

## **A technician-led ‘virtual clinic’ for triaging low risk glaucoma referrals**

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**Conflict of interest.**

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## **Abstract**

**Background:** We describe the outcomes of a technician-delivered glaucoma referral triaging service with ‘virtual review’ of resultant data by a consultant ophthalmologist.

**Methods:** The Glaucoma Screening Clinic reviewed new optometrist or GP-initiated glaucoma suspect referrals into the a specialist ophthalmic hospital. Patients underwent testing by two ophthalmic technicians and 1 healthcare assistant in a dedicated clinical facility. Data were reviewed at a different time and date by a consultant glaucoma ophthalmologist. Approximately 10% of discharged patients were reviewed in a face-to-face consultant led clinic to examine the false negative rate of the service.

**Results:** Between 1 March 2014 and 31 March 2016, 1380 patients were seen in the clinic. The number of patients discharged following consultant virtual review was 855 (62%). The positive predictive value of onward referrals was 84%. Three of the 82 patients brought back for face-to-face review were deemed to require treatment, equating to negative predictive value of 96%.

**Conclusions:** Our technician-delivered glaucoma referral triaging clinic incorporates consultant ‘virtual review’ to provide a service model that significantly reduces the number of onward referrals into the glaucoma outpatient department. This model may be an alternative to departments where there are difficulties in implementing optometrist-led community-based referral refinement schemes.

## Introduction

Glaucoma is the leading cause of irreversible blindness worldwide, {Tham, 2014 #2200} and once diagnosed requires lifelong monitoring. The disease is more prevalent with advancing age, and with our increasingly aging population, {ONS, #1785} the number of glaucoma cases is only set to increase. {Tuck, 2003 #1086}

In 2009, the National Institute for Health and Care Excellence (NICE) released guidance on the diagnosis and management of glaucoma. {NICE, April 2009 #2130} The intent of these guidelines was to both clarify and unify service provision between primary and secondary care on the management of OHT and open angle glaucoma. {Group, 2004 #2460} However, an unintended consequence of these guidelines was a change in the patterns of referral behaviour by community optometrists, which has led to an increased number of referrals to the hospital eye service (HES), {Edgar, 2010 #1775; Ratnarajan, 2013 #2464} with little change in the proportion of those with a 'true positive' for either OHT or glaucoma. {Shah, 2011 #1797; de Silva, 2013 #2139} To cope with the increase in referrals, some Clinical Commissioning Groups (CCGs) have developed either community optometrist repeat-measures schemes (whereby measurements such as intraocular pressure (IOP) or visual fields (VFs) are repeated to confirm the presence of an 'abnormal' result) or community optometrist referral refinement schemes, whereby community optometrists with a special interest in glaucoma are trained to interpret the results of clinical tests used specifically to detect OHT or open angle glaucoma. {STANDARD, March 2011 (updated March 2012) #2471} Published results suggest that these schemes are successful at reducing the number of onward referrals to the HES; however, uptake of these types of schemes across the country is not widespread. {Henson, 2003 #1090; Syam, 2010 #1803; Parkins, 2011 #1800; Bourne, 2010 #1802; Devarajan, 2011 #2109; Ratnarajan, 2013 #2104; Keenan, 2015 #2479; Roberts, 2015 #2494}

At Moorfields Eye Hospital NHS Foundation Trust, London, we have introduced an in-house referral triaging service that runs as an asynchronous virtual clinic. A virtual clinic is one in which the face-to-face clinician consultation is removed. In a synchronous model, the patient and clinician interact in real time, for example, via a webcam. In the asynchronous model, the interaction occurs at different times. Virtual monitoring clinics are not new to glaucoma monitoring, {Wright, 2015 #2218; Kotecha, 2015 #2347} and recently Trikha et al have described a virtual glaucoma refinement service utilising community optometrists. {Trikha,

2012 #2105} The feasibility of virtual clinics for new patient assessment has been examined by Rathod et al, {Rathod, 2008 #2126} who found good agreement between face-to-face clinical decision making and that made from assessment of clinical data for patients attending their Glaucoma Assessment Clinic.

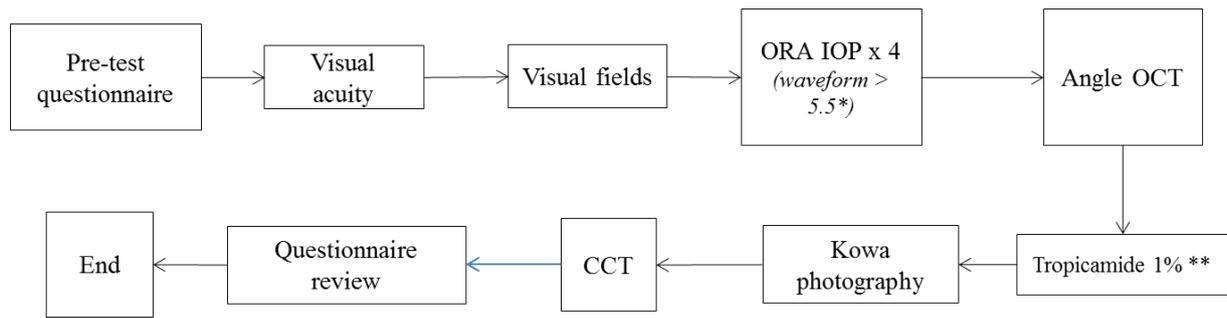
In our virtual glaucoma referral triaging service, trained ophthalmic technicians perform diagnostic testing on patients, the results of which are reviewed at a later time/date by a consultant glaucoma ophthalmologist. Technicians are all trained in-house and have internally approved competencies in using the diagnostic equipment within the service. The service was introduced following an unsuccessful pilot community optometrist referral refinement scheme.

## **Methods**

The Glaucoma Screening Clinic (GSC) was started in March 2014. All new optometrist or GP initiated glaucoma/OHT suspect referrals entering the hospital are directed to a centralised booking centre and scrutinised by 2 optometrists. For the first 12 months, only 'low risk' patients were allocated to the service. "Low risk" was defined as having only one of the following three risk factors: suspicious optic discs, suspicious visual fields, intraocular pressure (IOP) greater than 20mmHg. From March 2015 to present, the scrutinising optometrists are allowed to exercise their clinical judgment and include patients who present with up to 3 risk factors (where positive family history in a first degree relative is also included as a risk factor) into the GSC, if the evidence presented in the referral letter is inconclusive. As an example, a patient referred with optic disc asymmetry, a non-specific visual field defect and IOP of 21mmHg would be directed into the GSC. Referrals in which it was clear that the patient showed definitive signs of having the condition, or were angle closure suspects, or patients referred with an IOP greater than 32mmHg have been deemed ineligible for the GSC. Patients booked into the GSC are sent a patient information leaflet advising them of the nature of the clinic and that they do not see a doctor on the day of their appointment.

Patients attending the service are seen by three ophthalmic trained technicians who performed tests in a streamlined fashion (see Figure 1). Acuties are measured using COMplog (Version 1.3.60, COMplog Clinical Vision Measurement Systems Ltd, London, UK). The Humphrey Field Analyzer (HFA; Carl-Zeiss Meditec, CA, USA) SITA 24-2 standard test strategy is used to assess visual fields. Intraocular pressure is measured using the Reichert Ocular

Response Analyzer (ORA; Ametek Inc. and Reichert Inc., Depew, NY, USA); both IOPg and IOPcc are recorded. Angle assessment is performed with a temporal and nasal line scan using the Topcon 3D 2000 optical coherence tomographer (Topcon Corporation, Tokyo, Japan). Disc imaging is performed using the Kowa non-mydratic WX3D stereo-fundus camera (Kowa Ltd, Japan); two fundus images are taken in each eye; one a stereo-image of the optic disc and the second a wider field monoscopic image of the disc and macula. Central corneal thickness is measured using an ultrasound pachymeter (DGH Pachmate, DGH Technology Inc, Exton, PA, USA). A questionnaire enquiring about the presence of any systemic risk factors, medication details, previous ocular or other operations, family history and driving status is administered on arrival, and answers confirmed by the technician prior to the patient leaving the clinic. Patients who have an IOP > 32mmHg on the day of their screening visit are taken to a consultant delivered clinic on the same day. Patients are advised upon leaving the service that they will receive a letter advising the outcome within 2 weeks of their appointment.



**Figure 1: Flow through GSC.** Journey times from start to finish are collected on a paper proforma. Key \* = the ORA waveform score indicates the quality of measurement, thus only scores >5.5 (out of a possible 9) are acceptable, \*\* tropicamide would only be instilled if the angle measured > 25 degrees; CCT = central corneal thickness, measured following instillation of 1 drop of topical anaesthetic.

Data is entered into the patient's electronic patient record (EPR; Openeyes; [www.openeyes.org](http://www.openeyes.org)) and patients are 'referred' to the 'virtual clinic' list. When the reviewing consultant logs into their Openeyes page, they are directed to the 'virtual clinic' and a list of all patients seen in the GSC are available to view. The consultant has a laptop with a stereo-monitor (LG A520-3D; LG computing Seoul, Korea), thus all reviews are performed remotely without the need for paper notes. The consultant has one 3.5 hour session per week to review referrals. Since November 2015, the service is operating at 12 patients per 3.5 hour session, 2 sessions per week.

On review of the data, the consultant chooses two outcomes: discharge from the service or follow up in the outpatient clinic. The outcomes of those patients attending for a second face-to-face consultation were collected in order to determine the false positive rate of the GSC.

#### *False negative audit*

From November 2014, the clinic administrator was asked to randomly select one patient discharged from each GSC to bring back for a face-to-face consultant review within 8 weeks of being discharged. Patients were suitable to be booked into any glaucoma outpatient clinic excluding that led by the GSC reviewing consultant. These audit patients were advised that attendance was voluntary, and that the exercise was part of the hospital's ongoing quality assurance programme.

### **Results**

Between 1 March 2014 and 31 March 2016, 1,532 patients were booked into the GSC. One hundred and fifty two patients (10%) failed to attend their appointment. The average [standard deviation (SD)] journey time within the clinic was 58 [16] minutes. The majority of patients were reviewed by a single consultant (JB; 1097 patients, 79%), with leave cover by other glaucoma consultants. The average [SD] time from patient attendance to consultant virtual review was 4 [4] days. The number of patients discharged following consultant virtual review was 855 (62%).

Of the remaining 525 patients, sixteen patients (1%) required same day doctor assessment as they presented with elevated IOP. Ninety one (6%) patients were booked for a follow up in the Glaucoma Monitoring Service, the service's sister virtual clinic for stable OHT, glaucoma suspect or early to moderate glaucoma patients. {Kotecha, 2015 #2347} The diagnoses of the 418 patients who were referred for face-to-face outpatient review are presented in Table 1.

<b>Diagnosis</b>	<b>Number (%)</b>
OHT (monitor)	47 (11)
OHT (treat)	25 (6)
Glaucoma suspect (monitor)	155 (37)
Glaucoma (treat)	75 (18)
Non-occludable narrow angles (monitor)	7 (2)
Occludable, narrow angles (intervention required)	20 (5)
Discharged	64 (15)
Did not attend/awaiting appointment	25 (6)

Table 1: Outcomes of the 418 patients who were referred for face-to-face consultation.

The positive predictive value of the GSC was 83.7% [95% confidence intervals; CI = 79.9% to 87.2%].

#### *False negative audit*

Between 10 November 2014 and 14 March 2016, 157 (18%) patients discharged from the GSC following virtual review were invited to re-attend for a face-to-face ophthalmologist consultation; 82 patients (9%) accepted the invitation and were reviewed in clinic. Sixty six patients were discharged following consultation, in agreement with the virtual review; this equates to a GSC false negative rate of 20%. The negative predictive value (NPV) of the GSC was 79% (95% CI = 68.1% to 87.5%)

The diagnosis of the 16 patients in whom the face-to-face consultation disagreed with the decision of the virtual review are detailed in Table 1. For the majority of patients, no treatment was instigated at the face-to-face appointment, but instead they were kept under clinic review. However, only 3 patients required medical intervention, equivalent to a “significant” false negative rate of 4 %, or a revised NPV of 96.3% (95% CI = 89.7% to 99.2%). Two of these patients were diagnosed as being ocular hypertensives; one required treatment based on the NICE guidelines, whilst the second presented at the face-to-face review with an IOP level twice that found both at the GSC visit and in the original referral letter. One patient was diagnosed as having occludable angles requiring prophylactic laser iridotomy, but had no evidence of glaucoma.

<b>Diagnosis</b>	<b>Management</b>	<b>Number of patients</b>
OHT	Monitor	3
OHT	Treat	2
Glaucoma suspect: suspicious discs	Monitor	6
Unreliable visual fields	Monitor	2
Non-occludable, narrow angles*	Monitor	1
Occludable angles*	Treat	1
Angle recession	Monitor	1

Table 2: Outcomes of the 16 patients who were initially discharged following their GSC appointment, but deemed to require further management at their face-to-face visit. Key: \* = for both these patients, the original referral letter indicated a grade 4 Van Herick angle.

## Discussion

This paper reports the outcomes of an in-house, ophthalmic technician delivered 'virtual' glaucoma referral triaging service for new optometrist or GP initiated glaucoma suspect referrals into a specialist ophthalmic hospital in London. The service was successful at reducing the number of onward referrals to the glaucoma outpatient clinic by over 60%. The false positive rate of onward referrals to the outpatient service was 15%, and a 'glaucoma miss rate' of 4% for a sub-group assessed later and found to require medical intervention.

There are a number of established optometrist-delivered referral refinement schemes across the UK, with those based in Manchester, {Henson, 2003 #1090} Huntingdon, {Bourne, 2010 #1802} Cambridge, {Keenan, 2015 #2479} Cardiff, {Devarajan, 2011 #2109} and Bexley {Parkins, 2011 #1800} having published their experiences. In these schemes, the decision of whether the patient is 'normal' or 'suspect' is made by a suitably trained optometrist with appropriate in-house equipment. Another model is the virtual clinic model proposed by Trikha et al, {Trikha, 2012 #2105} whereby community-based optometrists collect clinical information, but the decision of 'normal' or 'suspect' is made by a consultant ophthalmologist. Optometrists are ideally placed to deliver community refinement, as they possess the equipment {Dabasia, 2014 #2472} and clinical expertise for assessments. However, whilst many community optometrists may wish to have a more extended role in primary care, the remuneration to participate in such schemes is often insufficient for the optometry practice business model. {Konstantakopoulou, 2014 #2341} We would propose that in areas where uptake of community refinement is low, or where there are scant resources to initiate these schemes, which include the training and education of personnel, our technician- delivered virtual glaucoma refinement model may be a suitable alternative.

The positive predictive value of the GSC was ~ 84%, which is comparable to the optometrist refinement schemes in Manchester {Henson, 2003 #1090} Huntingdon, {Bourne, 2010 #1802} and Carmarthenshire {Devarajan, 2011 #2109} and the Portsmouth community optometrist virtual clinic model. {Trikha, 2012 #2105} On first review, our false negative rate of 20% may be a cause of concern. However, on further inspection, if we assess the number of patients requiring an intervention who were missed by the GSC, this falls to 4%. The Carmarthenshire scheme estimated a false negative rate of between 3% and 10% based on consultant review of optic disc photographs. {Devarajan, 2011 #2109} In Huntingdon, a recent evaluation of community optometrists participating in the CHANGE scheme revealed

a false negative rate of 15%, but a 0% 'glaucoma miss rate'; that is, no patients discharged by the community optometrist required treatment following consultant review. In a recent report of the Cambridge community optometrist refinement scheme, a 5% false negative rate was found following consultant face-to-face review of a proportion of patients discharged following community refinement. {Keenan, 2015 #2479} In our study, 3 (4%) of the patients brought back for the false negative audit were deemed to require treatment, and 13 (16%) were kept under the HES for observation. It is recognised that very early glaucoma is challenging to detect. {National Eye Care Service Steering, 2004 #2460} Furthermore, it is well known that expert clinicians exhibit a wide range of agreement with each other, and even themselves, when diagnosing or managing the condition. {Weinreb, 1997 #2245;Murdoch, 2010 #1760;van der Schoot, 2013 #2473} It is our policy to advise all patients who are discharged from the GSC to visit their optometrist for annual or biennial eye exams in the future. If this advice is followed, we hope that any abnormality that was missed the first time would be detected at subsequent examinations, particularly if the physical signs become more pronounced. However, this remains unproven. The fact that two patients with narrow angles were 'missed' despite anterior segment imaging does raise some concerns. We have taken the view that angle-closure suspect referrals are not suitable for the clinic, and it should be noted that in both cases, the optometrist referral letter indicate wide open angle on Van Herick's assessment. In both cases, the anterior segment OCT showed no evidence of irido-trabecular contact. Studies suggest that anterior segment OCT tends to 'overcall' closed angles, {Nolan, 2007 #1180} and assessment of drainage angle width is exquisitely dependent on the lighting conditions and examination technique, especially in borderline cases. {Foster, 2004 #2486} Of the three patients who required intervention, none were given a diagnosis of glaucoma. Referral refinement services are put in place to improve the quality of referrals and not miss disease, and our service did not miss any cases of glaucoma. We should also put our findings into perspective; our false negative rate of 4% is better than that reported by some screening programmes for breast and cervical cancer, which report false negative rates of up to 34% and 58%, respectively. {Petticrew, 2000 #2477} However, we are looking for ways of improving the service and will soon be introducing optical coherence disc imaging as the standard method of optic disc assessment.

Another potential criticism of our service is that it is not in line with NICE guidelines, which recommend that referral refinement schemes use Van Herick's method for angle assessment and applanation tonometry for IOP measurement; {NICE, April 2009 #2130} we used

neither. In designing the clinic, we had to decide upon what was practical and maintain a balance between quality and efficiency. There are a number of reports that highlight the imprecision of applanation tonometry, {Whitacre, 1993 #803;Ajtony, 2016 #2476} and a recent NIHR Health Technology Assessment report concluded that, based on current evidence, Goldmann applanation tonometry may not be the most appropriate reference standard for IOP measurement. {Burr, 2012 #2480} Based on our experience, {Kotecha, 2010 #1673} we felt that the ORA was an acceptable alternative to use. In addition, the training and time required to undertake Van Herick assessment was felt to be outweighed by the simplicity of using an objective method which provides a documentary record of angle status. {Campbell, 2015 #2474} Emerging evidence suggests that implementation of NICE guidelines for glaucoma and OHT monitoring is not always feasible {Malik, 2013 #2152} or cost-effective {Hernandez, 2015 #2482} within most NHS HES departments. Year on year, data from NHS England shows that the use of hospital outpatient services for ophthalmology rank second in the country, with orthopaedics and trauma topping the list (7.07 million versus 7.52 million outpatient appointments in 2014-15, respectively, from <http://www.hscic.gov.uk/home>); we are in the midst of a capacity crisis. {Chalk, 2013 #2169;RNIB, November 2013 #2153;Smith, 15 August 2013 #2154;Kotecha, 2014 #2214} Thus, we need to be open to new models of service delivery if we are to cope, {Sim, 2016 #2485} and be pragmatic about the tests we need to conduct to detect sight-threatening disease. {Hernandez, 2015 #2482} Our GSC has freed up 24 face-to-face new patient slots per week, allowing more complex-needs patients to be assessed by a consultant team. As such, we feel that the model is a successful one and it is being expanded.

Our choice of developing the service in-house was primarily for convenience. As Trikha et al have shown, {Trikha, 2012 #2105} it is possible to have virtual refinement services in the community. Our model could be transferred to GP practices or even non-NHS organisations, such that patient data is collected in a location convenient to the patient, but clinical decision making and the overall responsibility for the patient lay with the secondary care consultant. However, this type of virtual refinement model relies on a solid IT infrastructure and the ability to securely share information between different healthcare providers. Up until now, it has been impossible to share electronic information, such as digital visual field and optic disc imaging data, between non-NHS and NHS settings without incurring the considerable expense of installing an N3 line. {Accounts, 2013 #2483} It is hoped that the new Health

and Social Care Network programme will better facilitate the secure sharing of medical information between different healthcare settings. {Centre, March 2015 #2484}

In summary, our novel technician-delivered glaucoma referral triaging service with consultant virtual review offers an alternative model for evaluating new glaucoma suspect referrals that is successful at reducing the number of onward referrals into the standard outpatient clinic. The service may be a useful alternative for Trusts where there are difficulties in implementing other community based referral refinement schemes. Further work will examine the cost comparisons between this model of service compared to other models of care, including the standard out-patient service.

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