiae	(0)		(1)	(0)		(1)
	Bombe	(0)		(1)	(0)		(1)
	Rubeosis	(0)		(1)	(0)		(1)
	Laser/surgical colobama	(0)		(1)	(0)		(1)
	Other	(0)		(1)	(0)		(1)
	Specify:	_____			_____		

2 of 6 ID: __ __ - __ __ __ __ - __ __ - __ __

		Right Eye		Left Eye	
5.	Anterior Chamber	no	yes	no	yes
	Ray	(0)	(1)	(0)	(1)
	Cell	(0)	(1)	(0)	(1)

		Right Eye			Left Eye		
6.	Gonioscopy						
	Angle depth:	Open	Borderline	Closed	Open	Borderline	Closed
	Superior	(0)	(1)	(2)	(0)	(1)	(2)
	Nasal	(0)	(1)	(2)	(0)	(1)	(2)
	Inferior	(0)	(1)	(2)	(0)	(1)	(2)
	Temporal	(0)	(1)	(2)	(0)	(1)	(2)

PAS (quadrant)	no	yes	no	yes
Superior	(0)	(1)	(0)	(1)
Nasal	(0)	(1)	(0)	(1)
Inferior	(0)	(1)	(0)	(1)
Temporal	(0)	(1)	(0)	(1)
Rubeosis	(0)	(1)	(0)	(1)
Recession	(0)	(1)	(0)	(1)
Other	(0)	(1)	(0)	(1)

Specify: _____ _____

7.	IOP (mm Hg)	Reading: 1st	____ ____	____ ____
		2nd	____ ____	____ ____
		3rd	____ ____	____ ____

3 of 6
Rev 14

ID: __ __-__ __ __ __-__ __-__ __

	Right Eye	Left Eye
8. Potentially occludable angle?	no (0) yes (1)	no (0) yes (1)
If yes:	dilate with 1% Mydriacyl (0) iridectomy (1)	dilate with 1% Mydriacyl (0) iridectomy (1)
If dilated with 1% Mydriacyl: IOP 40 min	_____ _____	_____ _____
Angle 40 min	open (0) closed (1)	open (0) closed (1)
If no, dilate with regular regimen:		
Dilated pupil size	___ ___mm	___ ___ mm

	Right Eye	Left Eye
9. Lens	phake (0) pseudo (1) aphake (2)	phake (0) pseudo (1) aphake (2)
If phakic or pseudo: Exfoliation	no (0) yes (1)	no (0) yes (1)
Dislocation	(0) (1)	(0) (1)
If phakic: Lens grading:		
Nuclear	_____._____	_____._____
Cortical	_____._____	_____._____
PSC	_____._____	_____._____

	Right Eye	Left Eye
10. Vitreous		
Visibility:	Good (0) Poor (1)	Good (0) Poor (1)
If good view: Cells	no (0) yes (1)	no (0) yes (1)
Blood	(0) (1)	(0) (1)
Other opacity	(0) (1)	(0) (1)
Specify:	_____	_____

4 of 6

Rev 14

ID: __ __-__ __ __ __-__ __-__ __

11. Macula	Right Eye			Left Eye		
	good	adequate	poor	good	adequate	poor
Macula view:	(0)	(1)	(2)	(0)	(1)	(2)
Hole/Cyst	(0)	(1)		(0)	(1)	
Macular Edema	(0)	(1)		(0)	(1)	
Large, soft drusen/pigmentary changes	(0)	(1)		(0)	(1)	
Geographic atrophy	(0)	(1)		(0)	(1)	
Disciform scar/ Subretinal neovasc	(0)	(1)		(0)	(1)	
Other	(0)	(1)		(0)	(1)	
Specify:	_____			_____		

12. Retina	Right Eye			Left Eye		
	good	adequate	poor	good	adequate	poor
Retina view:	(0)	(1)	(2)	(0)	(1)	(2)
Reattachment surgery		(0)	(1)		(0)	(1)
Pan retinal photocoag		(0)	(1)		(0)	(1)
Focal photocoag		(0)	(1)		(0)	(1)
Atrophy (location)		(0)	(1)		(0)	(1)
		_____			_____	
Scar (location)		(0)	(1)		(0)	(1)
		_____			_____	
Neovascularization		(0)	(1)		(0)	(1)
Cotton wool spots		(0)	(1)		(0)	(1)
IRMA		(0)	(1)		(0)	(1)

5 of 6
Rev 14

ID: __ __-__ __ __ __-__ __-__ __

	Right Eye	Left Eye
13. NFL		
NFL view:	good (0) adequate (1) poor (2)	good (0) adequate (1) poor (2)
If good or adequate:		
Worst diffuse atrophy grade:		
normal	(0)	(0)
mild	(1)	(1)
moderate	(2)	(2)
severe	(3)	(3)
Wedge defects:	no (0) yes (1)	no (0) yes (1)

	Right Eye	Left Eye
14. Disc & Peripapilla		
Visibility:	good (0) adequate (1) poor (2)	good (0) adequate (1) poor (2)
If good or adequate:		
Vertical C/D	___.___	___.___
	no (0) yes (1)	no (0) yes (1)
Notch	(0) (1)	(0) (1)
Hemorrhage	(0) (1)	(0) (1)
Pale disc	(0) (1)	(0) (1)
Optic pit	(0) (1)	(0) (1)
Drusen	(0) (1)	(0) (1)
Other	(0) (1)	(0) (1)
Specify:	_____	_____

6 of 6

Rev. 14

ID: __ __-__ __ __ __-__ __-__ __

15. Cause(s) of decreased acuity: Only if VA < 20/30:

RANK IN ORDER OF IMPORTANCE

	Right Eye	Left Eye
Cataract	___	___
AMD - geographic atrophy	___	___
AMD - exudative	___	___
Glaucoma	___	___
Diabetic retinopathy	___	___
Post cataract cystoid macular edema	___	___
Other retinal pathology	___	___
Specify:	_____	_____
Corneal opacity	___	___
Non-glaucomatous Optic atrophy	___	___
Amblyopia	___	___
Uncertain	___	___
Other	___	___
Specify:	_____	_____

ST. LUCIA EYE SURVEY
SCREENING EXAMINATION

STATION #3

HUMPHREY VISUAL FIELD TESTING

SCREEN DISPLAY

THIS IS....

PATIENT ID#: __ __ - __ __ __ __ - __ __ - __ __

ALONG WITH PATIENT'S NAME AND ID#, PLEASE ENTER THE FOLLOWING INFORMATION ONTO THE HUMPHREY FIELD ANALYZER "PATIENT INFORMATION SCREEN"...

DATE OF BIRTH _____

PATIENT'S DISTANCE CORRECTION

R __ __ __•__ __+__ __•__ __x__ __ __
L __ __ __•__ __+__ __•__ __x__ __ __

Attempt to perform **30-2** Humphrey Visual Field Test on **Right Eye.**
Visual Field for Right Eye was .....

Completed	(1)
Not completed due to poor vision	(2)
Not completed due to patient refusal	(3)
Not completed due to patient incapability	(8)

ID __ __ - __ __ - __ __ - __ __

continued..
Station #2

6. Perform **refractometry** and enter results here ...

   6a. R __ __ __ • __ __ + __ __ • __ __ x __ __ __

   6b. L __ __ __ • __ __ + __ __ • __ __ x __ __ __

7. **Refractometry** was performed ...

   using automated refractor (1)

   manually using phoropter (2)

8. **Visual Acuity Assessment.** First, let us check patient's **distance lane visual acuity** while they are wearing their **present correction** and record here...

   8a. R __ __/ __ __ __ (with presenting correction)

   8b. L __ __/ __ __ __ (with presenting correction)

9. Now, let us check patient's distance lane visual while using the **refraction correction.** Please record.

   9a. R __ __/ __ __ __ (with refraction correction)

   9b. L __ __/ __ __ __ (with refraction correction)

10. If patient's vision was less than 20/20 in testing both with present Rx **and** refraction please check vision again with a **multiple pinhole** in front of the **refraction correction.** Record here.

    10a. R __ __/ __ __ __ (with multiple pinhole)

    10b. L __ __/ __ __ __ (with multiple pinhole)

PLEASE DIRECT PATIENT TO STATION # 3
HUMPHREY VISUAL FIELDS

APPENDIX 3

CASE # .... ☐☐ - ☐☐☐☐ - ☐☐ - ☐☐

INTERVIEWER # ..... ☐☐☐☐

DATE ..... ☐☐ - ☐☐ - ☐☐

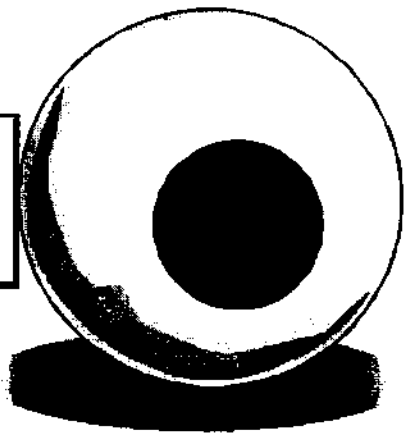
MM DD YY

EDITOR # ..... ☐☐☐☐

TOTAL TIME ..... ☐☐☐

FIELD EDIT INITIALS..... _____

ST. LUCIA GLAUCOMA SURVEY



FOLLOW- UP STUDY INTERVIEW

1997

ID __ __ - __ __ - __ __ - __ __

DECK 07

START TIME: __:__ 32

ST. LUCIA GLAUCOMA SURVEY FOLLOW-UP STUDY

INTERVIEW

SECTION A: Demographics

A1.	First, I would like to ask you some general background questions. How old were you on your last birthday?	AGE ..... __ __ YRS	36
A2.	What is your date of birth?	DOB ..... __ __ MM __ __ DD __ __ YY	38
A3.	Are you currently married, separated, divorced, widowed or have you never been married?	MARRIED ..... 1 SEPARATED ..... 2 DIVORCED ..... 3 WIDOWED ..... 4 NEVER MARRIED ..... 5 RF 7	44
A4.	What is the highest grade in school or year of college that you completed?	GRADE: 00 01 02 03 04 05 06 07 08 09 10 11 12 COLLEGE: 13 14 15 16 GRADUATE SCHOOL: 17	45
A5.	Are you currently employed, a homemaker, retired, disabled or unemployed? SPECIFY: _____	EMPLOYED ..... 1 HOMEMAKER ..... 2 RETIRED ..... 3 DISABLED ..... 4 UNEMPLOYED ..... 5 OTHER ..... (SPECIFY) 6	47
A6.	Not counting yourself, how many other people live in your household?	# IN HOUSEHOLD ..... __ __	48

ID ___-___-___-___

SECTION C: Medical/Eye History

DECK 03

C1. Now I'd like to ask you some questions about your medical history and more specifically about your eye health. How satisfied are you with your vision? Are you (READ CATEGORIES)?

Very satisfied 1
Satisfied 2
Dissatisfied 3
Very dissatisfied 4

34

C2. Do you currently wear glasses or contact lenses to see in the distance?

YES 1
NO 2

35

C3. Do you currently wear glasses or bifocals specifically made for close work such as knitting or reading?

YES 1
NO 2

36

C4. Using your glasses or contact lenses if you need them, can you see well enough to read ordinary newspaper print with (ASK a-c):

a. Your right eye?

YES 1
NO 2

37

b. Your left eye?

YES 1
NO 2

38

c. Both your eyes open?

YES 1
NO 2

39

C5. Have you ever been told that you had a cataract in either eye?

YES 1
NO ..... (GO TO C6) 2

40

a. Did your eye doctor advise you to have cataract surgery?

YES 1
NO ..... (GO TO C6) 2

41

b. Did you ever have cataract surgery?

YES, ONE EYE .... (GO TO C6) 1
YES, BOTH EYES .. (GO TO C6) 2
NO 3

42

c. What was the reason you did not have cataract surgery? Was it because (READ CATEGORIES)?

	YES	NO	RF	DK	
It cost too much?	1	2	7	8	43
You didn't know where to go?	1	2	7	8	44
You didn't have a way to get there?	1	2	7	8	45
You didn't think the problem was serious enough?	1	2	7	8	46
You didn't have insurance?	1	2	7	8	47
You were afraid of surgery?	1	2	7	8	48
Any other reason? ..... (SPECIFY)	1	2	7	8	49

SPECIFY: _____ 50

ID __ __ - __ __ - __ __ - __ __

C6. Have you ever been told by a doctor that you have glaucoma?
YES 1
NO ..... (GO TO C7) ..... 2 — 52

a. How old were you when you first learned you had glaucoma?
AGE ..... __ — 53

b. In the past 3 years, or since your diagnosis, how many times have you seen your eye doctor for your glaucoma?
TIMES ..... __ — 55

c. Have you ever gone more than one year without seeing your eye doctor for your glaucoma?
YES 1
NO ..... (GO TO e) ..... 2 — 57

d. What was the reason that you did not see your eye doctor? Was it because (READ CATEGORIES)?

	YES	NO	RF	DK	
It costs too much?	1	2	7	8	58
You didn't know where to go?	1	2	7	8	59
You didn't have a way to get there?	1	2	7	8	60
You didn't think the problem was serious enough?	1	2	7	8	61
You didn't have money?	1	2	7	8	62
You were afraid?	1	2	7	8	63
Any other reason? .....(SPECIFY)	1	2	7	8	64

SPECIFY: _____ — 65

e. Are you taking eye drops or oral medications for your glaucoma?
YES 1
NO ..... (GO TO g) ..... 2 — 67

f. What medications are you taking for glaucoma?

1. _____ — 68
2. _____ — 70
3. _____ — 72
4. _____ — 74

g. Are there any medications that the doctor has prescribed for your glaucoma but that you are not taking at all or as frequently as prescribed?
YES, NOT AT ALL 1
YES, NOT AS FREQUENTLY 2
NO ..... (GO TO i) ..... 3 — 76
END 03

(5)

ID __ __ - __ __ - __ __ - __ __

DECK 04

h. What is the main reason you are not taking your glaucoma medication as prescribed by your doctor? READ CATEGORIES.

It costs too much ..... 1 [13]
Don't need it 2
You didn't have a way to get it 3
You don't feel good when you take it (it hurts or burns my eyes) 4
Any other reason (SPECIFY) 5

SPECIFY: _____ [14]

i. Did your eye doctor ever tell you that you needed laser or surgery for your glaucoma?

YES ..... 1 [16]
NO ..... (GO TO C7) 2

j. Did you have glaucoma surgery? PROMPT: In one eye or both eyes?

YES, ONE EYE .... (GO TO C7) ..... 1 [17]
YES, BOTH EYES .. (GO TO C7) 2
NO 3

k. What was the reason why you did not have surgery for your glaucoma? Was it because (READ CATEGORIES)?

	YES	NO	RF	DK	
It costs too much?	1	2	7	8	[18]
You didn't know where to go?	1	2	7	8	[19]
You didn't have a way to get there?	1	2	7	8	[20]
You didn't think the problem was serious enough?	1	2	7	8	[21]
You didn't have money?	1	2	7	8	[22]
You were afraid of surgery?	1	2	7	8	[23]
Any other reason? ..... (SPECIFY)	1	2	7	8	[24]

SPECIFY: _____ [25]

C7. Are you currently using any prescription eye drops or ointment to treat any other eye disease (besides glaucoma) such as ocular inflammation or an eye infection?

YES ..... 1 [27]
NO ..... (GO TO C8) 2

a. What eye drops or ointments are you using?

b. What are you taking them for?

1. _____ [28] 1. _____
2. _____ [32] 2. _____
3. _____ [36] 3. _____
4. _____ [40] 4. _____
5. _____ [44] 5. _____

(6)

ID ___-___-___-___

DECK 04

C8. Are you currently using any oral medication to treat any other eye disease such as ocular inflammation or an eye infection? — 48

YES 1
NO ..... (GO TO C9) 2

a. What oral medications are you taking?

b. What are you taking them for?

1. _____ ☐☐ — 49
2. _____ ☐☐ — 53
3. _____ ☐☐ — 57
4. _____ ☐☐ — 61
5. _____ ☐☐ — 65

C9. Do your eyes ever feel dry? — 69

YES 1
NO ..... (GO TO C10) 2

a. HAND CARD E. Do they feel dry (READ CATEGORIES)? — 70

All the time (4 or more days/wk) 1
Often (1 to 3 days/wk) 2
Sometimes (2 to 3 days/month) 3
Rarely (once a month or less) ... (GO TO C10) ... 4

b. Is this symptom worse in the morning or evening, or is it the same all day? — 71

MORNING 1
EVENING 2
SAME 3

c. Are the symptoms (READ CATEGORIES)? — 72

Constant year round 1
Seasonal 2

C10. Do you ever feel a gritty or sandy sensation in your eyes? — 73

YES 1
NO ..... (GO TO C11) 2

a. HAND CARD E. Do they feel gritty all the time, often, sometimes, or rarely? — 74

ALL THE TIME 1
OFTEN 2
SOMETIMES 3
RARELY 4

C11. Do your eyes ever have a burning sensation? — 75

YES 1
NO ..... (GO TO C12) 2

a. HAND CARD E. Do they burn all the time, often, sometimes, or rarely? — 76

ALL THE TIME 1
OFTEN 2
SOMETIMES 3
RARELY 4

END 04

ID __ __ - __ __ - __ __ - __ __

DECK 05

C12. Are your eyes ever red?

YES ..... 1 | 13
NO ..... (GO TO C13) 2

a. HAND CARD E. Are they red all the time, often, sometimes, or rarely?

ALL THE TIME ..... 1 | 14
OFTEN 2
SOMETIMES 3
RARELY 4

C13. Do you use artificial tears or other nonprescription eye drops for dry eye?

YES ..... 1 | 15
NO ..... (GO TO C14) 2

a. How many times per day do you use them?

TIMES PER DAY ..... |__|__| | 16

b. For how many months have you been using them?

MONTHS ..... |__|__|__| | 18

C14. When you are in a mood to cry, can you normally produce tears?

YES ..... 1 | 21
NO 2

C15. Do you notice much crusting on your eye lashes?

YES ..... 1 | 22
NO ..... (GO TO C16) 2

a. HAND CARD E. Does this happen all the time, often, sometimes, or rarely?

ALL THE TIME ..... 1 | 23
OFTEN 2
SOMETIMES 3
RARELY 4

C16. Do your eyelids ever get stuck together in the morning?

YES ..... 1 | 24
NO ..... (GO TO C17) 2

a. HAND CARD E. Does this happen all the time, often, sometimes, or rarely?

ALL THE TIME ..... 1 | 25
OFTEN 2
SOMETIMES 3
RARELY 4

DECK 05

C17. Since the last time you were examined by Howard University Drs (DATE), have you had any surgery on your eyes? — YES ..... 1; NO ..... (GO TO C18) ..... 2 — 26

a. How many different surgeries did you have during this period? — # SURGERIES ..... ⌊⌊⌋⌋ — 27

ASK b–d FOR EACH SURGERY	FIRST SURGERY	SECOND SURGERY	THIRD SURGERY	FOURTH SURGERY
b. What eye was it on, the right or left?	29	36	43	50
RIGHT	1	1	1	1
LEFT	2	2	2	2
c. What type of surgery was it? READ CATEGORIES.	30	37	44	51
Cataract	01	01	01	01
Cataract (laser)	02	02	02	02
Glaucoma	03	03	03	03
Glaucoma (laser)	04	04	04	04
Diabetes (laser)	05	05	05	05
Retinal detachment	06	06	06	06
Other or combination (SPECIFY)	07	07	07	07
SPECIFY:				
DK	98	98	98	98
	32	39	46	53
d. When was this done?	⌊⌊⌋⌋ MM ⌊⌊⌋⌋ YY	⌊⌊⌋⌋ MM ⌊⌊⌋⌋ YY	⌊⌊⌋⌋ MM ⌊⌊⌋⌋ YY	⌊⌊⌋⌋ MM ⌊⌊⌋⌋ YY

C18. Now, I'm going to read you a list of eye conditions that you may have now or have had in the past. Has a doctor ever told you that you had Lazy Eye? — YES ..... 1; NO ..... 2 — 57

C19. Has a doctor ever told you that you had macular degeneration? — YES ..... 1; NO ..... (GO TO C20) ..... 2 — 58

a. Were you ever treated for macular degeneration? — YES ..... 1; NO ..... (GO TO C20) ..... 2 — 59

b. What type of treatment did you receive? — LASER ..... 1; SURGERY ..... 2; OTHER ..... (SPECIFY) ..... 3; DK ..... 8 — 60

SPECIFY: _____ ⌊⌋⌊⌋ — 61

ID ___-___-___-___

DECK 05

C20. Has a doctor ever told you that you had retinal detachment?
YES 1
NO ..... (GO TO C21) ..... 2 — 63

a. Were you ever treated for retinal detachment?
YES 1
NO ..... (GO TO C21) ..... 2 — 64

b. What type of treatment did you receive: laser, surgery, both, or some other type of treatment?
LASER 1
SURGERY 2
BOTH 3
OTHER ..... (SPECIFY) 4
DK ..... 8 — 65

SPECIFY: _____ — 66

C21. Has a doctor ever told you that you had any other eye problems?
YES ..... (SPECIFY) 1
NO ..... (GO TO C22) ..... 2 — 68

SPECIFY:

PROBLEM #1 _____ — 69

PROBLEM #2 _____ — 74 END 05

PROBLEM #3 _____ — 13

C22. Now, I'm going to read you a list of other health conditions. At the present time, do you have any of the following conditions?

		YES	NO	RF	DK	
a.	asthma?	1	2	7	8	18
b.	chronic bronchitis or emphysema?	1	2	7	8	19
c.	tuberculosis?	1	2	7	8	20
d.	other chronic lung trouble?	1	2	7	8	21
e.	repeated attacks of sinus trouble?	1	2	7	8	22
f.	arthritis, rheumatism, or bursitis?	1	2	7	8	23
g.	high blood pressure or hypertension?	1	2	7	8	24
h.	hardening of the arteries?	1	2	7	8	25
i.	a heart attack?	1	2	7	8	26
j.	any other heart trouble?	1	2	7	8	27
k.	a stroke?	1	2	7	8	28
l.	stomach, bowel or intestinal trouble?	1	2	7	8	29
m.	cancer?	1	2	7	8	30
n.	serious kidney or bladder disease?	1	2	7	8	31
o.	serious trouble with back or spine?	1	2	7	8	32
p.	paralysis of any kind?	1	2	7	8	33

DECK 06

C23. Do you presently have diabetes or sugar diabetes?
YES 1
NO ..... (GO TO C24) ..... 2 — 34

a. How many years have you had diabetes?
YEARS ..... ⌊__⌋ — 35

b. How is your diabetes currently treated?
INSULIN 1
ORAL DRUGS 2
DIET ALONE 3
NOT BEING TREATED ..... 4 — 37

c. Did your medical doctor ever tell you to have your eyes examined every year because of your diabetes?
YES 1
NO ..... 2 — 38

d. When was your last complete eye examination, one that included dilating your pupils, where the doctor used bright lights to look into the back of your eyes?
WITHIN PAST 12 MONTHS 1
1-2 YEARS AGO 2
3-5 YEARS AGO 3
OVER 5 YEARS AGO ..... 4 — 39

e. Have you had a complete eye exam every year for the past 3 years?
YES ..... (GO TO g) 1
NO ..... 2 — 40

f. Why have you not had these annual exams? Was it because (READ CATEGORIES)?

	YES	NO	RF	DK	
It costs too much?	1	2	7	8	41
You didn't know where to go?	1	2	7	8	42
You didn't have a way to get there?	1	2	7	8	43
You didn't think the problem was serious enough?	1	2	7	8	44
You didn't have money?	1	2	7	8	45
You were afraid?	1	2	7	8	46
Any other reason? .... (SPECIFY)	1	2	7	8	47

SPECIFY: _____ ⌊__⌋ — 48

g. Has a doctor ever told you that you had diabetic retinopathy or diabetic eye disease?
YES 1
NO ..... (GO TO C24) ..... 2 — 50

h. Has a doctor ever told you that you needed laser or surgery for your diabetic eye disease?
YES 1
NO ..... (GO TO C24) ..... 2 — 51

i. Did you have laser, surgery or both?
YES, LASER ..... (GO TO C24) 1
YES, SURGERY .... (GO TO C24) 2
YES, BOTH ..... (GO TO C24) 3
NO ..... 4 — 52

DECK 06

j. What was the reason you didn't have laser or surgery for your diabetic eye disease? Was it because (READ CATEGORIES)?

	YES	NO	RF	DK	
It costs too much?	1	2	7	8	53
You didn't know where to go?	1	2	7	8	54
You didn't have a way to get there?	1	2	7	8	55
You didn't think the problem was serious enough?	1	2	7	8	56
You didn't have insurance?	1	2	7	8	57
You were afraid of surgery?	1	2	7	8	58
Any other reason? (SPECIFY)	1	2	7	8	59

SPECIFY: _____ 60

C24. Do you presently have any other serious health problem that we have not already mentioned? SPECIFY.

YES ..... (SPECIFY) 1 62
NO ..... (GO TO SECTION D) 2

PROBLEM #1 _____ 63

PROBLEM #2 _____ 64

ID ___-___-___-___

SECTION D: Health Services

The next few questions will be about your use of health services in general and then more specifically about your use of eye care services. DECK 06

D1. In the past three years, did you stay in a hospital as a patient overnight? — YES ..... 1; NO ..... (GO TO D2) ..... 2 — 73

a. During that period, how many different times did you stay in a hospital overnight? — NUMBER OF TIMES ..... ___ — 74

b. How many were for eye problems? — NUMBER OF TIMES ..... ___ — 76 END 06

D2. Not counting times when you stayed overnight in a hospital, in the past three years did you ever go in and come out of a hospital on the same day for surgery? — YES ..... 1; NO ..... (GO TO D3) ..... 2 — 13

a. During that period, how many different times did you go into a hospital for one of these procedures without staying overnight? — NUMBER OF TIMES ..... ___ — 14

b. How many were related to an eye problem? — NUMBER OF TIMES ..... ___ — 16

D3. During the last three years, did you ever have surgery done in a special surgery center outside of a hospital? — YES ..... 1; NO ..... (GO TO D4) ..... 2 — 18

a. How many times did you have surgery at such a center? — NUMBER OF TIMES ..... ___ — 19

b. How many of these surgeries were for eye problems? — NUMBER OF TIMES ..... ___ — 21

D4. During the past three years, did you stay in a nursing home, convalescent home or similar place? — YES ..... 1; NO ..... (GO TO D5) ..... 2 — 23

a. How many times were you admitted to such a place? — NUMBER OF TIMES ..... ___ — 24

D5. During the past three years, how many times have you seen a medical doctor (not counting any doctors seen during hospital stays you already mentioned)? — NUMBER OF TIMES ..... ___ — 26

DECK 07

D6. How long has it been since you last saw a doctor?

WITHIN PAST 12 MONTHS ..... 1 | 28
1-2 YEARS 2
3-5 YEARS 3
MORE THAN 5 YEARS 4
DK 8

D7. For what reason did you last see a doctor? CODE ONE.

ROUTINE CHECK-UP/SHOTS ..... 01 | 29
SHORT TERM ILLNESS/INJURY 02
CARE OF A CHRONIC MEDICAL PROBLEM 03
SURGERY OR AFTERCARE 04
PREGNANCY/GYN EXAM 05
DENTAL SERVICES 06
EYE EXAM 07
TESTS 08
OTHER ..... (SPECIFY) 09
DK 98

SPECIFY: _____ | 31
OFFICE

D8. Where do you generally go for health care? CODE ONE.

Private MD .....01 | 33
Emergency Room 02
Hospital Clinic 03
Community Clinic 04
Nowhere.....05
Other .....(Specify).....06
DK.....07

SPECIFY: _____ | 35
OFFICE

D9. During the past three years, were there any times you thought you should see a doctor but did not?

YES ..... 1 | 37
NO ..... (GO TO D10) 2

a. What prevented you from going for care? Was it because (READ CATEGORIES)?

	YES	NO	RF	DK	
It cost too much	1	2	7	8	38
You didn't know where to go?	1	2	7	8	39
You didn't have a way to get there?	1	2	7	8	40
There wasn't a health professional or medical center close enough	1	2	7	8	41
It was too difficult to get an appointment	1	2	7	8	42
Office hours were not convenient	1	2	7	8	43
You didn't think the problem was serious enough?	1	2	7	8	44
Any other reason? ..... (SPECIFY)	1	2	7	8	45

SPECIFY: _____ | 46

DECK 07

D10. The next few questions are about eye care you may have received from an eye doctor. People often confuse the different types of eye doctors. Just to be sure I am being clear, could you please tell me the difference between an ophthalmologist and an optometrist?

IF R IS INCORRECT OR DOESN'T KNOW, READ: DEFINITION - An ophthalmologist is an M.D. who can perform surgery and issue prescription medication. An optometrist can do visual eye exams and prescribe only eye glasses.

CORRECT ..... 1 [48]
INCORRECT ..... (READ DEFINITION) 2
SUBJECT DOESN'T TRY/
DOESN'T KNOW ... (READ DEFINITION) 3

D11. In the past three years, have you seen an eye doctor, eye specialist or someone else for any type of eye care or routine eye examination?

YES ..... 1 [49]
NO ..... (GO TO D12) 2
DK ..... (GO TO D12) 8

a. How many visits have you made for eye care in the past three years?

NUMBER OF VISITS ..... [50]

b. How many of these times were to an ophthalmologist?

OF TIMES TO OPHTHALMOLOGIST ..... [52]

c. How many were to an optometrist?

OF TIMES TO OPTOMETRIST ..... [54]

D12. When was the last time you went for eye care?

WITHIN PAST 12 MONTHS ..... 1 [56]
1-2 YEARS 2
3-5 YEARS 3
MORE THAN 5 YEARS 4
NEVER ..... (GO TO D13) 5
DK 8

a. What was the main reason for your last visit for eye care?

ROUTINE CHECK-UP ..... 01 [57]
GLASSES/CONTACT LENS RELATED 02
ACUTE/SHORT-TERM PROBLEM 03
CHRONIC/LONG-TERM PROBLEM 04
SURGERY OR AFTER CARE 05
FAILED VISION TEST 06
FAILED GLAUCOMA TEST 07
OTHER ..... (SPECIFY) 08
DK 98

SPECIFY: _____ [59]

ID _ _ - _ _ - _ _ - _ _

DECK 06

c. What prevented you from going for care? Was it because (READ CATEGORIES)?

	YES	NO	RF	DK	
It costs too much?	1	2	7	8	13
You didn't know where to go?	1	2	7	8	14
You didn't have a way to get there?	1	2	7	8	15
There wasn't an eye care professional or center close enough?	1	2	7	8	16
It was too difficult to get an appointment?	1	2	7	8	17
Office hours were not convenient?	1	2	7	8	18
You didn't think the problem was serious enough?	1	2	7	8	19
Any other reason? ..... (SPECIFY)	1	2	7	8	20

SPECIFY: _____ [ ] 21

D14. During the past 3 years, how many times did you purchase a new pair of glasses or contact lenses?

NUMBER OF TIMES ..... [ ] 23

IF 00, GO TO SECTION E.

a. How much have you spent on glasses and contact lenses in the past three years?

DOLLAR AMOUNT ..... $[ ] 25

ID __ __ - __ __ - __ __ - __ __

SECTION E: Medications

Now, I'd like to ask you some questions about different medications that you may be using now or may have used in the past.

DECK 08

E1. Have you ever taken aspirin or aspirin containing drugs, not including Tylenol, etc., on a regular basis for a month or more?

YES 1
NO ..... (GO TO E2) 2
DK ..... (GO TO E2) 8

29

a. On the average how many aspirin did you take per week?

PILLS 30

b. How many months did you take (it/them) regularly?

MONTHS 32

c. Are you taking aspirin or aspirin containing drugs now?

YES 1
NO 2
DK 8

35

d. Why were you taking (it/them)?

DESCRIBE EACH: _____ 36

_____ 38

E2. Have you ever taken an anti-inflammatory drug on a regular basis for a month or more? These include ibuprofen, naprosyn and others. Please include both prescription and non-prescription drugs.

YES 1
NO ..... (GO TO E3) 2
DK ..... (GO TO E3) 8

40

a. On the average how many pills did you take per week?

PILLS 41

b. How many months did you take (it/them) regularly?

MONTHS 43

c. Are you taking any of these drugs now?

YES 1
NO 2
DK 8

46

d. Why were you taking (it/them)?

DESCRIBE EACH: _____ 47

_____ 49

E3. Have you ever taken steroids, such as prednisone, on a regular basis for a month or more?

YES 1
NO ..... (GO TO E4) 2
DK ..... (GO TO E4) 8

51

a. On the average how many pills did you take per week?

PILLS 52

b. How many months did you take (it/them) regularly?

MONTHS 54

ID __ __ - __ __ - __ __ - __ __

DECK 08

c. Are you taking steroids now? YES ..... 1 NO ..... 2 DK ..... 8 | 57

d. Why were you taking (it/them)?

DESCRIBE EACH: _____ | 58

_____ | 60

E4. Have you ever taken medicines for high blood pressure, such as lasix, reserpine, aldomet, HCTZ, inderal or others, on a regular basis for a month or more? YES ..... 1 NO ..... (GO TO E5) ..... 2 DK ..... (GO TO E5) ..... 8 | 62

a. Are you taking pills for high blood pressure now? YES ..... 1 NO ..... 2 DK ..... 8 | 63

E5. Have you ever taken medicines for heart disease, such as digoxin, isordil, nitroglycerine or others, on a regular basis for a month or more? YES ..... 1 NO ..... (GO TO E6) ..... 2 DK ..... (GO TO E6) ..... 8 | 64

a. Are you taking pills for heart disease now? YES ..... 1 NO ..... 2 DK ..... 8 | 65

E6. Have you ever taken medicines for poor circulation, such as vasodilan or others, on a regular basis for a month or more? YES ..... 1 NO ..... (GO TO SECTION F) ..... 2 DK ..... (GO TO SECTION F) ..... 8 | 66

a. Are you taking pills for poor circulation now? YES ..... 1 NO ..... 2 DK ..... 8 | 67

ID __ __ - __ __ - __ __ - __ __

SECTION G: Tobacco/Alcohol

DECK 09

G1. I'd like now to ask about smoking and drinking of alcoholic beverages. Have you ever smoked more than 100 cigarettes (5 packs) in your entire life?

YES ..... 1 [28]
NO ..... (GO TO G2) 2
DK ..... (GO TO G2) 8

a. How old were you when you first started smoking cigarettes regularly?

AGE ..... [__] [29]

b. On the average for the entire time you smoked, how many cigarettes did you smoke per day?
20 CIG = 1 PACK

PER DAY ..... [___] [31]

c. Did you ever stop smoking for a year or more and then start again?

YES ..... 1 [34]
NO ..... (GO TO e) 2
DK ..... (GO TO e) 8

d. For how many years did you stop?

YEARS ..... [__] [35]

e. Do you smoke cigarettes now?

YES ..... (GO TO G2) ..... 1 [37]
NO 2

f. How old were you when you stopped?

YEARS ..... [__] [38]

G2. The next questions are about alcoholic beverages such as beer, wine, and liquor. During the past month, on about how many different days did you drink any alcoholic beverage?

DAYS ..... [__] [40]
NONE ..... (GO TO G3) 00

a. On the days that you drink, how many drinks do you have on the average day?

DRINKS/BEERS/GLASSES OF WINE ..... [__] [42]

Pint = 16 oz.
Quart = 32 oz.

1 oz. liquor = 8 oz beer = 6 oz. wine = 1 drink

1 pint liquor = 16 drinks
1 quart beer = 4 beers
1 bottle wine = 6 glasses

b. Now think back over the past month and remember the time you had the most to drink. About how many drinks did you have at that time?

DRINKS/BEERS/GLASSES OF WINE ..... [__] [44]

c. During the past month, about how many days did you have 5 or more drinks?

DAYS ..... [__] [46]

ID ___-___-___-___

DECK 09

d. Nowadays, what do you usually drink? READ CATEGORIES.

Wine 1 (48)
Beer 2
Liquor 3
Combinations 4
DK 8

e. Are you currently drinking more, less or about the same amount as you were ten years ago?

MORE ..... (GO TO SECTION H) 1 (49)
LESS ..... (GO TO SECTION H) 2
SAME AMOUNT ..... (GO TO SECTION H) 3
DK ..... (GO TO SECTION H) 8

G3. Was there a time in the past when you drank any alcoholic beverages or have you always been a non-drinker?

NON-DRINKER 1 (50)
DRINKER IN PAST 2
DK 8