The Glaucoma Symptom Scale

A Brief Index of Glaucoma-Specific Symptoms

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Objective: To develop a brief symptom survey specific for persons with glaucoma, the Glaucoma Symptom Scale (GSS).

Design: Cross-sectional study of symptoms, functional impairment, and vision-targeted health-related quality of life among persons with glaucoma.

Patients: A sample of 147 persons with glaucoma among a broad range of treatment categories from 4 tertiary care glaucoma centers and 44 persons without eye disease enrolled from the same 4 centers.

Main Outcome Measures: Participants completed a modified version of the Ocular Hypertension Treatment Study 10-item symptom checklist. Participants also completed 2 vision-specific measures, the National Eye Institute Visual Function Questionnaire and the VF-14. Participants underwent a clinical evaluation, including ocular and medical history, dilated ophthalmic examination, and Humphrey 24-2 automated visual field testing.

Results: The GSS has 2 underlying domains that demonstrate sufficient internal consistency reliability for between-group comparisons. The GSS discriminates well between persons with and without glaucoma. Additionally, tests of association with clinical markers of glaucoma severity support the clinical validity of the measure and tests of association with established vision-targeted measures provide evidence of construct validity.

Conclusion: The simplicity, brevity, and psychometric properties of the GSS support its use in clinical practice and research to quantify symptoms in patients with glaucoma and to assist in investigations concerning the effect of glaucoma and treatments.


MORE THAN 1 million patients in the United States alone are being treated for chronic forms of glaucoma. The goal of treatment is to forestall deterioration of the traditional clinical end points of visual acuity and visual field. These parameters of functional loss are widely accepted and are regularly monitored in clinical settings. There is also a general awareness among ophthalmologists and patients with glaucoma that both disease progression and glaucoma treatments carry a burden of both nonvisual and visual symptoms and that these symptoms are of considerable concern to patients. However, such symptoms are often haphazardly monitored. This may be because symptoms as a clinical end point have been difficult to reproducibly quantify. Indeed, there is a dearth of published surveys affording a quantitative measurement of glaucoma-specific ocular symptoms.

This study introduces such a survey, the Glaucoma Symptom Scale (GSS). It consists of a 10-item scale developed from a modified version of a symptom checklist that was created for the Ocular Hypertension Treatment Study (OHTS). All items in the GSS address ocular complaints, some of a nonvisual nature and some of a visual nature, common to patients with glaucoma. In this report, we describe the development of the GSS and its psychometric properties among patients with glaucoma across a broad range of disease severity and treatment categories.

RESULTS

PATIENT POPULATION

Among both the glaucoma and reference group, 60% of participants were women. African Americans comprised 36% of the glaucoma group and 43% of the reference group. The average age of patients with glaucoma was 64 years and of reference group par-
SUBJECTS AND METHODS

STUDY DESIGN AND POPULATION

A prospective sample of patients with glaucoma and reference group patients who met eligibility criteria were enrolled from 4 university-based ophthalmology practices between June 1995 and January 1996. Participants were approached at the time of regularly scheduled visits. Eligible participants had to be at least 18 years old and had to speak English. They had to have adequate cognition, as assessed with an abbreviated form of the Folstein Mini-Mental State Examination, and adequate hearing to participate in an interview. The enrollment strategy sought to balance participants by age groups, gender, and race. Patients with glaucoma were recruited to represent the full spectrum of treatment modalities. Patients in the reference group who had no underlying vision problems except for correctable refractive error were enrolled from the same practices as the patients with glaucoma. The recruitment of patients with glaucoma from 4 treatment modalities is the reason there are 4 times as many patients with glaucoma as reference patients. Ophthalmologic eligibility criteria for the patients with glaucoma and for the reference group have been previously described. The research protocol was approved by all appropriate institutional review boards and participants gave written informed consent prior to enrollment.

DATA COLLECTION

To minimize possible bias from either good or bad news at the visit perturbing the participants’ perception of symptoms, patients completed all questionnaires before seeing the ophthalmologist.

Surveys

Participants were asked to complete self-administered versions of the GSS, the National Eye Institute Vision Function Questionnaire (NEI-VFQ), and the VF-14. Subjects were given oral instructions prior to completing the questionnaires. If a patient asked for help, the research interviewer was instructed to read each question verbatim as it was printed and to record the responses. Approximately 30% of the patients with glaucoma and none of the reference group patients required some assistance in completing the surveys. Variance estimates across the 2 modes of administration were similar for scale scores. To avoid a response-order bias, surveys were randomly ordered within each enrollment packet.

The GSS is a modified version of the OHTS symptom checklist (Figure). The OHTS symptom checklist was developed by the investigators of the OHTS. The checklist was designed to assess the side effects of a topical ocular hypotensive agent in a clinical trial of treatment for ocular hypertension. The items include 10 ocular complaints that are often associated with treatments for glaucoma: burning/smarring/stinging, tearing, dryness, itching, soreness/tiredness, feeling of something in the eye, blurry/dim vision, hard to see in daylight, hard to see in dark places, and halos around lights. The first 6 items consist of nonvisual ocular symptoms, whereas the last 4 items consist of visual ocular complaints. In the original OHTS symptom scale, each item consists of a yes/no response choice for the presence of the specific symptom within the past 4 weeks. The 10 items of the checklist query each eye separately. For this investigation, 2 of us (M.G. and C.M.M.) modified the OHTS scale response set by adding a 4-level bothersome scale for those who reported having a given symptom. For each eye, a 5-level score is generated, ranging from 0 (complaint present and very bothersome) to 4 (complaint absent). This score is then transformed to a 0 to 100 scale, with 0 representing presence of a very bothersome problem and 100 representing absence of a problem. The final GSS score is an unweighted average of the responses to all 10 items, averaged between the 2 eyes. Scores can be generated for each eye individually also. Final GSS subscale scores are an unweighted average of all items that comprise the particular subscale, averaged between the 2 eyes. Both parametric and nonparametric analyses were performed to account for the possibility that the points on the ordinal GSS scale may not be equidistant; because statistical results are similar with both types of analyses, only parametric results are reported.

The NEI-VFQ is a vision-targeted survey that assesses the influence of visual disability on health-related quality of life. It has been previously shown to be reliable and valid among persons with glaucoma. The content of the 51-item NEI-VFQ Field Test Version was derived from condition-specific focus groups. The NEI-VFQ subscales include overall vision, difficulty with near vision activities, difficulty with distance vision activities, limitations in social functioning due to vision, role limitations due to vision, dependency due to vision, mental health symptoms due to vision, driving difficulties, limitations with peripheral vision, difficulty with tasks requiring color vision, and pain or discomfort in or around the eyes. Additionally, the NEI-VFQ includes a pair of general health and vision rating questions. Subscales are scored on a 0 to 100 scale where 0 represents the worst possible score and 100 represents the best.

The VF-14 is a survey designed to study outcomes after cataract surgery. This questionnaire assesses difficulty with 14 vision-targeted activities, which range from reading prints of various sizes to driving. Items are scored from 0 (unable to do activity) to 5 (no difficulty), transformed to a 0 to 100 scale, and averaged to generate a score.

Clinical Evaluation

Each participant was asked to report current eye diseases and history of ophthalmic surgeries. Participants also completed a 16-item medical comorbidity checklist taken from the Medical Outcomes Study. A comprehensive dilated ophthalmologic examination was performed. Early Treatment Diabetic Retinopathy Study (ETDRS) standards for visual acuity were measured for each eye while patients were wearing their current, or “walking about,” correction. Further details of the examination have been previously described.

Participants was 49 years. The differences in race (P<.05) and in age (P<.01) were statistically significant. Patients with glaucoma had similar levels of medical comorbidity as those in the reference group (P<.21). As would be expected, patients with glaucoma had significantly poorer ETDRS and AGIS scores than persons in the reference group (Table 1).

Among those with glaucoma, 35% were taking medications only, 13% were not receiving medications (but had
Visual Field

Data from automated perimetry using the Humphrey 24-2 or 30-2 autoanalyzer were obtained within 6 months of the study enrollment. Advanced Glaucoma Intervention Study (AGIS) scores were calculated for each eye based on the mean deviation plot from the Humphrey 24-2 and 30-2 visual fields. AGIS scores represent the number and depth of depressed visual field sites found in less than 5% of normal values, and represent an index for quantifying visual field defects for the entire eye. AGIS scores can range from 0, indicating no defects, to 20, indicating near or complete visual field loss. AGIS scores are calculated from points awarded to 3 areas: the upper field, the lower field, and the nasal area. A maximum of 9 points can be awarded to the upper and lower fields, while the nasal area can be awarded a maximum of 2 points.

STATISTICAL ANALYSIS

Description of the Study Population

Univariate tests of association were used to compare persons with glaucoma with the reference participants. The statistical significance of observed between-group differences in demographic characteristics was evaluated with Student t tests for continuous variables and χ² tests for discrete variables. The statistical significance of differences in median ETDRS visual acuities for the persons with glaucoma vs those in the reference group was evaluated with Wilcoxon signed rank tests. The statistical significance of differences in mean AGIS scores was assessed with Student t tests.

Factor Analysis

The GSS consists of 6 items that identify nonvisual ocular symptoms (such as dryness or itching) and 4 items that identify visual ocular symptoms (such as difficulty seeing in dark places or halos around lights). To confirm the impression that the items in the GSS form 2 independent clinically meaningful domains, factor analysis using maximum likelihood solutions on a 2-common factor model was performed. Pearson correlations were calculated between the 2 factors and the 10 items of the GSS.

Discriminant Validity

Three comparisons between the glaucoma and the reference groups were performed to determine whether the items and summary scores from the GSS could discriminate between patients with and without glaucoma, as tests of between-group validity. The first comparison examined the significance of between-group differences in positive endorsement of each of the 10 items with χ² tests. The second comparison assessed the statistical significance of unadjusted between-group differences in overall and subscale GSS scores with Student t tests. The third comparison evaluated the statistical significance of adjusted between-group differences with multivariate linear regression to account for other factors that may influence the overall and subscale GSS scores. These factors included age, gender, race, and medical comorbidities. Additionally, because the primary issue of interest is the influence of glaucoma and its treatments on the GSS scores, these multivariate models also included variables for cataract and prior cataract surgery in 1 or both eyes; although patients known or suspected to have a cataract with a Lens Opacities Classification System II grading of 2 or greater were excluded from the survey phase of the study, 5% of participants with glaucoma had a grade 2 cataract in at least 1 eye, discovered only after study enrollment. Because presence of cataract among these few participants did not significantly change the GSS scores, we choose to retain them in the sample.

Clinical Validity

Clinical experience suggests that the visual functional loss intrinsic to glaucoma is a main component causing self-reported visual symptoms (such as blurriness), but not a contributor to self-reported nonvisual ocular symptoms (such as burning or dryness). To provide support for the clinical validity of each of the GSS subscales, Spearman correlations were performed between the 2 GSS scales and clinical measures of visual function. The expectation is that worse functional loss from disease would be associated with greater severity of visual symptoms, but would not be associated with nonvisual ocular symptoms. The clinical parameters of glaucomatous functional loss were ETDRS visual acuity and AGIS visual field scores in the better and the worse eye.

Construct Validity

The GSS consists of 2 subscales, one that identifies nonvisual ocular symptoms and one which identifies visual ocular symptoms. The former measures symptoms in and around the eye, unrelated to the visual function of the eye. The latter measures symptoms of visual disturbance, unrelated to the nonvisual sensations experienced by the eye. The expectation is that the nonvisual symptom subscale of the GSS would correlate well with the NEI-VFQ ophthalmic pain subscale, which assesses the impact of pain or discomfort in and around the eye. Similarly, the expectation is that the visual symptom subscale of the GSS would correlate well with, for example, the NEI-VFQ distance vision subscale, which assesses difficulty with activities requiring distance vision, or with the VF-14, which assesses difficulty with visual activities. Therefore, to confirm the construct validity of the GSS subscales, Spearman correlation coefficient R was calculated between each GSS subscale and each subscale of the NEI-VFQ and the VF-14, respectively.

Reliability

To determine whether the GSS has sufficient reliability for group comparisons, the Cronbach coefficient α was calculated. This measure of internal consistency was determined for each GSS subscale.

received either a laser trabeculoplasty or a trabeculectomy, 20% were taking medications and had received a laser trabeculoplasty, and 32% were taking medications and had received a trabeculectomy. Of the patients with glaucoma, 81% were taking a topical β-blocker, 21% were taking dipivefrin hydrochloride, 33% were taking pilocarpine hydrochloride, 6% were taking apraclonidine hydrochloride, and 27% were taking an oral carbonic anhydrase inhibitor.
As expected, a larger percentage of the glaucoma group positively endorsed each of the 10 ocular complaints of the GSS than reference group individuals (Table 2). This difference was significant \((P < .05)\) for 7 of the 10 survey items: burning/smarting/stinging, soreness/tiredness, feeling of something in the eye, blurry/dim vision, hard to see in daylight, hard to see in dark places, and halos around lights.

CONFIRMATORY FACTOR ANALYSIS OF UNDERLYING GSS CONSTRUCTS

The GSS includes 6 nonvisual ophthalmic symptoms (SYMP-6): burning/smarting/stinging, tearing, dryness, itching, soreness/tiredness, and feeling of something in the eye. It also includes 4 visual ophthalmic symptoms (FUNC-4): blurry/dim vision, hard to see in daylight, hard to see in dark places, and halos around lights. Pearson correlations of the GSS items and the 2 factors generated by maximum likelihood solutions on a 2-common factor model established that these clinically meaningful empirical item groupings truly represent 2 underlying constructs (Table 3). The items that comprise SYMP-6 had moderate to high correlations with factor 1 and had consistently higher correlations with factor 1 than with factor 2, indicating that these items grouped well with a single underlying domain. The items that comprise FUNC-4 had moderate to high correlations with factor 2 and had consistently higher correlations with factor 2 than with factor 1, indicating that these items grouped well as a separate domain or construct.

DISCRIMINANT VALIDITY

In both unadjusted and adjusted analyses, persons with glaucoma complained of significantly greater nonvisual ocular symptoms, as measured by SYMP-6, and noted significantly greater visual ocular symptoms, as measured by FUNC-4, than their reference group counterparts \((P < .05)\). Both unadjusted and adjusted differences in SYMP-6 and FUNC-4 were statistically significant \((P < .05)\) (Table 4). These data provide evidence of discriminant, or between-groups, validity for the GSS.10
Table 4. Comparison of Glaucoma Symptom Scale Scores for Patients With and Without Glaucoma*

<table>
<thead>
<tr>
<th></th>
<th>Glaucoma Group</th>
<th>Reference Group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYMP-6</td>
<td>78 (23)</td>
<td>85 (21)</td>
<td>.01</td>
</tr>
<tr>
<td>FUNC-4</td>
<td>63 (25)</td>
<td>88 (19)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Values are mean (SD). P value for comparison of glaucoma vs reference group for linear regression adjusted for age, sex, race, medical comorbidities, pseudophakia, and cataract. SYMP-6 and FUNC-4 are explained in the “Results” section in the text.

**CLINICAL VALIDITY**

As was hypothesized, analyses of those with glaucoma demonstrated that clinical measures of glaucomatous functional loss (visual acuity and visual field) were significantly correlated (P<.05) with severity of reported visual symptoms (FUNC-4), but were not significantly associated with reported nonsurgical ocular symptoms (SYMP-6). Spearman correlations of FUNC-4 and AGIS scores in the better and worse eye were −0.36 and −0.23, respectively; Spearman correlations of SYMP-6 and visual acuity in the better and worse eye were 0.20 and 0.25, respectively. In contrast, Spearman correlation of SYMP-6 and AGIS scores in the better and worse eye were −0.05 and −0.02, respectively; Spearman correlations of SYMP-6 and visual acuity in the better and worse eye were 0.01 and 0.04, respectively.

**CONSTRUCT VALIDITY**

Specific GSS subscales correlated with NEI-VFQ subscales designed to capture similar constructs (Table 5). Specifically, SYMP-6 correlated highly with the NEI-VFQ ocular pain subscale (Spearman R=0.65). As would be expected, correlations between SYMP-6 and the 10 remaining subscales of the NEI-VFQ, many of which probe the multidimensional influence of visual function on health-related quality of life, were much lower (Spearman R range, 0.18-0.45). In contrast, moderate to high correlations existed between FUNC-4 and these remaining 10 subscales of the NEI-VFQ (Spearman R range, 0.41-0.67). The correlation of FUNC-4 was highest with scales that assess difficulty with visual activity performance (distance, near, and general vision) (Spearman R=0.67 for each). SYMP-6 had a low correlation with the VF-14, a measure of visual task performance (Spearman R=0.33); FUNC-4 had a high correlation with the VF-14 (Spearman R=0.62). These findings provide evidence of construct validity for the GSS subscales.

**RELIABILITY**

The Cronbach coefficient α was .83 for SYMP-6 and 0.74 for FUNC-4. The internal consistency of each of these subscales is sufficient for group-to-group comparisons.12

**COMMENT**

This report introduces a self-administered questionnaire, the Glaucoma Symptom Scale (GSS), which quantitatively assesses ophthalmic symptoms common to patients with glaucoma. Such a scale is important because, although, as clinical experience suggests, chronic ocular symptoms are a major clinical issue to patients, the absence of standardized quantifiable methods of measurement has precluded accurate monitoring of such symptoms. In clinical and research settings, this absence is conspicuous. For example, in the recent randomized trials on the intraocular pressure response to the newest topical glaucoma medication, latanoprost, the arm that documents the adverse effects of these medications appears to consist of unstructured self-reporting by the study patients themselves.13-15 With inclusion of a standardized symptom scale with established reliability and validity, ophthalmologists and patients have the information needed to compare, with respect to the important clinical parameter of symptoms, treatment alternatives that are potentially equally as effective from a disease progression perspective.

Two characteristics of the GSS make it an ideal index for measuring symptoms in patients with glaucoma. The first characteristic is that the GSS is brief and simple. It consists of 10 items that query fundamental symptoms using a structured 5-choice response set. The first and only other published survey designed to assess symptoms in patients being treated for glaucoma is complex and, as indicated by its authors, intended to be administered with an interviewer.16

The second characteristic is that the GSS appears to be a valid and reliable measure across a broad range of treatment groups and disease severities. Confirmatory factor analysis supports that the GSS consists of 2 clinically meaningful underlying subscales: SYMP-6, which characterizes nonvisual ocular symptoms and FUNC-4, which characterizes visual symptoms. These subscales possess excellent discriminant validity between patients with and without glaucoma, clinical validity with traditional measures of visual function, construct validity with established measures designed to capture similar domains, and internal consistency reliability. Both

Table 5. Correlations Between the GSS and Established Vision-Targeted Surveys*

<table>
<thead>
<tr>
<th>Vision-Targeted Survey</th>
<th>SYMP-6</th>
<th>FUNC-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocular pain</td>
<td>0.65</td>
<td>0.38</td>
</tr>
<tr>
<td>Distant vision</td>
<td>0.36</td>
<td>0.67</td>
</tr>
<tr>
<td>Near vision</td>
<td>0.37</td>
<td>0.67</td>
</tr>
<tr>
<td>General vision</td>
<td>0.37</td>
<td>0.66</td>
</tr>
<tr>
<td>Role difficulties</td>
<td>0.45</td>
<td>0.57</td>
</tr>
<tr>
<td>Peripheral vision</td>
<td>0.36</td>
<td>0.54</td>
</tr>
<tr>
<td>Dependency</td>
<td>0.38</td>
<td>0.53</td>
</tr>
<tr>
<td>Emotion/well-being</td>
<td>0.38</td>
<td>0.53</td>
</tr>
<tr>
<td>Driving</td>
<td>0.26</td>
<td>0.51</td>
</tr>
<tr>
<td>Social functioning</td>
<td>0.26</td>
<td>0.50</td>
</tr>
<tr>
<td>Color vision</td>
<td>0.18</td>
<td>0.41</td>
</tr>
<tr>
<td>VF-14</td>
<td>0.33</td>
<td>0.62</td>
</tr>
</tbody>
</table>

*GSS indicates Glaucoma Symptom Scale (SYMP-6 and FUNC-4 are explained in the “Results” section in the text); NEI-VFQ, National Eye Institute Visual Function Questionnaire.
SYMP-6 and FUNC-4 discriminated well between persons with and without glaucoma in both unadjusted and adjusted comparisons, suggesting that the GSS is sensitive to the unique characteristics of symptoms associated with glaucoma and its treatments. Both SYMP-6 and FUNC-4 demonstrated expected correlations with clinical parameters of visual function and with established vision-targeted survey instruments that capture similar constructs, suggesting that each GSS subscale is a valid measure of what it is intended to measure. Both SYMP-6 and FUNC-4 demonstrate sufficiently high internal consistency, suggesting that the GSS has adequate reliability to be a useful measure of symptoms in settings where group level comparison will be made. 10

The study population used in this study was deliberately constructed to represent a full spectrum of disease severity and treatment modalities to simulate the entire breadth of glaucoma as a disease, as well as to optimize the process of scale development and testing. However, such a study population may not accurately represent a community-based setting, where populations of persons with glaucoma are likely to have milder disease and/or are likely to receive different treatments. In addition, since enrollment for this study, there may be wider acceptance of other treatment modalities, especially the topical medications dorzolamide and latanoprost. The authors do not know how changes in practice patterns and disease severity will alter the psychometric properties of the GSS.

The brevity and simplicity of the GSS suggests that it can serve as an efficient self-administered instrument. Although it cannot be determined whether the scale measures symptoms of glaucoma or symptoms of glaucoma treatment, the psychometric properties of the measure show that it provides a valid and reliable estimate of symptoms associated with glaucoma and its treatments. Therefore, the GSS should prove to be a valuable patient-centered tool for the assessment and comparison of symptoms experienced by patients with glaucoma, in both clinical and research settings. Inclusion of the GSS into routine clinical practice and future clinical trials can complement the data collected by more traditional tools such as tonometry or perimetry, by providing comparable symptom profiles across treatment modalities. And, ultimately, use of the GSS may help illuminate the quality of life experienced by persons with glaucoma. Further studies involving the use of the GSS will address these issues by investigating the influence of symptoms on vision-targeted health-related quality of life and by investigating the effect on symptoms by type of glaucoma treatment option.