Knowledge of Glaucoma Among Patients Attending Virtual and Face-to-Face Glaucoma Clinics

Andrew J. Tatham, MD, Ameer M. Ali, BSc, and Niamh Hillier, MBChB

ORIGINAL STUDY

Glauc...
Pavilion, Edinburgh, United Kingdom, was conducted in February and March 2020. All methods were reviewed by the institutional quality improvement committee, who deemed the study of a quality improvement project, and as such, research ethics committee approval was not required. All methods adhered to the tenants of the Declaration of Helsinki. Potential participants with a diagnosis of glaucoma were approached at the completion of their clinic visit and asked if they would be willing to complete the survey.

All participants had previously completed a comprehensive ophthalmic examination by their treating clinician (A.T.) to confirm the diagnosis and type of glaucoma. The same clinician was responsible for reviewing the results obtained in the virtual clinic. Assessment included slit-lamp examination, gonioscopy, Goldmann applanation tonometry, dilated fundoscopy, standard automated perimetry (SAP) using the 24-2 SITA Fast program of the Humphrey Field Analyzer (Zeiss Meditec Inc), and spectral-domain optical coherence tomography (Spectralis, Heidelberg Engineering) measurement of the circumpapillary retinal nerve fiber layer (RNFL). The treating physician determined the diagnosis of glaucoma based on the presence of a repeatable defect on SAP, in conjunction with glaucomatous changes noted to the optic nerve head or RNFL. Primary angle-closure glaucoma (PACG) was defined when patients had been noted at any point during monitoring to have ≥ 270 degrees of contact between the iris and pigmented trabecular meshwork on gonioscopy.

Testing in the virtual glaucoma clinic followed a standard operating procedure during which the patient was seen by a technician. A short medical history was taken followed by Goldmann applanation tonometer, optical coherence tomography of the RNFL and macula, and SAP. The patient then left the clinic and the information collected was reviewed by a clinician (A.T.) within 2 weeks who relayed the results to the patient by letter, or telephone if a potential change in management needed to be discussed. The standard operating procedure included a provision for urgent same-day assessment by a clinician if any patient was found to have an IOP > 30 mm Hg or large unexplained reduction in best-corrected visual acuity. No patients included in the study required an urgent same-day review. The patient letter, which was copied to the patient’s general practitioner, included information regarding diagnosis, medications, IOP, target IOP, whether the patient’s glaucoma was stable, and interval to next review.

Visits to the face-to-face clinic involved the same standard clinical tests; however, the patient was seen face-to-face by a clinician (A.T.) for a consultation before leaving the department. A summary letter similar to that provided to patients attending the virtual clinic was sent to all patients to their treating clinician (A.T.) to convey to the patient requested to answer true, false, or not sure to each. Statements include; “glaucoma tends to run in families,” “people over the age of 60 years are more likely to get glaucoma,” “eye pain is often a symptom of glaucoma,” and “vision lost from glaucoma can be restored.” The complete list of statements is shown in Table 1. Knowledge of glaucoma was summarized by the total score from the Eye-Q test, with a score of 10 indicating excellent knowledge. A previous study found patients with glaucoma achieved a mean score on the Eye-Q test of 7.3 ± 0.8. The test was administered by a medical student (A.A.) at the conclusion of the patient’s visit to either the face-to-face or virtual clinic. Patients were observed during the test to ensure that they did not confer or use the internet or written resources to aid their answers.

Patients were also asked what type of glaucoma they had been diagnosed with and given a list of 6 options including POAG, PACG, normal tension glaucoma, secondary glaucoma, congenital glaucoma, and “don’t know.” They were also asked how strongly they agreed with the statement “I am well informed about my condition” using a 5-item Likert scale ranging from strongly agree to strongly disagree. Patients were also asked if they would like to know more about glaucoma, with a simple yes or no response requested. Finally, patients were asked where they obtain information about glaucoma from the options of “during consultations with medical professionals,” “information leaflets,” “internet,” “online videos,” for example, YouTube, “news articles/magazines,” “posters,” “family and friends,” and “other.” If patients wished to receive more information about glaucoma, they would like this to be provided, given the options of “during consultations,” “leaflets,” “posters,” “educational videos,” “telephone advice,” “email,” “letters,” or “other.”

Statistical Analysis

Demographic and clinical characteristics of patients attending the virtual clinic and face-to-face clinics were compared using the 2 independent sample t test for normally distributed data and the Wilcoxon-Mann Whitney test for nonparametric data. The normality of data was assessed by inspection of histograms and by using the Shapiro-Wilk test. For categorical data, the Fisher exact test was used. The primary outcome was a comparison of total Eye-Q test scores between patients attending the virtual and face-to-face clinics. Responses to each of the 10 questions of the Eye-Q test were also examined.

Regression analyses were performed using pooled group data to examine possible relationships between Eye-Q test scores and virtual versus face-to-face clinic attendance, age sex, duration since diagnosis, visual field MD, education level, self-perception of being well informed about glaucoma, type of glaucoma, correct knowledge of diagnosis, and interest in knowing more about glaucoma. All statistical analyses were completed using STATA version 15.1; StataCorp LP, College Station, TX.
Of the 115 patients invited to participate, 105 agreed, representing a response rate of 91.3%. 50 patients were included from the virtual clinic and 55 from the face-to-face clinic. On average, patients attending the virtual clinic had less severe glaucoma with an MD in the better eye of $-4.7 \pm 4.9$ dB compared with $-11.5 \pm 8.6$ dB in those attending face-to-face clinics ($P < 0.001$). There was no significant difference in baseline demographics between groups (Table 1). A slightly higher proportion of patients attending the face-to-face clinic, compared with virtual clinic, reported strong agreement (20% vs. 14%, respectively) or agreement (56% vs. 32%, respectively) with the statement “I am well informed about my condition.” However, a higher proportion

| TABLE 1. Demographic and Clinical Characteristics, and Satisfaction and Glaucoma Knowledge Scores of Those Included in the Study |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | Virtual Clinic (N = 50) | Controls (N = 55) | P           |
| Age (y)         | 72.9 ± 12.1 (73, 68-80) | 68.8 ± 10.5 (71, 62-76) | 0.065      |
| Sex, female (n, %) | 20 (40%) | 30 (54.5%) | 0.136      |
| Duration since diagnosis (y) | 6.02 ± 5.15 (4.55, 2.68-8.44) | 8.05 ± 6.89 (5.79, 3.49-10.19) | 0.134      |
| Mean deviation in worse eye (dB) | $-4.7 \pm 4.9$ ($-3.8$, $-6.5$ to $-0.9$) | $-11.5 \pm 8.6$ ($-9.7$, $-16.5$ to $-4.3$) | $< 0.001$  |
| Type of glaucoma | POAG 46 (92%) | 52 (94.5%) | 0.670      |
|                  | PACG 4 (8%)  | 3 (5.5%)    | 0.911      |
| Education        | No qualifications 1 (2%) | 2 (3.6%) | 0.911      |
|                  | Basic schooling 19 (38%) | 19 (34.5%) | 0.911      |
|                  | Higher schooling 7 (14%) | 10 (18.2%) | 0.911      |
|                  | Vocational qualification 9 (18%) | 6 (10.9%) | 0.911      |
|                  | Undergraduate degree 8 (16%) | 8 (14.5%) | 0.911      |
|                  | Postgraduate degree 6 (12%) | 5 (9.1%) | 0.911      |
|                  | SA A U D SD SA A U D SD | 0 0 0 0 0 | 0.043      |
| I am well informed about my condition Correct type of glaucoma (yes) | 7 (14%) | 21 (42%) | 16 (32%) | 3 (6%) | 3 (6%) | 11 (20%) | 31 (56.4%) | 11 (20%) | 0 0 0 0 | 0.005      |
| Do you want to know more about glaucoma? (yes) | 37 (74%) | 29 (52.7%) | 0.005      |
| Eye-Q test score Correct Incorrect Do not know Correct Incorrect Do not know | 5.6 ± 1.0 (6, 5-7) | 6.0 ± 1.6 (6, 5-7) | 0.762      |
| 1. Glaucoma is more common in African Americans than Whites | 9 (18.6%) | 1 (2.1%) | 38 (79.2%) | 16 (32%) | 6 (12%) | 28 (56%) | 0.032      |
| 2. Glaucoma tends to run in families | 35 (72.9%) | 5 (10.4%) | 8 (16.7%) | 39 (76.5%) | 2 (3.9%) | 10 (19.6%) | 0.471      |
| 3. A person can have glaucoma and not know it | 42 (87.5%) | 1 (2.1%) | 5 (10.4%) | 48 (92.3%) | 1 (1.9%) | 3 (5.8%) | 0.735      |
| 4. People over the age of 60 years are more likely to get glaucoma | 31 (66.0%) | 7 (14.9%) | 9 (19.1%) | 36 (69.2%) | 7 (13.5%) | 9 (17.3%) | 0.955      |
| 5. Eye pain is often a symptom of glaucoma | 22 (46.8%) | 7 (14.9%) | 18 (38.3%) | 21 (41.2%) | 9 (17.6%) | 21 (41.2%) | 0.860      |
| 6. Glaucoma can be controlled | 45 (91.8%) | 1 (2.0%) | 3 (6.1%) | 47 (90.4%) | 0 (0%) | 5 (9.6%) | 0.596      |
| 7. Glaucoma is caused by increased eye pressure | 1 (2.0%) | 43 (87.8%) | 5 (10.2%) | 1 (2.0%) | 2 (3.9%) | 48 (94.1%) | 0.628      |
| 8. Vision lost from glaucoma can be restored | 32 (65.3%) | 2 (4.1%) | 15 (30.6%) | 34 (66.7%) | 7 (13.7%) | 10 (19.6%) | 0.150      |
| 9. A complete glaucoma examination consists only of measuring eye pressure | 40 (81.6%) | 4 (8.2%) | 5 (10.2%) | 38 (73.1%) | 13 (25%) | 1 (1.9%) | 0.026      |
| 10. People at risk for glaucoma should have an eye examination through dilated pupils | 19 (39.6%) | 7 (14.6%) | 22 (45.8%) | 33 (63.5%) | 2 (3.8%) | 17 (32.7%) | 0.028      |

Values shown include mean ± SD (median, interquartile range).
A indicates agree; D, disagree; dB, decibels; n, number; PACG, primary angle-closure glaucoma; POAG, primary open angle glaucoma; Q, question; SA, strongly agree; SD, strongly disagree; U, uncertain.
of patients attending the virtual clinic could correctly identify the type of glaucoma they had (74% vs. 52.7%; \( P = 0.005 \)) (Table 1). Those attending the virtual clinic had 3.3-fold higher odds (95% confidence interval, 1.44-7.56; \( P = 0.005 \)) to correctly identify the type of glaucoma they had, compared with those attending the face-to-face clinic.

Eye-Q test scores were similar between patients attending the virtual and face-to-face clinics, with mean scores of 5.6 ± 1.0 and 6.0 ± 1.6, respectively (\( P = 0.762 \)) (Fig. 1). Responses to individual questions are summarized in Figure 2. There was no difference between groups in correct responses to questions 2, 3, 4, 5, 6, 7, and 8. However, a higher proportion of patients attending the face-to-face clinic correctly answered questions 1 and 10, which relate to glaucoma being more common in African Americans compared with Whites and that people at risk of glaucoma should have an eye examination through dilated pupils. The questions most frequently answered incorrectly were 1, 5, and 7.
Regression analyses examining the potential impact on Eye-Q test scores of factors including clinic type, age, sex, duration since diagnosis, glaucoma severity (MD in the worse eye), education level, self-perception of being well informed about glaucoma, type of glaucoma, correct knowledge of type of glaucoma, and interest in knowing more about glaucoma, found only education level, and correct knowledge of type of glaucoma were significant (Table 2).

Participants with no or basic school qualifications (n = 41) had a mean Eye-Q test score of 5.4 ± 1.7 (IQ range, 4 to 7), compared with 5.7 ± 2.0 (IQ range, 5 to 7) for those with higher-level school qualifications (n = 30) and 6.6 ± 1.4 (IQ range, 6 to 7) for those with university qualifications (n = 30) (Fig. 3). There was no significant difference in test score between those with no or basic school qualifications and those with higher-level school qualifications (P = 0.5663), however, those with university qualifications scored significantly higher than those with no or basic school qualifications (P = 0.003) and higher-level school qualifications (P = 0.038). Table 3 shows the sources of information from which patients reported receiving information about glaucoma and preferred sources of future information. The most popular sources of information about glaucoma, in both virtual and face-to-face clinics, was from health care professionals during consultations, (n = 25, 71.4%) and face-to-face clinics (n = 30, 73.2%). Fewer patients in virtual clinic reported using information leaflets and information leaflets and books compared with face-to-face clinic (n = 13, 26%) respectfully (Table 3).

There was no difference in the proportion of patients wanting to know more about glaucoma between groups (70% for virtual clinic compared with 73.2% face-to-face clinic attendance, P = 0.658). Approximately one third of patients expressed a preference for email provision of information. Although 32% of patients reported having used the internet as a source of information previously, <1% of patients reported using the International Glaucoma Association (Glaucoma, United Kingdom) website as a source of information despite this being advertised in the information leaflets and on posters in the hospital.

**DISCUSSION**

The purpose of this study was to examine knowledge of glaucoma among patients attending virtual compared with face-to-face glaucoma clinics to test the hypothesis that patients attending virtual clinics may be less well informed about their disease because of less face-to-face time with a clinician. However, in contrast to this hypothesis, we found no significant difference in knowledge scores between groups, suggesting that patients’ knowledge is not disadvantaged by virtual review. Similar levels of knowledge between groups also suggest, though are no guarantee of, similar levels of patient engagement and provide evidence to support the use of teleophthalmology clinics for monitoring patients with low-risk glaucoma. The results support the findings of Court and Austin, who also found no difference in knowledge of glaucoma between patients attending...
virtual and traditional clinics. However, to the best of our knowledge, the present study is the first to compare the knowledge of glaucoma among these groups using a validated and glaucoma-specific questionnaire.

Overall, mean knowledge scores were 5.6 ± 1.0 and 6.0 ± 1.6 among patients attending virtual and face-to-face clinics, respectively (P = 0.0762). Although these results demonstrate comparability between groups, scores were lower than obtained by patients enrolled in the Eye-Q test validation study, which reported a mean score of 7.3 ± 0.8. Comparison between studies is difficult given differences in the characteristics of participants. For example, a large proportion of patients in the validation study had undergone previous glaucoma surgery, which may have influenced the understanding of glaucoma. The validation study also included only 12 participants so is liable to be influenced by the responses of individual patients with particularly high or low knowledge scores. Nevertheless, there is considerable room for improved knowledge scores, suggesting that not enough emphasis is placed on providing patients with information about glaucoma, regardless of whether they are attending a virtual or face-to-face clinic. The observation that almost 3-quarters of patients attending both clinic types wanted to know more about glaucoma also suggests that current levels of provision of information are inadequate.

The present study also revealed a discrepancy between self-perceived understanding of glaucoma and knowledge scores. Although knowledge scores were comparable between those attending virtual and face-to-face clinics, patients’ self-perceived understanding of their condition was higher in the face-to-face clinic group. This also contrasted with the finding that significantly more patients in the virtual glaucoma clinic were able to correctly identify their glaucoma diagnosis, suggesting that patients reviewed in the virtual clinic may lack confidence, or trust in their own knowledge, perhaps because of a lack of positive reinforcement provided by a face-to-face consultation with their treating ophthalmologist. Qualitative research into patients’ experience of a glaucoma virtual clinic has emphasized the importance of trust in the patient-care provider relationship as a key theme in patients’ confidence in the virtual clinic model.

We examined factors that may be associated with knowledge of glaucoma and found only education level and correct knowledge of the type of glaucoma were significant. Eye-Q test scores were higher in those with higher levels of schooling, with patients with university qualifications obtaining significantly higher scores than those with no or basic school qualifications and higher-level school qualifications. Patients who were able to correctly identify the type of glaucoma they had also achieved higher scores. The difference in glaucoma knowledge among patients with different levels of education suggests that glaucoma education may need to be tailored to individual patients or that different methods of engaging patients with educational materials are needed. It was interesting to observe that a higher proportion of patients attending the virtual clinic were able to correctly identify which type of glaucoma they had. A possible explanation is that this information was included in the summary letter sent to the patient after their virtual clinic visit; however, the same information was provided to patients attending the traditional face-to-face clinics.

Our exploration of where patients obtained information about glaucoma revealed that the most commonly reported source of prior information was during consultations as a source of information likely reflected consultations before enrollment in the telemedicine service or information gained from telephone consultations subsequent to enrollment. A smaller proportion of patients attending the virtual clinic reported information leaflets as a prior source of information, suggesting that more needs to be done to make written information available. Patients expressed a preference for future information to be provided during consultations, with over 70% in each group listing this as a preferred method, which presents a challenge for virtual clinics. Our standard method of informing patients of results was by letter, if no changes to treatment were deemed necessary, or by telephone, if there was a change in treatment indicated. Importantly, no patients in either the virtual clinic or face-to-face clinic groups expressed a preference for information by telephone. The reasons for this are not clear but may be because of patients having hearing or other communication difficulties. New technologies such as phone or web-based video communication technologies, which have become increasingly utilized during the COVID-19 pandemic, may offer a better alternative, and although we defined the traditional clinic format as face-to-face, these technologies also provide a type of face-to-face consultation. Further studies are needed to explore the most effective methods of communication for asynchronous teleophthalmology services.

The study has several limitations, including the choice of the questionnaire. The Eye-Q test is tailored toward patients in the United States, particularly the question “glaucoma is more common in African Americans than Whites.” It is perhaps not surprising that a large proportion of our Scottish cohort (79.2% of the virtual clinic and 56% of face-to-face clinic patients) responded “don’t know” to this question, highlighting that questionnaires developed and validated in one population may need to be adapted for use in others. In addition, the study included only a small number of patients with PACG, meaning it was not possible to examine whether glaucoma knowledge was influenced by the type of glaucoma. Patients attending the face-to-face clinics also had worse baseline MD than those attending the virtual clinic. This is a potential source of bias as although we found no relationship between disease severity and glaucoma knowledge, this analysis was potentially confounded by those with more severe disease attending the face-to-face clinics. This also reflects the use of virtual clinics for monitoring low-risk patients. It is also important to acknowledge that patients attending virtual clinics had previously been seen in face-to-face clinics, and their knowledge of glaucoma may have been gained from prior face-to-face interactions. For this reason, we included patients whose previous 2 visits had been in the virtual clinic; nevertheless, it would be interesting to determine whether knowledge of glaucoma changes over time differently among those attending face-to-face and virtual clinics. Unfortunately, we were not able to record the number of face-to-face visits each patient had attended before transfer to the virtual clinic, as some patients had been seen by other providers before referral to our institution. Though there was no relationship between the duration since diagnosis and glaucoma knowledge scores, it is possible that the number of provider-patient interactions may be a better indicator of opportunity for patient education and thus patient knowledge. Similarly, we were not able to capture information about the duration of face-to-face visits and the proportion of time spent answering patients’ questions or...
providing patient education, which is highly likely to influence the degree of patient engagement and knowledge of their disease.

In conclusion, this study found no significant difference in knowledge of glaucoma among patients attending virtual and face-to-face glaucoma clinics. Nevertheless, among both groups of patients, significant gaps in knowledge were identified, and most patients desired to know more about their condition, indicating not enough is being done to provide information to patients. As the understanding of the disease is important to better engage patients in managing chronic diseases such as glaucoma, it is essential that methods of patient education are incorporated into the design of glaucoma services. New communication technologies provide an opportunity for a renewed focus on patient education.

REFERENCES
1. Tham YC, Li X, Wong TY, et al. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. Ophthalmology. 2014;121:2081–2090.
2. Tuck MW, Crick RP. The projected increase in glaucoma due to an ageing population. Ophthalmic Physiol Opt. 2003;23:175–179.
3. Gunn PJG, Marks JR, Au L, et al. Acceptability and use of glaucoma virtual clinics in the UK: a national survey of clinical leads. BMJ Open. Ophthalmology. 2018;3:e000127.
4. Hark LA, Myers JS, Ines A, et al. Philadelphia Telemedicine Glaucoma Detection and Follow-up Study: confirmation between eye screening and comprehensive eye examination diagnoses. Br J Ophthalmol. 2019;103:1820–1826.
5. Clarke J, Puertas R, Kotecha A, et al. Virtual clinics in glaucoma care: face-to-face versus remote decision-making. Br J Ophthalmol. 2017;101:892–895.
6. Vass C, Him C, Sycha T, et al. Medical interventions for primary open angle glaucoma and ocular hypertension. Cochrane Database Syst Rev. 2004;3.
7. Haynes RB, McDonald HP, Garg AX. Helping patients follow prescribed treatment: clinical applications. JAMA. 2002;288:2880–2883.
8. Nordstrom BL, Friedman DS, Mozaffari E, et al. Persistence and adherence with topical glaucoma therapy. Am J Ophthalmol. 2005;140:598–606.
9. Kosoko O, Quigely HA, Vitale S, et al. Risk factors for noncompliance with glaucoma follow-up visits in a residents’ eye clinic. Ophthalmology. 1998;105:2105–2111.
10. Olthoff CM, Schouten JSAG, van de Borne B, et al. Noncompliance with ocular hypotensive treatment in patients with glaucoma or ocular hypertension an evidence-based review. Ophthalmology. 2005;112:953–961.
11. Tsai IC. A comprehensive perspective on patient adherence to topical glaucoma therapy. Ophthalmology. 2009;116(suppl 11):S30–S36.
12. Blondeau P, Carbonneau M, Esper P, et al. A 2-hour information session and patient recall has minimal impact on glaucoma-treatment persistence in a mature practice. J Glaucoma. 2012;21:379–382.
13. Chen X, Chen Y, Sun X. Notable role of glaucoma club on patients’ knowledge of glaucoma. Clin Exp Ophthalmol. 2009;37:590–594.
14. Muir KW, Staniago-Turla C, Steinmett SS, et al. Health literacy and adherence to glaucoma therapy. Am J Ophthalmol. 2006;142:223–226.
15. Jueych MS, Randhawa S, Shukairy A, et al. Functional health literacy in patients with glaucoma in urban settings. Arch Ophthalmol. 2008;126:718–724.
16. Peralta E, Muir KW, Rosdahl JA. Systematic review of knowledge assessments for glaucoma patients. Semin Ophthalmol. 2018;33:377–388.
17. Gray TA, Fenerty C, Harper R, et al. Preliminary survey of educational support for patients prescribed ocular hypotensive therapy, Eye (Lond). 2010;24:1777–1786.
18. Hoevenaars JG, Schouten JSAG, van den Borne B, et al. Knowledge base and preferred methods of obtaining knowledge of glaucoma patients. Eur J Ophthalmol. 2005;15:32–40.
19. Rao VS, Peralta EA, Rosdahl JA. Validation of a glaucoma knowledge assessment in glaucoma patients. Clin Ophthalmol. 2016;10:1913–1918.
20. Rosdahl JA, Muir KW. Finding the best glaucoma questionnaire: a qualitative and quantitative evaluation of glaucoma knowledge assessments. Clin Ophthalmol. 2015;9:1845–1852.
21. Court JH, Austin MW. Virtual glaucoma clinics: patient acceptance and quality of patient education compared to standard clinics. Clin Ophthalmol. 2015;9:745–749.
22. Kotecha A, Bonstein K, Cable R, et al. Qualitative investigation of patients’ experience of a glaucoma virtual clinic in a specialist ophthalmic hospital in London, UK. BMJ Open. 2015;5:e009463.