Clinical Outcomes of a Hospital-based Teleophthalmology Service: What happens to patients in a virtual clinic?

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Financial support: none

Conflict of interest: no conflicting relationship exists for any author

Running head: Clinical outcomes of a virtual medical retina clinic

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Abstract

Objective: Demographic changes as well as increasing referral rates from national screening services put pressure on available ophthalmologic resources in the UK. To improve resource allocation, virtual medical retina clinics were introduced in 2016 in Moorfields Eye Hospital, South Division. The scope of this work was to assess clinical outcomes of patients followed up in a virtual clinic setting.

Design: Retrospective database study.

Participants: Patients booked for a consecutive appointment in our virtual medical retina clinic.

Methods: 728 patients booked for their second virtual clinic appointment in a in a tertiary eye care referral center between November 2016 and July 2018 were identified retrospectively from our electronic health records and patient administration systems. Information about disease grade, clinical and visual outcomes was assessed.

Main Outcome measures: Clinical outcome of the virtual clinic visit: virtual follow-up; urgent referral to face-to-face clinic or discharge.

Results: 712 out of all 728 patients received a clinical outcome. 497 (70%) patients were eligible for further virtual follow up after the second virtual clinic visit, whereas 15% each (107 and 108 patients) were either discharged or referred to a face to face clinic. In total 661 patients attended their appointments in person and were reviewed by trained staff. 17 patients were referred for urgent treatment and 8 patients were not suitable for virtual follow up. With 542 (82%) of all cases, diabetic retinopathy was the most common diagnosis.

Conclusion: This study reports clinical outcomes of a virtual model of care for medical retina clinics which imply safety of patient care in this clinic setting. This clinic format optimizes the use of already available resources and serves to upskill our existing workforce whilst maintaining high quality clinical standards.

Advanced retinal imaging modalities revolutionized ophthalmology with optical coherence tomography (OCT) in recent years becoming a cornerstone in diagnosing and treatment monitoring of patients with retinal disorders like age related macular degeneration and diabetic macular edema. [1,2] Diagnosis as well as treatment efficacy relies increasingly on imaging devices than on binocular fundoscopy. [3] These advancing retinal imaging technologies and the comparability of ultra-wide field images to the "gold standard" of Early Treatment Diabetic Retinopathy Study (ETDRS) standard fields photography , facilitates telemedicine especially in the subspecialty of medical retina. [4,5]

The increasing age of the population in industrialized countries and continued growth in diabetes prevalence has resulted in an expanding demand for ophthalmological care. [6,7] This trend is evident in the United Kingdom (UK) with already a low number of ophthalmologists per capita and an expected growth of the population over 60 years at twice the rate of the profession. [8] Ophthalmology resources are particularly disproportionate in the field of medical retina.

Since 2003 a national screening program (Diabetic Retinopathy Screening Service [DRSS]) for all diabetic patients is in place, reaching more than 80% of all diabetic patients within the UK. [9] By picking up previously undetected diabetic retinopathy, an increase of 30% in eye clinic attendances was observed within the last 5 years throughout the UK. [10] The low threshold for referable disease in the DRSS further raises the workload in ophthalmology. [11,12] To address this increasing workload and to optimize usage of available resources, a virtual medical retina clinic (VMRC) setting for low risk referrals is in place since September 2016 in four sites of Moorfields Eye Hospital, South Division, London, UK. [13] Our work group described the implementation of this clinic setting and reported the outcome of the first virtual clinic visit after referral.

The term "virtual clinic" was borrowed from our orthopedic colleagues who coined it whilst developing the Glasgow Fracture Pathway: a virtual clinic first implemented in 2011 that has successfully upscaled across the country. [14,15] The British Broadcasting Corporation succinctly reported this success as "Virtual clinics reduce waiting times". [16] To overcome imbalance between supply and demand, ophthalmologic subspecialties like glaucoma introduced virtual clinic settings consisting of visual acuity testing, color photos of the optic disc and a visual field examination by specially trained nurses. [17] These clinics were shown to reduce the patients' journey time in the outpatient departments allowing more patients to be monitored. [18] No difference was found between the functional outcome of patients monitored in virtual or regular glaucoma clinics. [19] This suggests that virtual clinics may offer a safe and resource-efficient alternative to regular face-to-face clinics (F2FC). [20] Telemedicine has already been successfully applied for other diseases like

retinopathy of the prematurity and diabetic retinopathy and shown the potential to maximize the usage of available resources. [4,21,22]

Differential labelling of a similar pathway (e.g. stable monitoring clinics or digital surveillance clinics) led to some controversy in the use of the term "virtual" in Ophthalmology. This has largely been due to the interpretation of healthcare commissioners and insurers about the construct of an ophthalmology virtual clinic; where patients are not monitored at home but instead attend for the collection of clinical parameters without seeing a doctor in a face-to-face setting. Their clinical encounter is therefore replaced by optometrists who have been trained to take relevant clinical history and perform ocular measurements. The terminology used to describe this pathway is important; Standards defined in the well-established field of telemedicine must be embedded into teleophthalmology to allow systematic evaluation of quality.

In this study we report on patient characteristics and clinical outcomes of patients attending follow-up appointments in consultant-led virtual medical retina clinics at Moorfields Eye Hospital.

Materials and Methods

All second attendances (follow-up visits) at the virtual medical retina clinic at Moorfields Eye Hospital, NHS foundation Trust, South Division (St. George's Hospital, The Nelson Health Centre, Purley War Memorial Hospital and Croydon University Hospital) were included into this study. This work was registered with the Service Improvement Department of Moorfields Eye Hospital and complies with the criteria defined in the Declaration of Helsinki.

Inclusion criteria applying to all patients in this study were: Patients must have had a first virtual appointment with the clinical outcome to be kept in a virtual clinic setting and formed part of our initial study. [13] General inclusion criteria for internal and external referrals to attend our virtual clinic are presented in **Figure 1**. Period of observation for clinical outcomes of the second virtual visit was from November 2016 to July 2018.

Each virtual appointment consisted of collection of clinical parameters by trained nurses and ophthalmic technicians. Past medical and ocular history as well as visual acuity and non-contact intraocular pressure were taken and entered in an electronic health record system which differs between the sites; either Medisoft (Medisoft, Leeds, UK) or OpenEyes (OpenEyes Foundation, London, UK). Patients virtual follow-up visits were allocated into a "color fundus" or "Ultra-Wide Field Imaging" (UWFI) driven clinic depending on DR grade, reviewer's choice and availability. Every patient receives a macular OCT volume scan by Topcon 3D OCT-2000 (Topcon Corporation, Tokyo, Japan), followed by fundus photography. This is performed by two 45° field color fundus

photography by Topcon 3D OCT-2000 (Topcon Corporation, Tokyo, Japan) centered on optic disc and fovea in the “color fundus” and by ultra-wide field fundus photography (Optos, Dunfermline, UK) in the “UWFI” clinic. An intranet-based worklist, containing data from the electronic health record and patient administration system (Silverlink, Newcastle upon Tyde, UK), is regularly created using SQL Server Reporting Services Software (Microsoft, Redmond, WA, United States of America) to select patients awaiting reporting. This was performed by 5 reviewers; one ophthalmological consultant, two medical retina fellows, one optometrist and one senior screener with DRSS background. All diabetic patients were graded following the national UK guidelines of retinopathy severity: none (R0), background (R1), preproliferate (R2) and proliferative (R3). [23] Diabetic maculopathy was graded as absent (M0) or present (M1). For further analysis, each patient was graded following his worse eye (higher R grading). A clinical outcome letter was sent to the patient, the general practitioner, and if applicable to the local screening service. Outcome was classified as: follow-up in the virtual clinic (virtual); follow up in a face-to-face medical retina clinic (F2FC); or discharge.

Primary study endpoint was the outcome of the second virtual visit. Secondary endpoints were disease classification, attendance rates and processing time (time between patient’s visit and virtual review). If the outcome was face-to-face or discharge, further classification applied. For face-to-face this was:

- Urgent referral: This means treatable disease was detected and urgent treatment (intravitreal injections or panretinal laser coagulation) is necessary within less than 4 weeks.
- Worsening of monitored disease: Retinopathy grading or monitored disease worsened compared to the first virtual visit and must be assessed by a clinician within more than 4 weeks. Urgent referral criteria not met.
- Routine referral: e.g. due to cataract or glaucoma suspicious disc.
- Poor image quality: in case of inadequate photographs (either due to media opacities or compliance).
- Booking Error: The patient was accidentally booked to a face-to-face setting
- Not suitable for virtual clinic: If patients have physical inabilities (neck kyphosis, wheelchair etc.)

All patients discharged were categorized to discharge back to the diabetic retinopathy screening service, discharge after two consecutive missed appointments (did not attend x2; DNAx2) or deceased.

Data from the hospital's data warehouse, the electronic health record and the patient administration system was exported to an Excel spreadsheet for further statistical analyses performed by using SPSS Version 24 (IBM, Armonk, USA).

Results

728 patients were booked for a second virtual medical retina clinic appointment after planned virtual follow-up in the first visit. 224 (30.8%) patients had appointments booked in the color fundus clinic and 504 (69.2%) in the UWFI clinic. The average time between the first and second virtual appointment was 226.8 days (SD ± 89.7 days) compared to a suggested follow-up time of 214.3 days (SD ± 80.5 days) by the reviewers of the first VMRC visit. The average age was 62.8 [20;95] years and 308 (42.3%) patients were female. The mean best corrected visual acuity of the better eye was 83.3 (SD ± 10.2) ETDRS letters (20/25) on the second VMRC appointment. The average reviewing process took place within 5.0 days (SD ± 5.5 days) after attending the appointment.

Attendance rates for the second virtual medical retina appointment

Of 728 patients booked for a second virtual appointment 661 (90.8%) attended their appointment. 123 (16.9%) of all booked patients did not attend their second virtual clinic appointment at least once and 67 (9.2%) cancelled at least one second appointment. 59 (8.1%) patients were discharged from the virtual out of administrative reasons (40 – DNAx2, 12 – deceased and 7 – lost-to-follow-up (LTF)) without assessment. Thereof, 41 (5.6%) patients did not attend and 18 (2.5%) patients cancelled their second appointment before discharge. At the end of the observation period 9 patients still had their second virtual clinic appointment pending. In St. George's Hospital, we observed 17 (2.3%) patients booked into virtual clinics were seen due to a booking error in a face-to-face clinic.

Diagnoses of patients seen for a follow-up appointment in virtual medical retina clinics

Diabetic retinopathy was the most common diagnosis with 542 cases (82%) of all patients seen in a virtual clinic. This was followed by patients with age-related macular disease, retinal vein occlusions, choroidal naevi and central serous chorioretinopathy. All other diagnoses like Sickle-Cell retinopathy, Macular Telangiectasia Type II, vitelliform macular degeneration and other degenerative disorders were summarized in "other". **Table 1** gives and overview over the diagnosis and the diabetic retinopathy grading.

Outcome of second virtual medical retina clinic visit

Of 728 booked patients, 712 patients received an outcome for their second virtual clinic appointment until the end of observation period. We identified 16 patients without a clinical

outcome, whereof seven patients were loss to follow-up after not attending or cancelling their second virtual appointment and nine patients had an appointment in the future. 661 patients attended their appointments in person and were reviewed. 70% of the patients were kept in the virtual setting. An equal amount of almost 15% each was either discharged or seen in a face-to-face for their next appointment. The reasons for discharge and face-to-face referrals are summarized in **Table 2**. The outcomes differed following stratification by diagnosis or clinical rank of the reviewer (**Figure 2 and Figure 3**). Time until next follow-up was 211.3 days (± 79.3 days) in the virtual and 122.7 days (± 87.1 days) in the face-to-face setting.

Discussion

In this study we examined patient characteristics and clinical outcome for patients followed up in a virtual medical retina clinic. Of all 728 patients that were booked initially for their second virtual appointment we were able to observe the outcome of 712 patients. Diabetic retinopathy was the most common diagnosis in all patients. Most of the patients (70%) were eligible for further virtual follow up after the second virtual visit, whereas 15% each were either discharged or referred to a face-to-face setting. In total 17 patients were referred for urgent treatment and eight patients were not suitable for virtual follow up due to poor image quality (e.g. increasing cataract since first virtual appointment). The turnaround time for obtaining a review letter was five days for all patients.

The process of implementation and initial clinical outcomes in our virtual medical retina clinic were published recently by our workgroup. [13] After implementation, a reduction of referral to appointment time and suitability as a first-line rapid-access clinic for low-risk referrals was shown. More than half of the patients was eligible for virtual follow up, but we observed a face-to-face referral rate of 30% due to various reasons. In this study major differences of clinical outcomes have been revealed between the first and second virtual visit. Whereas55 % of first referrals continued follow-up in a virtual setting, in this follow-up study more than 70% were kept within the virtual clinic. The discharge rate was 15% for the first as well as the second virtual visit. A major difference was seen for the face to face referrals. After the first appointment in a virtual clinic the face-to-face rate was more than 30% whereas it was only 15% in the follow up visit. Urgent referrals were less in the follow-up visit compared to the first visit (15% vs. 20% of face-to-face referrals). **Figure 3** gives an overview of the clinical outcome of the first and the second virtual visit stratified by disease grade and diagnosis. The lower face-to-face referral rate of the second visit can be explained about the triage that already took place after initial referral to a virtual clinic. The number of patients that were “not suitable” for a virtual setting or were seen face-to-face due to “poor image quality” was reduced from 34.7% to 1% in the second virtual visit. Time to next follow- up was comparable for

virtual appointments (215 days vs. 211 days). For face-to-face visits, time to follow-up was less in this study (173 days vs. 123 days), which could be explained by the high rate of "worsening of the monitored disease" of 47% of all face-to-face referrals with a mean follow-up time of only 100.2 days ± 45.1 days.

By optimizing the workflow within the reviewing process, we achieved to reduce the average processing time from nine days after the first visit to five days in the second visit. This was achieved by better training as well as increasing experience in digital reviewing, even though the number of reviewers reduced from 6 to 5. The use of several software programs in reviewing patients was a new and unfamiliar approach for decision making after initial introduction of virtual clinics. We suggest that the review process is accelerating as reviewers are familiar with patient history and disease in a follow-up visit, like face-to-face clinics of other specialities.[24]

Diabetic retinopathy telemedicine programs are classified into 4 categories by the American Telemedicine Association depending on the accuracy of disease stratification and the function of the program. [25] Whereas category 1 programs only differentiate between "presence" or "absence" of diabetic changes, category 2 programs like the DRSS categorize for "vision threatening" and "non-vision threatening" disease severity. [9] Category 3 programs enable remote decision making by more accurate disease stratification. Currently there are no telemedicine programs qualifying for the most complex category 4, where imaging methods used for disease stratification must be comparable to gold standard. Considering that ultra-wide field imaging was found equal to ETDRS photographs in determining diabetic retinopathy disease severity, our UWFI virtual clinic setting might qualify into a category 3 program. [5] 30% of patients have been seen in a color fundus driven clinic, where retinal imaging does not achieve the standards of seven fields ETDRS photography and must be classified in category 2 accordingly. For a tertiary eye care referral center, category 3 should be targeted not only because of resources available, but also to guarantee patients safety.

Even though Telemedicine has the advantage of distinguishing between patients that only require surveillance and those who need urgent treatment, a major concern of this new setting was, if it is safe to keep patients within a virtual setting. [26] Virtual clinic settings have been described as a safe and efficient alternative to face-to-face in diagnosing and managing eye diseases. [27] A prospective evaluation of a teleophthalmology clinic for age related macular degeneration found no difference for the visual acuity outcomes between virtual and face-to-face setting. [28] In Our study, no deterioration in mean visual acuity or mean diabetic retinopathy severity grades could be observed between the first and second virtual visit. The visual acuity of all patients attending our virtual clinic was 66.2 ETDRS letters (20/50) at first referral and 83.3 ETDRS letters (20/25) at their second visit.

The number of patients with preproliferative (R2) or proliferative (R3) retinopathy decreased from 16% in the first visit to 14.5% in the follow-up virtual visit. Moreover, an increased number of patients remained in the virtual clinic (70% compared to 55% at the first virtual review) and a reduction in the number requiring urgent referral (17 compared to 66 at the first virtual review) has been observed. These results may have been influenced by positive selection after the first visit (eligible for further virtual follow up). Based on the observed changes in clinical outcomes, we suggest that the virtual clinic is a safe environment for medical retina patients and continues to improve as the pathway matures.

We reduced our face-to-face referral rate from more than 30% to 15% in the second virtual visit. This was defined as our internal benchmark for the outcome of first virtual visits, where we should also aim for a 15% face-to-face referral rate only. To achieve this goal, several measures for initial internal and external referrals to our virtual clinic are in place. (**Figure 1**) Not only by positive selection after the first visit, but also by better training of technicians with OCT and widefield devices, we achieved to reduce the rate of face-to face referral due to poor image quality from 34.7% to 1.0%. We believe that a virtual medical retina setting as described offers an opportunity to improve medical resource allocation in a setting of broad use of validated telemedicine for the remoted diagnosis and management of retinal conditions.

The retrospective study design and the allocation to a color and UWFI clinic is a limitation when interpreting these study results. Ongoing quality assurance programs should be embedded in teleophthalmology services to allow more dynamic service evaluation and to be able to respond to the need of population served. Further examinations must evaluate safety of a virtual clinic setting by comparing clinical outcomes in a prospective setting to today's clinical standard: a face-to-face examination including binocular dilated fundoscopy. Patient acceptance and quality of patient education were found to be similar in virtual and face-to-face glaucoma clinics.[29] To cover patient experience in a virtual medical retina clinic setting, we will explore acceptability and satisfaction in a future work.

With the results of this study we presented clinical outcomes of patients in a virtual medical retina clinic. Reduction in urgent referral rates and consistent DR gradings between the first and second virtual visit may imply the safety of this specific clinic setting. The use of already available resources is optimized and serves to upskill our existing workforce whilst maintaining high quality clinical standards. Future application of artificial intelligence algorithms such as Deep learning on OCT retinal scans may further improve workflow and resource utilization. [30] For such an eventuality,

evidence of baseline quality assurance processes as evidenced in this paper must be in place to provide a benchmark for the introduction of new technologies.

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Figure legends

Figure 1 Guidance for initial referral into “color fundus” or “UWFI” driven virtual medical retina clinics

Figure 2 Available Outcomes for 712 out of 728 patients booked for a second virtual visit stratified by clinical rank: virtual medical retina clinic (VMRC); face-to-face clinic (F2FC) and discharge. Vertical axis gives percentage, numbers on bars give absolute numbers of patients. No data available for patients with an appointment in the future (n=9) and lost-to-follow-up (n=7).

Figure 3 Comparison of the Outcomes of the first and the second virtual visit stratified by clinical rank: virtual medical retina clinic (VMRC); face-to-face clinic (F2FC) and discharge. Vertical axis gives

percentage, numbers on bars give absolute numbers of patients. AMD, age-related macular degeneration; RVO, retinal vein occlusion; CSCR, central serous chorioretinopathy.