Article published online: 2022-09-02

Accuracy Assessment of Outpatient Telemedicine Encounters at an Academic Ophthalmology Department

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J Acad Ophthalmol 2022;14:e193–e200.

Abstract

Purpose We assess the clinical accuracy of direct-to-patient real-time outpatient video visit encounters at our eye center.

Design This was a retrospective longitudinal study.

Subjects and Methods Patients who completed a video visit over a 3-week period between March and April 2020 were included. Accuracy assessment was determined by comparing diagnosis and management from the video visit with subsequent in-person follow-up over the next year.

Results A total of 210 patients (mean age 55 ± 18 years) were included, of whom 172 (82%) were recommended a scheduled in-person follow-up encounter after their video visit. Among the 141 total patients who completed in-person follow-up, 137 (97%) had a diagnostic agreement between telemedicine and in-person evaluation. Management plan agreed for 116 (82%), with the remainder of visits either escalating or deescalating treatment upon in-person follow-up with little substantive change. Compared with established patients, new patients had higher diagnostic disagreement following video visits (12 vs. 1%, $p = 0.014$). Acute visits trended toward more diagnostic disagreement compared with routine visits (6 vs. 1%, $p = 0.28$) but had a similar rate of management change on follow-up (21 vs. 16%, $p = 0.48$). New patients were more likely to have early unplanned follow-up than established patients (17 vs. 5%, $p = 0.029$), and acute video visits were associated with unplanned early in-person assessments compared with routine video visits (13 vs. 3%, $p = 0.027$). There were no serious adverse events associated with the use of our telemedicine program in the outpatient setting.

Conclusions Video visits had high diagnostic and management agreement with subsequent in-person follow-up encounters.

Keywords
- real-time telemedicine
- COVID-19 pandemic
- clinical accuracy of telemedicine
- diagnosis and management
- outpatient telemedicine
- direct-to-patient

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received
September 8, 2021
accepted
June 16, 2022

DOI https://doi.org/10.1055/s-0042-1756200.
ISSN 2475-4757.

Thieme Medical Publishers, Inc., 333 Seventh Avenue, 18th Floor, New York, NY 10001, USA

Key Messages

- Telemedicine is an increasingly adopted method of care delivery during the COVID-19 pandemic, but limited data exist regarding diagnostic accuracy and outcomes of telemedicine in ophthalmology.
- Our data describe the characteristics of comprehensive telemedicine program at an academic ophthalmology department.
- Our data illustrate that video visits had high diagnostic and management agreement with subsequent in-person follow-up encounters.

In response to the global coronavirus disease 2019 (COVID-19) pandemic, ophthalmology practices deferred routine patient visits, redesigned clinic roles and protocols, and limited office visits to maximize patient and provider safety.[1–3] Accordingly, ophthalmology practices experienced a marked reduction in patient visits, estimated at a 79% decrease from prepandemic totals.[4,5]

To continue managing ophthalmic conditions while minimizing in-office exposure, ophthalmologists rapidly adopted telemedicine into their practices. Telemedicine, the remote delivery of health care services via telecommunication, has increased in both interest and adoption among medical providers and practices during the COVID-19 pandemic.[6–8] Whereas previous teleophthalmology initiatives have relied on "store-and-forward" techniques of capturing patient data for future use (a process in which medical information is captured and later shared with a provider at another location and/or time), the COVID-19 pandemic prompted urgent adoption of direct-to-patient real-time teleophthalmology encounters.[9–13] However, the efficacy and accuracy of these urgently adopted, real-time teleophthalmology visits remain underexamined.

We previously described our initial experience with adapting teleophthalmology for outpatient visits at our institution, including our workflow, clinical encounters, and patient satisfaction.[2,11] However, little is known about the clinical accuracy of these teleophthalmology encounters. The purpose of this study is to examine the diagnostic accuracy and management agreement of patients seen by teleophthalmology at our institution who were later evaluated at a subsequent in-person visit.

Methods

This retrospective longitudinal study was approved by the Institutional Review Board of the University of Pittsburgh Medical Center (STUDY20040002), adhered to the tenets of the Declaration of Helsinki and its later amendments, and maintained Health Insurance Portability and Accessibility Act compliance. Informed consent was waived for this retrospective chart review.

Video Visit Workflow

Our teleophthalmology encounters occurred over real-time video encounters (video visits). Return patients were generally assigned to video visits with their established ophthalmologists. New patients were triaged to specialty service based on chief complaint (e.g., referring eye irritation or redness to the Cornea Service) or based on clinical findings from another department (such as orbital fracture follow-up with the Oculoplastic Service).

We have described the workflow of our video visit encounters previously.[11] In brief, approximately 1 day before their scheduled video visit, patients were contacted by an ophthalmic technician or optometrist to familiarize them with the video platform (Epic; Verona, WI). Visual acuity was self-measured by the patient over the phone call by using a static webpage with a Rosenbaum-style eye chart (available at https://farsight.care). Further examination and assessment were then performed by the ophthalmologist over real-time video communication.

Video Visit Cohort

We included a cohort of patients who underwent a video visit over the 3-week period from March 25 to April 16, 2020. For patients with more than one video visit, clinical characteristics from the first encounter were used for analysis. Video visit encounters were reviewed for patient demographics, number of video visits, patient type (new or established), visit type (acute or routine), need for urgent in-person follow-up, modality of follow-up (video, in-person, or no recommended follow-up), and recommended time frame for follow-up (in weeks).

Clinical Accuracy Assessment

Our cohort of video visit patients was examined for clinical outcomes at outpatient follow-up for up to 1 year following the initial video encounter (►**Fig. 1**). Diagnosis and management were compared between the video visit and the first subsequent in-person follow-up encounter. This retrospective chart review included analysis of the following characteristics: follow-up timing compared with recommendation (on-time, delayed, unplanned early, or lost to follow-up), diagnostic agreement on subsequent follow-up, and management over time (treatment continuation, escalation, deescalation, or substantive change). The timing of follow-up was defined as "on-time" if the visit was within 1 month window of the recommended follow-up period, "delayed" if the visit was delayed beyond the 1-month window, and "unplanned early" if the patient follow-up occurred prior to the completion of the recommended follow-up period. Management was considered "continued" if there were no changes in therapy or if the anticipated management course was continued (e.g., if a postoperative steroid taper was continued as planned). If management was changed on follow-up outside the anticipated course, it was characterized as either escalation, deescalation, or substantive change by physician review.

Statistical Analysis

Data were summarized during descriptive statistics, including mean and standard deviation. Single-sided and double-sided Pearson's chi-square test was used to draw comparisons between single and multilevel categorical variables.

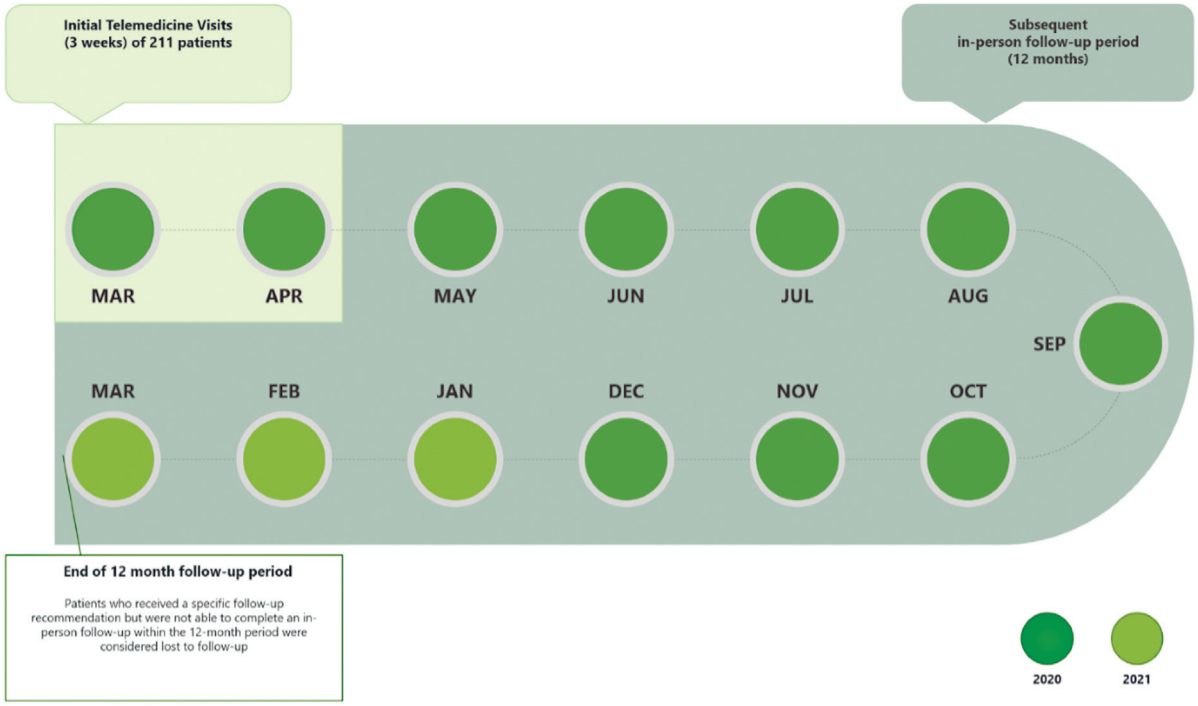

Fig. 1 Telemedicine follow-up analysis schematic.

Fisher's exact test was used to calculate odds ratios. The Welch two-sample *t*-test was used to compare continuous variables between groups. Statistical significance was assumed at $p < 0.05$. All analyses were performed in R (v4.0.1, John Chambers and colleagues, Bell Laboratories).

Results

A total of 210 patients completed at least one video visit from March 25 to April 16, 2020 and were included in this study. In this cohort, 114 (54%) were female and the mean age was 55 ± 18 years. Most patients had one video visit encounter (165, 78%), with the remainder undergoing two or more video visits (►**Table 1**).

Video Visit Characteristics

Of the 210 patients with video visit encounters, 86 patients (41%) presented for an acute concern and 124 (59%) sought routine care. Most patients were previously established with our practice (163, 77%), whereas 47 (23%) presented as new patients who had not previously established care with our center (►**Table 2**).

Common diagnoses included postoperative state (51, 24%), conjunctivitis (21, 10%), infectious keratitis (9, 4%), blepharitis (7, 3%), anterior uveitis (6, 3%), benign eyelid lesion (5, 2%), age-related macular degeneration (5, 2%), thyroid eye disease (5, 2%), dry eye disease (5, 2%), scleritis (4, 2%), and glaucoma (4, 2%).

Regarding management over video, half of all patients were given reassurance (104, 49%) and medication was prescribed for 61 (29%). Forty-five were referred for further evaluation in-person (21%), 22 of whom were recommended to come in urgently within 2 weeks (11% of the total).

Video Visit Characteristics for New Patients

Forty-eight patients established care with our practice by video visit without a previous office encounter. Almost all new patients presented for an acute concern (45 out of 48, 94%). Diagnoses made by video visit are outlined in ►**Table 3** and include conjunctivitis (11, 23%), blepharitis (4, 8%), thyroid eye disease (2, 4%), infectious keratitis (2, 4%), orbital fracture (2, 4%), benign orbital lesion (2, 4%), nonspecific eye pain (2, 4%), and transient visual obscuration (2, 4%). Management involved medication (20, 41%), referral for in-person evaluation (14, 27%), reassurance (13, 27%), and urgent-in person evaluation (8, 19%). The most common follow-up recommendations included in-person (20, 41%) and as needed only (19, 40%).

Diagnostic Accuracy and Management at Subsequent In-Person Assessment

Of 172 patients recommended follow-up with a subsequent visit, 141 (82%) followed through with an in-person appointment. Of this group, 126 followed up on time (89%), 10 presented for an unplanned early visit (8%), and 5 (3%) had a delayed office encounter. Almost all (137, 97%) had diagnostic agreement between the telemedicine and in-person visit, whereas four (3%) received a different diagnosis than the one from their initial video visit (►**Table 4**).

Management in-person was generally consistent with that from the video visit, as outlined in ►**Table 5**. One-hundred-and-sixteen (82%) patients received a continuation of the same management paradigm as offered on the initial

Table 1 Demographic characteristics of 210 patients who completed a video visit encounter from March 25, 2020, to April 16, 2020

Characteristic	Statistic
Gender, *n* (%)	
Male	96 (46)
Female	114 (54)
Age (years), mean ± SD	55 ± 18
Total number of video visit encounters, *n* (%)[a]	
One	165 (78)
Two	31 (15)
Three	6 (3)
Four	4 (2)
More than four	4 (2)

Abbreviation: SD, standard deviation.
[a]Includes follow-up video visits extending to 1 year beyond the initial encounter.

Table 2 Characteristics of 210 video visit encounters from March 25, 2020, to April 16, 2020

Characteristic	*n* (%)
Visit type	
Routine	124 (59)
Acute	86 (41)
Patient type	
Established	163 (77)
New	47 (23)
Visit diagnosis	
Postoperative state	51 (24)
Conjunctivitis	21 (10)
Infectious keratitis	9 (4)
Blepharitis	7 (3)
Anterior uveitis	6 (3)
Age-related macular degeneration	5 (2)
Dry eye	5 (2)
Eyelid lesion, benign	5 (2)
Thyroid eye disease	5 (2)
Glaucoma	4 (2)
Scleritis	4 (2)
Cystoid macular edema	3 (1)
Eye pain, NOS	3 (1)
Orbital lesion, benign	3 (1)
Refractive error	3 (1)
Transient visual obscuration	3 (1)
Eye irritation, NOS	2 (1)
Corneal abrasion	2 (1)
Epiretinal membrane	2 (1)
Hyphema	2 (1)
Keratoconus	2 (1)
Lagophthalmos	2 (1)
Macular hole	2 (1)
Ocular cicatricial pemphigoid	2 (1)
Orbital fracture	2 (1)
Peripheral ulcerative keratitis	2 (1)
Subconjunctival hemorrhage	2 (1)
Other[a]	52 (25)
Management[b]	
Reassurance	104 (49)
Medication	61 (29)
Referral for in-person evaluation	45 (21)
Urgent in-person evaluation (within 2 wk)	22 (11)
Imaging and/or laboratory testing	17 (8)
Recommended follow up interval (weeks), mean ± SD	9 ± 11

Abbreviations: NOS, not otherwise specified; SD, standard deviation.
[a]Miscellaneous: pattern retinal dystrophy, diabetic retinopathy, pterygium, epiphora, optic neuritis, bullous keratopathy, posterior vitreous detachment, episcleritis, retinitis pigmentosa exposure keratopathy, cancer-associated retinopathy, convergence insufficiency, canthal abscess, pigment dispersion syndrome, cataract, preseptal cellulitis, eyelid lesion (NOS), retinal migraine, floater, anophthalmia, chalazion, trauma, vitreous hemorrhage, ocular surface squamous neoplasia, anterior uveitis, atopic dermatitis, idiopathic intracranial hypertension, papilledema, choroidal neovascularization, band keratopathy, ischemic optic neuropathy, posterior capsular opacity, keratoconjunctivitis sicca, corneal neovascularization, chronic intermediate uveitis, presumed ocular histoplasmosis syndrome, chronic posterior uveitis, corneal perforation, chronic serous chorioretinopathy, retinal tear, malt lymphoma, corneal scar, medication-induced uveitis, Thygeson's superficial punctate keratitis, neurotrophic keratitis, diplopia, neurotrophic keratopathy, uveitis, nonarteritic anterior ischemic optic neuropathy, conjunctival cyst, idiopathic orbital inflammatory syndrome.
[b]Some patients had more than one management type; thus, percentages may not total 100%.

video encounter or reassurance on their in-person follow-up. Twenty-five patients (18%) had a change in management plan from the original management plan established during the video visit, of whom 19 (13%) received escalation of therapy, 4 (3%) received an entirely different treatment course, and 3 (2%) received deescalation of therapy with tapering or cessation of treatment.

New patients were 16 times more likely to have diagnostic disagreement following a video visit than established patients (12 vs. 1%, $p = 0.014$) (►**Table 5**). Acute visits

Table 3 Characteristics and management of 48 new patient video visits

Characteristic	*n* (%)
Specialty service	
Cornea	16 (33)
Retina	16 (33)
Comprehensive	6 (13)
Oculoplastics	6 (13)
Adult strabismus	2 (4)
Glaucoma	1 (2)
Neuroophthalmology	1 (2)
Video visit diagnosis	
Conjunctivitis	11 (23)
Blepharitis	4 (8)
Eye pain, NOS	2 (4)
Infectious keratitis	2 (4)
Orbital fracture	2 (4)
Orbital lesion, benign	2 (4)
Thyroid eye disease	2 (4)
Transient visual obscuration	2 (4)
Other[a]	21 (44)
Management[b]	
Medication	20 (41)
Referral for in-person evaluation	14 (27)
Urgent in-person evaluation (within 2 wk)	9 (19)
Reassurance	13 (27)
Imaging and laboratory testing	6 (13)
Recommended follow up type	
In person	19 (41)
As needed	19 (40)
Another video visit	9 (19)

Abbreviation: NOS, not otherwise specified.
[a]Miscellaneous (one patient each): Refractive error, atopic dermatitis, diplopia, epiphora, pigment dispersion syndrome, exposure keratopathy, scleritis, optic neuritis, eyelid lesion (benign), corneal abrasion, cataract, postoperative state, anterior uveitis, retinal migraine, idiopathic orbital inflammatory syndrome, subconjunctival hemorrhage, conjunctival cyst, macular hole, eyelid lesion (NOS), floater.
[b]Some patients had more than one management type; thus, percentages may not total 100%.

trended toward more diagnostic disagreement compared with routine visits (6 vs. 1%, $p = 0.28$) with a similar rate of management change (21 vs. 16%, $p = 0.48$). New patients were 4.8 times more likely to have early unplanned visits than established patients (17 vs. 5%, $p = 0.029$), and acute visits were associated with 5.3-fold higher odds of having an unplanned visit than routine visits (13 vs. 3%, $0 = 0.027$). New patients and acute patients had a shorter follow-up duration than their counterparts (3.8 vs. 8.5 weeks for new vs. established, $p = 0.002$; 5.0 vs. 9.2 weeks for acute vs. routine, $p = 0.009$; ►**Table 5**).

Discussion

We report the accuracy of outpatient video visits at our academic ophthalmology practice by evaluating diagnosis and management agreement compared with subsequent in-person follow-up. Our cohort of patients was seen via direct-to-patient real-time video visits during the early stages of the COVID-19 pandemic in the spring of 2020 and includes a mix of established and new patients who presented for both routine and acute concerns. Our retrospective review of follow-up outcomes identified excellent agreement between initial video visits and subsequent in-person evaluations for both diagnosis (97%) and management (82%). The diagnostic agreement was weaker for new patients (88%) compared with established ones (99%, $p = 0.014$), which suggests an advantage of having a previously established patient–physician relationship with the practice.

Our report is the first, to our knowledge, to assess the clinical accuracy of direct-to-patient real-time telemedicine for outpatient ophthalmic care. We have previously reported our experience implementing outpatient video visits and high levels of patient satisfaction with virtual encounters for ophthalmic care.[2,11] The diagnoses managed by telemedicine at our practice are similar to those that have been billed by other groups during the pandemic, with cornea and external diseases comprising a large proportion of visits.[14] Our current work provides evidence that teleophthalmology can deliver routine care with a high degree of agreement with decisions made at subsequent in-person follow-up.

Although not previously reported for routine outpatient practice, the clinical accuracy of telemedicine in ophthalmology has been assessed for emergency referrals and phone-based triage.[15] Deaner et al reported that triaging ophthalmologists correctly made a diagnosis over the phone with a referring provider 70% of the time and accurately triaged all vision- and life-threatening conditions.[15] Early use of indirect real-time telemedicine for ophthalmic emergencies identified 75% total agreement between video conference evaluation and face-to-face consultation, with clinically important disagreement occurring in only 5% of cases.[16] Our diagnostic agreement of 88% for new patients and 94% for acute visits exceeds that of these previous reports—perhaps due to the direct-to-patient video component of our encounters—and our assessment provides further evidence that video visits can be safely and effectively utilized for triage and management of outpatient ophthalmic concerns. Although the clinical accuracy of telemedicine for our new patient visits was high, our diagnostic and management agreement for new patients was significantly lower than for patients previously established with our practice. This may be attributed to the absence of prior in-person clinical examination and ancillary studies or to the higher prevalence of undifferentiated

Table 4 Cases with diagnostic disagreement between video visit and in-person follow-up

	Patient type	Visit type	Follow-up timing[a]	Video visit		In-person follow-up	
				Diagnosis	Management	Diagnosis	Management
Case 1	New	Acute	Unplanned early	Viral conjunctivitis	Artificial tears	Bilateral uveitis	Topical steroid, cycloplegic
Case 2	New	Acute	Unplanned early	Bacterial conjunctivitis	Antibiotic drops	Allergic conjunctivitis	Switch to antihistaminic drops
Case 3	Established	Routine	Delayed	Suture irritation	Antibiotic drops	Episcleritis	Topical steroid
Case 4	New	Acute	On time	Epiphora	Reassurance	Dermatitis	Antibiotic ointment

[a]Unplanned Early: earlier than 30 days prior from their scheduled follow-up. Delayed: Longer than 30 days after their scheduled follow-up. On time: within 30 days of their scheduled follow-up.

acute complaints compared with established patients. Future research and innovation for home-based technologies could improve the accuracy of telemedicine encounters by facilitating the collection of remotely accessible objective data.

Outpatient telemedicine has been demonstrated to have high levels of accuracy compared with in-person encounters in other medical specialties, including cardiology (94% agreement) and burn clinics (98%).[17–19] In neurology, telemedicine-based neurological examination and traditional neurological examination have fair to excellent agreement. Although the adoption has been lower among surgical subspecialties, the agreement between telemedicine and in-person visits has been similarly high in orthopedic surgery (96%) and otolaryngology (97%).[20,21] Our results suggest a similar promise for telemedicine in routine outpatient ophthalmology encounters.

Although our study demonstrates early evidence for clinical accuracy in teleophthalmology, it has the expected limitations associated with a single-institution, retrospective study. First, our patient population may not be representative of ophthalmology patients as a whole. For example, some patients may not have had the technology required to participate in a video visit; such patients with urgent concerns were subsequently directed to have an in-person evaluation. Additionally, we have so far included only English-speaking patients in our program, and the incorporation of translators for video visits would be an important future direction to promote access to video visits for non-English-speaking patients. A second limitation is the relatively short-term follow-up in this study, and further investigation would be beneficial to accurately assess longitudinal outcomes of this telemedicine model. Third, little is known about the outcomes of patients who received follow-up recommendations but were subsequently lost to follow-up. Finally, while telemedicine offers a valuable new tool for remote ophthalmologic assessment, further research is needed to confirm its validity. Therefore, we generally recommend following up a video-visit encounter with a traditional in-person assessment by an ophthalmologist.

In conclusion, we present a clinical accuracy assessment of a direct-to-patient real-time outpatient ophthalmic telemedicine program at our institution and demonstrate high diagnostic and management agreement between video visit and subsequent in-person follow-up. Our results provide further support the routine implementation of teleophthalmology in the outpatient setting. Although our in-person clinic volumes have nearly returned to prepandemic levels, video visits continue to have an important role in our department for nonurgent patient concerns, particularly for postoperative patients and those who live far from the clinic. Prospective and multicenter studies are required in this area to further this research.

Availability of Data and Material

Available upon request.

Table 5 Clinical outcomes at in-person follow-up after video visit by patient type and visit type

Characteristic	All patients	Patient type			Visit type		
		Established	New	Statistic[a]	Routine	Acute	Statistic[a]
	n (%)	*n* (%)	*n* (%)		*n* (%)	*n* (%)	
Total	141 (100)	117 (100)	24 (100)		89 (100)	52 (100)	
Diagnostic agreement							
Same as video visit	137 (97)	116 (99)	21 (88)	**OR = 16, $p = 0.014$**	88 (99)	49 (94)	OR = 5.3, $p = 0.281$
Different from video visit	4 (3)	1 (1)	3 (12)		1 (1)	3 (6)	
Management							
Continuation of current treatment	116 (82)	98 (84)	17 (71)	OR = 1.7, $p = 0.465$	75 (84)	41 (79)	OR = 1.4, $p = 0.416$
Management change	25 (18)	19 (16)	7 (29)		14 (16)	11 (21)	
Escalation of therapy	18 (13)	13 (11)	5 (21)		9 (10)	8 (15)	
Different course of therapy	4 (3)	1 (1)	2 (8)		1 (1)	3 (6)	
Deescalation of therapy	3 (2)	3 (3)	0		4 (5)	0	
Follow up duration (weeks), mean ± SD	7.7 ± 9.9	8.5 ± 10.4	3.8 ± 5.9	**$p = 0.002$**	9.2 ± 10.4	5.0 ± 8.6	**$p = 0.009$**
Timing of in-person encounter after video visit							
As recommended[b]	124 (87)	105 (90)	19 (79)	**OR = 4.8, $p = 0.029$**	81 (91)	43 (83)	**OR = 5.3, $p = 0.027$**
Unplanned or early follow-up visit	10 (8)	6 (5)	4 (17)		3 (3)	7 (13)	
Delayed[c]	7 (5)	6 (5)	1 (4)		5 (6)	2 (4)	

Abbreviations: OR, odds ratio; SD, standard deviation.
[a]Established patient and routine visit were used as reference categories for calculation of odds ratios.
[b]Follow-up occurred "as recommended" if the in-person encounter took place within 1 month of the recommended interval.
[c]Patients were considered delayed if they had no follow up visit after 1 month beyond the recommended follow up interval.
Note: The bold text indicates those *p*-values that are statistically significant.

Code Availability
Not applicable.

Ethics Approval
This retrospective longitudinal study was approved by the Institutional Review Board of the University of Pittsburgh Medical Center (STUDY20040002), adhered to the tenets of the Declaration of Helsinki and its later amendments, and maintained Health Insurance Portability and Accessibility Act (HIPAA) compliance. Informed consent was waived for this retrospective chart review.

Authors' Contribution
All authors contributed to the study conception and design. The first draft of the manuscript was written by T.S. and G.K., with additional contributions from all authors. All authors read and approved the final manuscript.

Funding
This work was supported by the Henry L. Hillman Foundation, National Institutes of Health (NIH) CORE Grant P30 EY08098, the Eye and Ear Foundation of Pittsburgh, and from an unrestricted grant from Research to Prevent Blindness to the Department of Ophthalmology at the University of Pittsburgh. A.M.W received funding from Research to Prevent Blindness and a Mentoring for the Advancement of Physician Scientists (MAPS) award from the American Glaucoma Society. The funding organizations had no role in the design or conduct of this research.

Conflicts of Interest
None declared.

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