

The Role of Telemedicine in Glaucoma Care Triggered by the SARS-CoV-2 Pandemic: A Qualitative Study

Helen Liu^{1,*}, Stephanie Ying^{1,*}, Samir Kamat¹, Connor Tukul¹, Janet Serle^{2,3}, Robert Fallar¹, Tak Yee Tania Tai^{2,3}, Nisha Chadha^{2,3}

¹Department of Medical Education, Icahn School of Medicine at Mount Sinai, New York, NY, USA; ²Department of Ophthalmology, Icahn School of Medicine at Mount Sinai, New York, NY, USA; ³Department of Ophthalmology, New York Eye and Ear Infirmary, New York, NY, USA

*These authors contributed equally to this work

Correspondence: Nisha Chadha, Ophthalmology and Medical Education, Department of Ophthalmology, Icahn School of Medicine and New York Eye and Ear Infirmary of Mount Sinai, 17 E 102nd Street, New York, NY, 10029, USA, Tel + (212) 731-3355, Fax + (212) 824-2325, Email nisha.chadha@mssm.edu

Purpose: To explore and report on how glaucoma care was impacted by the SARS-CoV-2 pandemic (COVID-19) in New York City (NYC) with a specific emphasis on the role of telemedicine.

Patients and Methods: This was a qualitative, cross-sectional study that engaged glaucoma clinicians in semi-structured interviews to elicit perspectives on telemedicine and patient care experiences during the pandemic. Interview responses were coded and analyzed thematically.

Results: Twenty clinicians participated. Mean participant age was 48.8 ± 12.3 years, and the mean number of years in practice post-glaucoma fellowship was 17.5 ± 12.4 years. Four main themes pertinent to the role of telemedicine triggered by the COVID-19 pandemic were identified: (1) The Need to Ensure Patient and Staff Safety Drove Telemedicine Uptake; (2) Telemedicine Allowed Providers to Address Subjective Complaints; (3) Telemedicine was Discontinued Due To Concerns of Compromised Patient Safety and Measurement Inaccuracy; (4) Technological Advances are Needed for Continued Telemedicine Usage and Uptake in Glaucoma Care. The interviews suggested that telemedicine usage dropped markedly within just a few months during the pandemic, and for most physicians interviewed, telemedicine is no longer part of their clinical practice. Several clinicians reported optimism towards future implementation of telemedicine as the technology develops.

Conclusion: This study identified 4 themes outlining the uptake, application, discontinuation and overall perspectives on telemedicine by glaucoma clinicians. The role of telemedicine, as triggered by the COVID-19 pandemic, may have lasting implications for patient safety, continuity of care, and glaucoma care delivery beyond this public health crisis.

Keywords: telemedicine, interview, COVID-19, pandemic, healthcare delivery, physician experiences

Introduction

Glaucoma refers to a group of diseases that damage the optic nerve, resulting in vision loss. As the leading cause of irreversible blindness worldwide, it is estimated to affect more than 60 million people worldwide and more than 3 million Americans.^{1,2} As such, it is not surprising that the estimated annual cost for glaucoma management in the United States exceeds \$2.9 billion.³ Since glaucoma is a chronic disease, it is of importance that patients are monitored at clinic visits at least once a year.

However, unprecedented spread of the SARS-CoV-2 pandemic (COVID-19) markedly transformed health care delivery across specialties.⁴ Hospitals and clinics closed most of their outpatient practices, and medical practices and patients turned to telemedicine.^{4,5} Similarly, only emergent patients were given in-person ophthalmology appointments.⁵ Most ophthalmology societies recommended avoiding elective care.⁵ Guidelines by the American Academy of

Ophthalmology (AAO) included instructions for social distancing and infection prevention protocols in order to safely resume elective procedures.⁶ The pandemic presented challenges for the delivery of glaucoma care, which typically requires close-contact in-person evaluation with high patient volume and a need for many ancillary tests. Furthermore, providers in New York City (NYC) have endured a substantial burden given space limitations, a dense population, and the city's heavy regional burden of COVID-19 infections in the United States, particularly in the early phase of the pandemic.⁷ As NYC was the United States' first epicenter during the COVID-19 pandemic, it is of particular interest to analyze how clinicians in this region adapted to the pandemic.

The pandemic left glaucoma clinicians searching for answers with critical decisions to make, including: close contact glaucoma examination vs virtual telemedicine, disinfection vs cost of disposable supplies, aerosolization concerns vs cost and accuracy of disposable tonometer tips,⁸ patient volume vs space, and continued utilization of visual fields.⁹ As the pandemic continued, telemedicine became increasingly implemented. Studies conducted on teleophthalmology have consistently demonstrated its effectiveness in providing consultative services, remote supervision, and triaging for eye conditions.^{10,11} Multiple studies investigate the efficacy of telemedicine for glaucoma screening and showed teleglaucoma screening reduced false positive referrals.^{10–12} A meta-analysis of 45 studies showed teleglaucoma had a sensitivity of 83% and specificity of 79% as a test for glaucoma screening.¹³ Telemedicine has also been studied as a tool for monitoring glaucoma patients. Teleglaucoma reduced the time physicians spent reviewing each case and the access time for patients. In one such study by Thomas et al, it was found that telemedicine significantly reduced patient travel times by an average of 61 hours and decreased physician wait times by 30% as compared to traditional in-person examinations.¹¹ Unfortunately, however, virtual telemedicine also comes with many challenges for several components of glaucoma care — visual acuity testing, visual field testing, intraocular pressure (IOP) and pachymetry measurements, biomicroscopy examination including gonioscopy, optic nerve assessment, and the imaging and photographic modalities that are standard of care for glaucoma management.¹³ Other methods of reduced contact care delivery were implemented across the United States, such as drive-through IOP measurements. However, in areas with denser populations and limited open public space, such as New York City, these types of mitigation measures were unfeasible, resulting in unique challenges for clinicians practicing in urban areas. Because of the usual reliance on physical measurements and testing in glaucoma care, we were especially interested in how the shift to telemedicine affected glaucoma care.

In this study, interviews with glaucoma clinicians in NYC during the pandemic were conducted and analyzed in a qualitative manner. The goal was to understand how glaucoma clinicians responded to the pandemic, including why and how telemedicine was implemented and how physicians viewed the future of telemedicine in glaucoma care.

Materials and Methods

Design

This is a qualitative, cross-sectional study. Semi-structured interviews were conducted (by H.L. or S.Y.) with NYC glaucoma clinicians between July and December 2021, approximately 15–18 months after the start of the pandemic in New York. The study used a phenomenological approach to its design. Such an approach allows for the study of participants' shared experiences dealing with a specific phenomenon: how glaucoma clinicians responded to the COVID pandemic.¹⁴ Such studies focus primarily on interviews to understand the participants' experiences. Institutional Review Board (IRB)/Ethics Committee approval was obtained (No.20–01609, Mount Sinai Hospital, New York, New York).

Participant Recruitment

All clinicians recruited are ophthalmologists. Specifically, clinicians that had completed glaucoma fellowship training and were practicing ophthalmology in New York City during the COVID-19 pandemic were recruited to participate. Participants were identified first by convenience sampling using a list of all actively practicing NYC glaucoma clinicians. Contact information for these 45 clinicians were found on the New York Glaucoma Society mailing list, and additional glaucoma clinicians were suggested by the senior authors. Snowball sampling was used to suggest and identify glaucoma colleagues by study participants. Participants were recruited through email.

Data Collection

A research information sheet was shared with participants prior to the interview. Verbal consent with a nonparticipating witness was obtained at the start of the interviews from all participants, and participants were notified about the purpose and research question of the study. Informed consent included publication of anonymized responses. Participating glaucoma clinicians completed one 20-minute to 40-minute audio-recorded interview with one of the authors (H.L. or S.Y.) via a remote video conferencing tool (Zoom). All interviews were conducted individually. An interview guide ([Supplement 1](#)) was developed and refined by all the authors to standardize the interview process. The interview guide included 15 preliminary open-ended questions to elicit glaucoma clinicians' perspectives and experiences pertaining to clinical care during the pandemic. Quantitative questions about telemedicine use and the participants' demographics and practice experience were asked. This semi-structured interview guide was tested within the research group through 2 pilot interviews by S.Y. or H. L. with the senior authors (T.Y.T.T. and J.B.S.). The flexibility of semi-structured interviews helps define areas to be explored while also allowing the interviewer to probe ideas in more detail. Interviews were audio recorded and transcribed verbatim. Transcripts were manually reviewed to confirm accuracy by H.L. and S.Y. To protect confidentiality, all identifying information was removed from the transcripts. Transcripts were not returned to participants for comment and/or correction. No field notes were made during and/or after the interviews, and no repeated interviews were conducted.

Data Analysis

Thematic analysis and theme generation were performed using NVivo software (QSR International Pty Ltd. (2020)). Three of the authors (S.Y., H.L. and C.T.) developed codes using both deductive and inductive methods. S.Y. and H. L. developed an a priori list of codes to identify common barriers and also allowed for in vivo codes from the interviewees' own discussions. S.Y., H.L., and C.T. each independently reviewed and coded 4 transcripts, comparing results and clarifying any disagreement until a final code set was agreed upon. S.Y. and H.L. coded all remaining transcripts and re-coded prior transcripts using these agreed-upon codes. All authors collectively reviewed codes and developed overarching themes that were derived from the data. H.L. and S.Y. selected representative quotes to illustrate these themes. Findings from the study were not reviewed by participants.

Results

45 glaucoma clinicians were contacted, 20 of whom agreed to participate (44%) and 25 (56%) did not respond. The mean and standard deviation age of participants was 48.8 ± 12.3 years ([Table 1](#)). Most participants were female (12 [60%]) and practicing in large academic hospitals (17 [85%]). Clinicians were all attending glaucoma clinicians; the mean and

Table 1 Patient Characteristics

Characteristic	Participants (N = 20)	
	N	%
Age, mean (SD)	48.8 (12.3)	
Sex		
Female	12	60
Male	8	40
Years in Glaucoma Practice		
<1-10	7	35
11-20	4	20
21-30	5	25
31-40	4	20
Years in Glaucoma Practice, mean (SD)	18.5 (12.4)	
Practice Type		
Academic (6)*	17	90
Private Practice (3)*	3	10

Notes: *Number of institutions represented.

standard deviation number of years in practice post-fellowship was 17.5 ± 12.4 years. Clinicians ranged from <1 to 38 years of practicing. Clinicians ranged from having 50%-100% of their practice consist of glaucoma patients, with the mean proportion and standard deviation being $77.4\% \pm 17.8\%$. All participants practiced in New York City during the COVID-19 pandemic. 17 clinicians were recruited from 6 different academic practices, while 3 clinicians were recruited from 3 different private practices to participate in the study.

Providers were asked about their specific usage of telemedicine prior, during, and after the first peak of the pandemic. Prior to the pandemic, all physicians (20/20, 100%) interviewed did not utilize telemedicine into their practice. Practitioners reported telemedicine was used for $29.1\% \pm 30.0\%$ (mean \pm standard deviation) of their patient practice during the peak of COVID (Figure 1). After the first few months of the pandemic, telemedicine use dropped markedly ($3.1\% \pm 5.1\%$) (p value < 0.001).

Four themes emerged regarding the implementation of telemedicine in response to the COVID-19 pandemic and the concerns of COVID-19 transmission: (1) The Need to Ensure Patient and Staff Safety Drove Telemedicine Uptake; (2) Telemedicine Allowed Providers to Address Subjective Complaints; (3) Telemedicine was Discontinued Due To Concerns of Compromised Patient Safety and Measurement Inaccuracy; (4) Technological Advances are Needed for Continued Telemedicine Usage and Uptake in Glaucoma Care.

Theme I: The Need to Ensure Patient and Staff Safety Drove Telemedicine Uptake

The COVID-19 pandemic presented threats of disease transmission, especially during settings of close contact and interaction, such as patient visits with glaucoma clinicians. Interviewees reported sentiments of fear among patients, clinicians, and clinic staff, particularly at the start of the pandemic (Table 2).

Everybody was scared. There were a lot of people dying, and nobody wanted to be one of them.... We didn't have any patients who we saw who didn't wear a mask. So if somebody refused to wear a mask, we didn't see them. And you know, we tried to have a frank discussion and convince them to wear a mask. It was a very small number of people. But we made sure that the number one thing was that everybody was safe. And that means for the patients and also for the employees and faculty trainees and the department. (Interview 9)

The threat to safe glaucoma care delivery drove all clinicians interviewed to implement practice changes to ensure the health and safety of clinicians, patients and other stakeholders. One of the major changes implemented to practice social

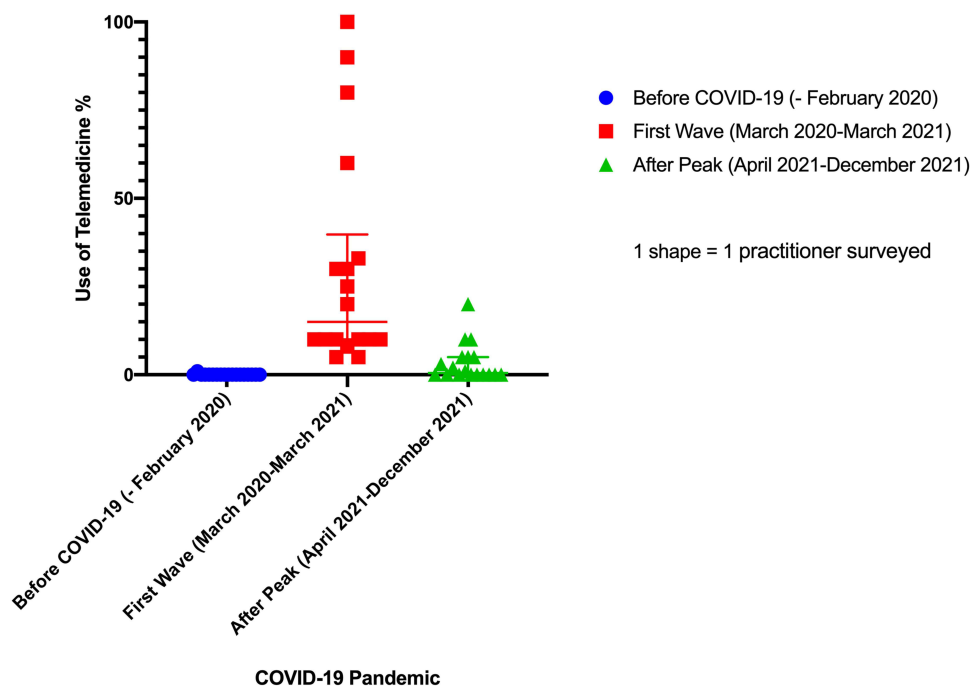


Figure 1 Telemedicine Usage During the COVID-19 Pandemic For Glaucoma Practitioners Surveyed.

Table 2 Quotes for Theme 1: The Need for Safe Glaucoma Care Delivery During the COVID-19 Pandemic Drove Telemedicine Uptake

Quote	Interview No.
Everybody was scared. There were a lot of people dying, and nobody wanted to be one of them.... We did not have any patients who we saw who did not wear a mask. So if somebody refused to wear a mask, we did not see them. And you know, we tried to have a frank discussion and convince them to wear a mask. It was a very small number of people. But we made sure that the number one thing was that everybody was safe. And that means for the patients and also for the employees and faculty trainees and the department.	9
At the start of COVID pandemic, everybody was scared to come into the clinic. Even if you tried to convince them and say, look, this could be a major problem, they might not even want to. And so that made patient care a lot more difficult in the beginning... The pros are that it helped kickstart telemedicine because that's when the administration decided that we really have to develop this program.	5
During televisits, people were very openly saying I am too scared. I do not want to get sick. I am elderly. I have "XYZ" underlying conditions. I am not going to put myself at risk. I refuse to come in. So they would be very open about that. And rightly so were their concerns and we respected their worries.	8
There were some people who were reluctant to come into the hospital for their eyecare, and for those people, we offered tele-ophthalmology, if we could. Or else those patients either sought other care another way. We did not, and we do not have the ability to do what some practices and institutions were able to do where they saw the patient in the parking lot or the patient would park on the street and have their exam. That's hard to do in Manhattan.	9
I had a cadre of patients that were very afraid to come in that I did some televisits for.	14
With COVID, of course I did a lot more telemedicine. During the height of COVID, when we were shut down, I probably had a few video visits a day and a few scheduled phone calls a day. Once we got back into the clinic, I did a few video visits for people who were still really reluctant to come in.	14

distancing and minimize disease spread between clinicians and patients was telemedicine. Prior to the pandemic, none of the clinicians interviewed had utilized telemedicine in their practices, but they all started to implement at least some form of telemedicine into their practices with the onset of the COVID-19 pandemic (eg, telephone calls, video visits). This had potential benefits for both patients and staff. Interviewed clinicians reported that on average, they used telemedicine for around 30% of their patient practice during the pandemic's peak.

At the start of COVID pandemic, everybody was scared to come into the clinic. Even if you tried to convince them and say, look, this could be a major problem, they might not even want to. And so that made patient care a lot more difficult in the beginning... The pros are that it helped kickstart telemedicine because that's when the administration decided that we really have to develop this program. (Interview 5)

One clinician commented that although she was unsure whether telemedicine was developed enough to be used, safety concerns caused by the pandemic necessitated the adoption of telemedicine much sooner than anticipated.

Not just us, but a lot of places you know, sort of implemented telehealth much sooner than they would have, and to a much greater degree, because we were forced to do things differently. (Interview 7)

Maximizing physical distance between patient and provider through telemedicine was one of very few options available to clinicians other than an in-person visit in an urban landscape like New York City.

There were some people who were reluctant to come into the hospital for their eyecare, and for those people, we offered tele-ophthalmology, if we could. Or else those patients either sought other care another way. We didn't, and we don't have the ability to do what some practices and institutions were able to do where they saw the patient in the parking lot, or the patient would park on the street and have their exam. That's hard to do in Manhattan. (Interview 9)

As the COVID-19 pandemic progressed into later waves and phases, clinics began to reopen and see patients in-person. At this point, some clinicians reported that they would still conduct telemedicine visits, but their patients' fear dictated the level of telemedicine that was done. If a select group of patients continued to fear disease transmission, providers would use telemedicine to a lesser degree even as the majority of their patients returned to in-person visits.

With COVID, of course I did a lot more telemedicine. During the height of COVID, when we were shut down, I probably had a few video visits a day and a few scheduled phone calls a day. Once we got back into the clinic, I did a few video visits for people who were still really reluctant to come in. (Interview 14)

Theme 2: Telemedicine Allowed Providers to Address Subjective Complaints

Telemedicine was implemented quickly during the pandemic, due to the unique concerns and fears of unsafe in-person care, and glaucoma clinicians found that telemedicine gave them the tools to deliver high-level health care (Table 3). Almost half (8) of the glaucoma clinicians interviewed specifically mentioned the use of telemedicine to deliver reassurance to patients, especially for those with anxiety.

Table 3 Quotes for Theme 2: Telemedicine Allowed Providers to Address Subjective Complaints

Quote	Interview No.
A lot of patients with glaucoma are very anxious about their vision. They like coming in pretty frequently just to make sure that their pressures are okay. So I used [telemedicine] a lot, I think more to just ease the anxiety of the patients who were not able to come in to see us as opposed to really managing their care... For the patients, it's helpful. Because I think they feel reassured that someone's thinking about them – that they are still being cared for.	6
I definitely did some [remote calls] initially and honestly, most of those phone calls were kind of trying to reassure patients.	17
I would say I did things like red eye exams and some post-op care pretty successfully... Telemedicine is good just to kind of keep tabs on the patient and emphasize the importance of drops and so forth.	3
I think it's good for the patients who may just need an annual like follow up. You can just reassure them, refill their medications, you know, and that kind of stuff... or if for a postop patient, like a straight up postop patient, you just wanna make sure they are doing okay. They are using their drop instructions correctly. Yeah, I think for that, that was fine.	21
So when you are talking about the time where you are really having no office visits and try to substitute something for that, telehealth was a good, a good way to fill in the gap in the hospital clinic. We used it for triage and that's something that's carried over. So what we would do is in patients who had emergencies, instead of coming to the hospital, they would call.	7
We did a great job of getting people in, getting them tested, getting them surgery if they needed it. Video visits were really helpful for that.	6
I will tell you the one place where we really stood up and we have actually published on this, is around triage. We stood up a triage system very early on. So we realized during the first phase, if we were going to cancel, you know, thousands of patients, we are still getting, you know, the same number of emergency calls per day eye infections, eye injury, post-operative problems, et cetera. So we stood up a telemedicine platform with triage that involved a number of caregivers.	14
If you count the patients getting their histories via phone, it was like a hundred percent [telemedicine use]. [Telemedicine was] more efficient for our history taking process for patients.	3
I think some of my colleagues had to learn how to utilize telemedicine in post-op patients, where they actually had the patient kind of palpating their eye to get a sense of what their eye pressure was post-operatively.	2
We had a tele-ophthalmology consult and I was teaching him how to check his own eye pressures with his two fingers... I walked him through it a few times. I see he was doing it wrong. And then when he finally got it right, I said, how does it feel? Does it feel like a grape or does it feel more like an apple? And he will say, grape. I was like, all right, that's good. And he ended up doing well... this improvisation to get someone to check their own eye pressures, which is just a critical thing to catch, seemed to be helpful.	10

For the patients, it's helpful. Because I think they feel reassured that someone's thinking about them – that they're still being cared for. (Interview 6)

New concerns such as being unable to come into the office, as well as other general fears about the pandemic, were addressed through telemedicine, which also allowed glaucoma clinicians to have successful maintenance and follow-up care as well.

I would say I did things like red eye exams and some post-op care pretty successfully... Telemedicine is good just to kind of keep tabs on the patient and emphasize the importance of drops and so forth. (Interview 3)

The role of telemedicine quickly and unexpectedly became triage. About a third of the glaucoma clinicians (7) spoke about how helpful telemedicine and video visits were for triaging patients and how they are still being implemented for this role today. In fact, one glaucoma clinician reported that triage was “the one place where [telemedicine] really stood up” (Interview 14). One provider mentioned using telemedicine 100% of the time for their practice during the pandemic; another provider reported 90% usage and yet another reported 80%. These glaucoma clinicians specifically mentioned triage and reassurance as telemedicine strengths.

We did a great job of getting people in, getting them tested, getting them surgery if they needed it. Video visits were really helpful for that. (Interview 6)

There were additional strengths of telemedicine reported by a few interviewees. Two glaucoma clinicians discussed the utility of telemedicine for history-taking. One reported that “if you count the patients getting their histories via phone, it was like a hundred percent [telemedicine use]” (Interview 3). Several mentioned that telemedicine was able to assist in certain areas of ophthalmology, namely for subconjunctival hemorrhages and other subspecialties such as neuro-ophthalmology and oculoplastics. Further, attempts have been made to collect relative subjective measurements. Four interviewees reported instances of relatively measuring intraocular pressure given its unique importance in glaucoma care.

I think some of my colleagues had to learn how to utilize telemedicine in post-op patients, where they actually had the patient kind of palpating their eye to get a sense of what their eye pressure was post-operatively. (Interview 2)

We had a tele-ophthalmology consult and I was teaching him how to check his own eye pressures with his two fingers... I walked him through it a few times. I see he was doing it wrong. And then when he finally got it right, I said, how does it feel? Does it feel like a grape or does it feel more like an apple? And he'll say, grape. I was like, all right, that's good. And he ended up doing well... this improvisation to get someone to check their own eye pressures, which is just a critical thing to catch, seemed to be helpful. (Interview 10)

Theme 3: Telemedicine Was Discontinued Due to Concerns of Compromised Patient Safety and Measurement Inaccuracy

Despite some success in the utilization of telemedicine as highlighted in Theme 2, many clinicians brought up the limitations of telemedicine in glaucoma care (Table 4). All clinicians interviewed reported that telemedicine in its current state is inadequate for glaucoma practitioners. The predominant reason they expressed was the inability to collect critical measurements for the glaucoma examination such as IOP, visual field testing, and examination of the optic nerve and retina. The inability to collect these data accurately subsequently compromised patient safety.

[Telemedicine] was mostly more hand holding than anything else and sort of checking in with people, things like that. But as far as actual care, I found the utility of it not so special. (Interviewee 14)

There's so much data collection needed whether it be a slit lamp examination, intraocular pressure assessment structure or function analysis of the optic nerve, whether it be visual fields or CCT. [Telemedicine]'s somewhat limited because you can't do most of the things. You can check vision. You can check eye movements. You can check other things that aren't as relevant to glaucoma care. But most of it is not possible. (Interviewee 13)

Table 4 Quotes for Theme 3: Telemedicine Was Discontinued for Concerns of Compromised Patient Safety and Measurement Inaccuracy

Quote	Interview No.
[Telemedicine] was mostly more hand holding than anything else and sort of checking in with people, things like that. But as far as actual care, I found the utility of it not so special.	14
There's so much data collection needed whether it be a slit lamp examination, intraocular pressure assessment structure or function analysis of the optic nerve, whether it be visual fields or OCT. [Telemedicine]'s somewhat limited because you cannot do most of the things. You can check vision. You can check eye movements. You can check other things that are not as relevant than to glaucoma care. But most of it is not possible.	13
"It was challenging doing telemedicine when you are also seeing patients at the same time... when you are doing telemedicine, it's a specific time you gotta be on, on the zoom or on the call at a certain time. It's very stressful. And I think some of my colleagues around the country are finding that they do their telemedicine at separate times than when they are seeing patients, that is, they will do their telemedicine at the front of their practice time or the end of their practice time. So it does not conflict with their seeing patients during the regular day".	11
Especially in glaucoma, I think we feel that we need to check the eye pressure, and we have to look at the nerve... we could not envision telemedicine.	2
Well, think that, you know, you had to think twice about patients who needed a trabeculectomy because trabeculectomy requires a lot of follow-up visits. Literally patients need to be seen every other day in the first week, and when you really need to get a low target pressure, it's just not going to work. And that was really difficult during the pandemic and it's still somewhat difficult now. So I think that that's a big change... there was one patient whose surgery was delayed for almost a year. Luckily it was not a trabeculectomy but a transscleral cyclophotocoagulation in an eye that was not seeing well to begin with. But you know, you hate to have those kinds of delays, but that's kind of what happened.	10
I have to tell you, I underbilled because it was so complicated how much time it took to document that. I looked at photos, I spoke with them and did very little billing, because that was not what was important. What was important is that I was providing care and that I was continuing the practice and that the practice would survive this.	12
Some people did, in my practice, use tele-video, but they did it when they came into work. There was somebody to help them to set up. I think technical difficulties, number one, prevented those kinds of visits. And secondly, coming to the office and doing that kind of work defeats the purpose. If you do not have technical support at home, you have to go to work to do telehealth. It was not that practical, but you really wanted to do it.	16
Pre-COVID I had no telemedicine. Zero. I would have phone calls to patients every once in a while, but they were definitely non-scheduled phone calls and very casual... With COVID of course I did a lot more telemedicine... But even during the height of COVID, like when we were shut down, I probably had a few video visits a day and a few scheduled phone calls a day... Once we got back into the clinic, I did a few video visits for people who were really reluctant to still come in. I do very little video visits now... very, very little, I mean, it's been a while since I did a video visit. Of course I am still now back to just returning phone calls and things like that, like normal, but again, like for glaucoma, you cannot check somebody's eye pressure remotely.	15
Sanitation protocols honestly still seem to be kind of the same. I do not think those have really gone back to anything different.	16
We have cut down the number of our seats available in the waiting room. And we did not want to have people congregate together... I had a lot of patients who were happy that there were fewer patients in the waiting room, and they had to wait less time. So I have had positive feedback and that they actually are coming to the office now more than in the past.	3
For equipment, we moved to using a lot of disposable items: tonometer tips, gonioscopy lenses, lenses for laser procedures. Those are all disposable and we have continued that practice. Part of that was that those are the, I guess, safest in terms of infection prevention.	6
But when you are talking about patient safety, there's no, there's no debating. You know, what if a patient who goes on to be diagnosed with some type of viral keratitis or severe ocular infection, secondary to a non-disposable Goldmann applanation? It's not worth it.	18

(Continued)

Table 4 (Continued).

Quote	Interview No.
I think probably all of the other subspecialties within ophthalmology are really still using the iCare or the tonopen to measure eye pressure. But in glaucoma, we have gone back to Goldmann applanation because it's just more accurate.	5
They tried, we had these disposable tonometer tips for a while, but they were terrible for glaucoma and they just were... Like I actually, I could not use them and we ended up soaking them in alcohol... We did use the disposable ones for a while, but they were so bad. It was not worth it.	14
I definitely extended my time of follow-up with patients. So initially, obviously when I first started practicing, I was seeing patients like every three months, whether or not they needed it and then I extended it into four months. Now, I would say since COVID my stable patients are six months now. And then I see my patients who were somewhat stable or mostly stable at four months. And even the not so stable people are maybe two to three months and not every month. So I would say my length of asking people to come back, like that interval has definitely no question extended.	14
My level of comfort of having a patient come back many months later than I usually would got better. So in other words, if I usually saw a patient three times a year, and it became twice or once a year because of the pandemic, I did not notice a major problem with a lot of those pretty stable patients. So I am having patients come back less too for those that I feel are stable, and I am more comfortable with that decision.	10

The transition to telemedicine and avoidance of in-person visits also caused delayed care. One clinician specifically mentioned that they were hesitant to perform certain procedures like trabeculectomies, given the number of in-person postoperative follow-up appointments required. For example, they recalled a patient whose transscleral cyclophotocoagulation was delayed for almost a year.

Well, think that, you know, you had to think twice about patients who needed a trabeculectomy because trabeculectomy requires a lot of follow-up visits. Literally patients need to be seen every other day in the first week, and when you really need to get a low target pressure, it's just not going to work. And that was really difficult during the pandemic and it's still somewhat difficult now. So I think that that's a big change... there was one patient whose surgery was delayed for almost a year. Luckily it wasn't a trabeculectomy but a transscleral cyclophotocoagulation in an eye that was not seeing well to begin with. But you know, you hate to have those kinds of delays, but that's kind of what happened. (Interview 10)

A minority of those interviewed also emphasized unique challenges related to telemedicine, including unclear and new guidelines for billing, and technical difficulties such as difficulty setting up video conferencing and internet connectivity issues. One provider also reported a difficulty in balancing telemedicine and in person practice.

I have to tell you, I underbilled because it was so complicated how much time it took to document that. I looked at photos, I spoke with them and did very little billing, because that wasn't what was important. What was important is that I was providing care and that I was continuing the practice and that the practice would survive this. (Interview 12)

Some people did, in my practice, use tele-video, but they did it when they came into work. There was somebody to help them to set up. I think technical difficulties, number one, prevented those kinds of visits. And secondly, coming to the office and doing that kind of work defeats the purpose. If you don't have technical support at home, you have to go to work to do telehealth. It wasn't that practical, but you really wanted to do it. (Interview 16)

Altogether, these difficulties led to a cessation of the use of telemedicine among those interviewed. Half of the clinicians interviewed had completely discontinued their telemedicine usage at the time of their interview.

Pre-COVID I had no telemedicine. Zero. I would have phone calls to patients every once in a while, but they were definitely non-scheduled phone calls and very casual... With COVID of course I did a lot more telemedicine... But even during the height of COVID, like when we were shut down, I probably had a few video visits a day and a few scheduled phone calls a day... Once we got back into the clinic, I did a few video visits for people who were really reluctant to still come in. I do very little video visits now... very, very little, I mean, it's been a while since I did a video visit. Of course I'm still now back to just

returning phone calls and things like that, like normal, but again, like for glaucoma, you can't check somebody's eye pressure remotely. (Interview 15)

Among those who continued to utilize telemedicine, only one provider reported that telemedicine comprised more than 10% of their practice. This provider, a partner at a private practice, uniquely spoke on the assistance given by the government to businesses as a positive outcome of the pandemic. In addition, this practitioner reported the utility of telemedicine and their own personal heightened fear of the pandemic.

With the cessation of telemedicine and return to in-person appointments, glaucoma clinicians needed to provide safe clinical environments to treat patients, a conundrum that was previously helped by telemedicine. For instance, all interviewed clinicians therefore implemented modified safety provisions. All of the interviewees implemented modifications to improve existing infection protocols such as disinfection of surfaces, rooms and equipment, social distancing, and mask donning. All now used disposable tools; most had to switch from reusable tools while several had already been using disposable ones. They had also switched from reusable tools (eg Goldmann applanation tonometers) that were disinfected between patients to disposable tools (eg rebound tonometer tips, gonioscopy lenses). Around half of the interviewees discontinued disposable tool usage while the other half continued to use disposable tools at the time of interview, of which a minority had already been using disposable tools prior to the pandemic due to institutional policies. Around half of the clinicians interviewed also reported extension of follow-up windows for patients. Follow-up intervals were sometimes increased for example, from 3 months to 6 months for stable patients. Interviewees also reported switching from seeing a patient 3 times a year to twice or even once annually. Many of these safety provisions continued to be implemented in clinicians' practices at the time of interview.

We've cut down the number of our seats available in the waiting room. And we didn't want to have people congregate together... I had a lot of patients who were happy that there were fewer patients in the waiting room, and they had to wait less time. So I've had positive feedback and that they actually are coming to the office now more than in the past. (Interviewee 3)

But when you're talking about patient safety, there's no, there's no debating. You know, what if a patient who goes on to be diagnosed with some type of viral keratitis or severe ocular infection, secondary to a non-disposable Goldmann applanation? It's not worth it. (Interviewee 18)

I think probably all of the other subspecialties within ophthalmology are really still using the iCare or the tonopen to measure eye pressure. But in glaucoma, we've gone back to Goldmann applanation because it's just more accurate. (Interviewee 5)

I definitely extended my time of follow-up with patients. So initially, obviously when I first started practicing, I was seeing patients like every three months, whether or not they needed it and then I extended it into four months. Now, I would say since COVID my stable patients are six months now. And then I see my patients who were somewhat stable or mostly stable at four months. And even the not so stable people are maybe two to three months and not every month. So I would say my length of asking people to come back, like that interval has definitely no question extended. (Interviewee 14)

Theme 4: Technological Advances are Needed for Continued Telemedicine Usage and Uptake in Glaucoma Care

Despite the discontinuation of telemedicine in glaucoma care, several glaucoma clinicians reported optimism for telemedicine if significant technological development is made (Table 5).

I think we're going to need new digital technologies that patients have at home to be able to look at the optic nerve, to get a higher level of magnification of their anterior segment, to be able to maybe have them check their high pressures, self tonometry, either through an app on one of the smartphones. (Interview 2)

I think there are a few things that telemedicine can be used for, for glaucoma, especially if there's a way to do the imaging and then interpret the imaging separately. That could be really helpful. (Interview 18)

Table 5 Quotes for Theme 4: Technological Advances are Needed for Continued Telemedicine Usage and Uptake in Glaucoma Care

Quote	Interview No.
I think we are going to need new digital technologies that patients have at home to be able to look at the optic nerve, to get a higher level of magnification of their anterior segment, to be able to maybe have them check their high pressures, self tonometry, either through an app on one of the smartphones. I think we are a bit off that, several years off, at least. I mean, people are using visual fields testing on the computer and there have been for at least a decade visual field programs that people can access on their laptop, but it's not there yet.	2
We looked into a number of home visual field devices and trialed some of those. I do not know if it was not a long enough period, but we did not implement them at least not to any great degree. We do have some of those devices that we are still working with. And so that provides the opportunity to assess eye pressure and visual fields. There are some home kits but they are not really made for glaucoma assessment. They do not have the resolution or the density of evaluation of the retina.	9
If we were able to have the OCT at home for the patients, theoretically [they] would never have to come in because they can get their visual field, OCT and IOP. One of our faculty did develop a visual acuity app which... ties into their electronic health record in Epic. And so patients can test their vision at home and the result ends up in their chart... that was another innovation. So, you know, I think that there are innovations that were developed during the pandemic that allowed us to provide patient care without the patient having to come in in person. But they are not nearly as mature as the techniques that we use when patients do come into the office. That said, I think they will continue to be developed and we will see more at-home care for our patients, as opposed to them having to come into the offices frequently. In terms of the frequency of visits, changing that has not really impacted at least on my patient population.	9
If we had mobile screening units or mobile assessment units or centralized, you know, technically driven assessments, it could be done but for the most part, it ends up just being handled.	14
[Telehealth use] not right now, not until we have some sort, I want to use some inexpensive way for patients to take their own pressure at home. Some inexpensive way or some technology where you can maybe have the patient look into and we can get some type of answer in terms of what's going on in their posterior pole... For instance... [if there was an app], download the app, take a look into the app and the app would snap a photo of the nerves, and also like the new, more nimble tonometers to take the pressure. Until that is current, there's not much we can do from a glaucoma perspective differently.	19
I know it's very limited. Because I mean, we cannot really check the patient's pressure unless they have like a home iCare, which is economic factor that not everybody can get. I know some devices or apps are trying to do visual fields through that, through your phone, which also has its limitations socioeconomically. So, you know, so I think like there's a lot of good things that come about it, but I think that it's also going to be very difficult for the people who actually really need it. But, you know, for glaucoma, when we know that African-Americans and Hispanics are five times more likely to go blind from, from glaucoma, like trying to institute some of these different devices, that equipment, that they are more than likely not... is going to be very limiting.	20
I think we are more likely to be receptive to telemedicine.	2
I think there are a few things that telemedicine can be used for, for glaucoma, especially if there's a way to do the imaging and then interpret the imaging separately. That could be really helpful.	18
For glaucoma, especially, it's very, very challenging for telehealth. [The pandemic] showed us that it's something that needs to be developed because now it's COVID-19 but it may be a different thing, a natural disaster or whatever. So, yeah. So I think the effort in trying to find ways to come around it are very important. And I think for glaucoma specifically if there's any way to rely less on functional tests and more on structural tests, that would be good.	18

One interviewee discussed the importance of technological advancements in preparation for future pandemics or situations in which we must utilize and implement telemedicine. They expressed the view that in order to deliver high quality healthcare, we need to continuously improve telemedicine practices even in times where in-person care is safe.

For glaucoma, especially, it's very, very challenging for telehealth. [The pandemic] showed us that it's something that needs to be developed because now it's COVID-19 but it may be a different thing, a natural disaster or whatever. So, yeah. So I think the

effort in trying to find ways to come around it are very important. And I think for glaucoma specifically if there's any way to rely less on functional tests and more on structural tests, that would be good. (Interview 18)

I think that there are innovations that were developed during the pandemic that allowed us to provide patient care without the patient having to come in in person. But they're not nearly as mature as the techniques that we use when patients do come into the office. That said, I think they'll continue to be developed and we'll see more at-home care for our patients. (Interview 9)

Furthermore, two glaucoma clinicians mentioned the prohibitive cost of technological development for lower socioeconomic communities. Even smartphone applications have socioeconomic implications. And so, glaucoma clinicians must also keep in mind that some of these technological advancements may not be available to all of their patients.

I know [telemedicine]'s very limited... We can't really check the patient's pressure unless they have a home iCare, which is an economic factor that not everybody can get. Yeah. I know some devices or apps are trying to do visual fields through that, through your phone, which also has its limitations socioeconomically. So, you know, so I think like there's a lot of good things that come about it, but I think that it's also going to be very difficult for the people who actually really need it... for glaucoma, when we know that African-Americans and Hispanics are five times more likely to go blind from glaucoma, trying to institute some of these different devices, that equipment, that they're more than likely not... is going to be very limiting. (Interview 20)

Glaucoma clinicians discussed what they learned from the pandemic – telemedicine is essential but its present state was inadequate to deliver quality glaucoma care. For example, telemedicine could address subjective concerns, but its role in assisting with objective data needs further work in order to be successful as a modality to deliver glaucoma care.

Discussion

This phenomenologic study identifies the impact of telemedicine on glaucoma care in response to the COVID-19 pandemic. Interviews provided first-hand insight into how glaucoma providers adapted to evolving COVID-19 developments. Four major themes regarding telemedicine's impact on glaucoma practice care changes were identified: (1) The Need for Safe Glaucoma Care Delivery During the COVID-19 Pandemic Drove Telemedicine Uptake, (2) Telemedicine Allowed Providers to Address Subjective Complaints, (3) Telemedicine was Discontinued Due to Concerns of Compromised Patient Safety and Measurement Inaccuracy, and (4) Technological Advances are Needed for Continued Telemedicine Usage and Uptake in Glaucoma Care.

At the start of the pandemic, COVID-19 transmission routes and best practices within ophthalmology to respond to such issues were not yet fully understood. To reduce contact exposures to ensure safety of staff and patients, telemedicine was swiftly adopted for glaucoma care. At the start of the pandemic, the Centers for Disease Control and Prevention (CDC) also recommended telemedicine in lieu of in-person visits.¹⁵ Data reported by telemedicine companies further indicate that patients themselves sought out digital healthcare rather than in-person visits.^{16–18}

Our study suggested that while clinicians were unable to hold in-person examinations for their patients at the peak of the pandemic, the providers were able to use telemedicine to triage patients efficiently and effectively, reassure long-term glaucoma patients, and ensure proper follow-up care all in a timely and safe manner. Thus, our study demonstrated that the use of telemedicine for glaucoma patients was a useful tool for healthcare delivery during the pandemic. Likewise, other studies showed similar uses of telemedicine for triage and consistent disease monitoring care.^{19,20}

For visits that required in-person care, institutions began to update their infection prevention protocols.^{6,21} The evidence around COVID-19 related eye transmission and resultant protective measures have mixed evidence. Some studies pointed to the possibility of infection through the eye. Xia et al detected COVID-19 in tears and conjunctival secretions,²² and Zhou et al found that ocular surface cells are susceptible to COVID-19 infection.²³ Other studies suggested that the risk of COVID-19 infection through ocular secretions is low.²⁴ Furthermore, formalized methods of COVID-19 disinfection of particular instruments essential to glaucoma care such as Visual Field Analyzers were not definitively established until later in the pandemic.²⁵ Nonetheless, given the close proximity of ophthalmologists to patients during ophthalmic exams, all interviewees reported implementation of CDC²⁶ and AAO⁶ guidelines for infection prevention via respiratory droplets and contaminated surfaces. While some practices have since been discontinued, at the time of interview, many changes still remained in place and included the donning of surgical N95 respirators and surgical masks, gloves, eye protection and

rigorous disinfection of waiting rooms, office furniture, restrooms and exam rooms. With increasing knowledge regarding transmission, sharing of information across institutions,²⁷ and release of protocols by device manufacturers,²⁵ clinicians quickly adapted and continued to exercise caution through rigorous, revised infection prevention protocols. Of note, these interviews took place after vaccine roll-out and the uptick in patient volumes, and prior to the outbreak of the Omicron variant. Given that during this time, COVID-19 transmission potential was still prevalent, this may partially explain the unanimous implementation of infection prevention protocols among respondents.

Telemedicine usage, while implemented heavily initially in response to the threats of COVID-19 transmission during the pandemic, did not persist, with all but one clinician mostly discontinuing telemedicine in their practices. All clinicians suggested the present state of telemedicine is currently insufficient for comprehensive glaucoma care delivery. This is in line with other studies that found telemedicine trends in ophthalmology differ from other specialties.²⁸ In general across specialties, the number of telemedicine visits increased in 2020 up to 154% compared to 2019.²⁹ However, a study by Patel et al,²⁸ using data from 16.7 million commercially insured and Medicare Advantage enrollees between January to June 2020, revealed that ophthalmologists had among the lowest in terms of telemedicine engagement. In fact, only 9.3% of ophthalmologists used telemedicine at least once, contrasted by significantly higher engagement in other specialties (eg, 67.7% for endocrinologists and 50.2% for psychiatrists). Furthermore, only 2.6% of glaucoma visits were delivered via telemedicine during this time, and total visits fell by 52.2%. Substantial barriers to telemedicine in glaucoma care have been reported, which we likewise found in our interview discussions. These barriers include the dependence on physical examination findings, ancillary testing such as pachymetry, tonometry, gonioscopy, optic disc photography, optical coherence tomography, standard automated perimetry, and specialized equipment for accurate diagnosis and follow-up of glaucoma.^{28,30} Given its inability to collect and analyze key information, telemedicine could not be used to achieve optimal patient care. Thus, telemedicine was widely discontinued for patient safety, and the delivery of more complete glaucoma care.

However, while the current state of telemedicine is inadequate for glaucoma care, our study showed that many glaucoma clinicians are still hopeful for future implementation. As technology advances in remote glaucoma care and testing, such as home monitoring of visual fields,^{31,32} telemedicine remains highly promising for wider uptake, with potential as a forefront modality in glaucoma care delivery. Public policy developments further facilitate this transition. In particular, in 2019 the Centers for Medicare and Medicaid Services (CMS) instituted billing reimbursement codes for “remote physiologic monitoring”, which may encompass at-home tonometer measurements.³³ Patient reception seems positive as well. A study by Zwingelberg et al³⁴ found 74% of 100 glaucoma patients surveyed would accept telemedicine and virtual clinics, an important finding for the reception of new medical interventions.

In-person modalities still remain the gold standard for patient care, and increased patient education on the limitations of telemedicine for ocular examination and glaucoma management may be warranted to ensure continuity of effective patient care.

Finally, another interesting point from this study was that all interviewees were New York City-based glaucoma clinicians, who presented unique perspectives on patient care in an urban setting. While health centers in less dense regions could roll out novel interventions such as drive-through IOP checks,³⁵ clinicians interviewed reported that NYC’s dense population and sparse open public space limited implementation of similar interventions. Instead, for safe data collection such as IOP measurements, they identified other alternatives, making the in-person visit safer through disposable tools, social distancing, less crowded waiting rooms, or even partially switching to telemedicine visits.⁶ Institutional mandates and a personal risk-benefit analysis accounting for patient safety, accuracy, waste accumulation, and personal preference ultimately guided clinician decision making.

Study Limitations

Our study has several limitations. First, participants only included glaucoma clinicians in the metropolitan New York City area. While this interview sample may provide perspectives of clinicians in one particularly urban area, their perspectives may not generalize to those of clinicians practicing in other settings. We also only interviewed clinicians, whose experiences may differ from those of other healthcare stakeholders such as patients, administrators, and nurses. We acknowledge that the composition of our study population consisting of glaucoma specialists may introduce a potential bias in the interview responses. To address this concern, we have implemented strategies to mitigate bias

and enhance the comprehensiveness of our findings. One approach we employed to minimize bias was to ensure thematic saturation, a methodology commonly utilized in qualitative studies. This technique ensures that we have captured a wide range of diverse ideas and themes by conducting interviews until no new significant information or perspectives emerge. By reaching thematic saturation, we aimed to encompass a broad spectrum of viewpoints within the specialist population, thus reducing the potential bias associated with a limited range of responses. Another measure we took to mitigate bias was to include clinicians at different stages of their career, ranging from recently graduated fellows to senior administrative faculty. We diversified our sample population by including clinicians practicing in various settings, such as different practice compositions (those with exclusive glaucoma cases or a mix of glaucoma and comprehensive eye care) in both academia and private practice settings. This allowed us to capture a comprehensive range of perspectives and insights from different types of practitioners. We aimed to capture a more comprehensive understanding of the topic and minimize bias stemming from a specific practice environment. While our study primarily focused on the opinions of physicians, we acknowledge that responses from other stakeholders, such as optometrists, ophthalmic technicians, and patients, would likely yield different perspectives. As a result, we acknowledge that the scope of our study is limited to physicians and recognize the potential for variations in opinions from these other parties. A large majority of interviewees practiced at academic institutions and therefore, findings reported may not reflect all the challenges and adaptations implemented by private offices. We also did not specifically inquire as to each clinicians' baseline comfort with using telemedicine and related technologies. Recognizing that a clinician's comfort with telemedicine technologies could strongly affect their opinions and usage patterns, this is noted as a limitation in our study. Additionally, given the open-ended nature of the interviews, certain topics were not covered by all clinicians interviewed. For instance, 17 of 20 interviewees commented on disposable tool usage, and 3 interviewees did not comment on this topic, either due to time constraints during the interview or the nature of questions posed. Lastly, with the diverse and constantly evolving nature of the COVID-19 pandemic, our findings may not reflect all implemented or forthcoming changes within NYC institutions or glaucoma practices nationwide. Nevertheless, saturation of themes was achieved with our study cohort.

Conclusion

In conclusion, this interview study identified changes in glaucoma care delivery, specifically the role of telemedicine, following the onset of the COVID-19 pandemic. As glaucoma care continues to evolve, these changes have lasting implications for continuity of care, patient safety and care delivery. The findings of this study suggest that telemedicine, in its current state, can be effectively utilized for triage, determining the appropriate timing of follow-up visits for established glaucoma patients, and providing reassurance. However, this study also highlights the strong need to focus on improving technologies and exploring alternative methods for delivering essential information such as intraocular pressure (IOP) measurements and ancillary testing in a manner that aligns with strict infection prevention protocols, should another public health crisis arise. By addressing these challenges and enhancing our preparedness, we can ensure the effective delivery of glaucoma care regardless of future pandemics or public health emergencies.

Funding

This work was supported in part by a Challenge Grant award from Research to Prevent Blindness, NY.

Disclosure

JS reports Scientific Advisory Board – Qlaris. Consultant for – AscelpiX, Gedeon Richter, Allergan, Kriya, Palatin, Aerie, Bausch & Lomb. The authors report no other conflicts of interest in this work.

References

1. Gan K, Liu Y, Stagg B, Rathi S, Pasquale LR, Damji K. Telemedicine for glaucoma: guidelines and recommendations. *Telemed E-Health*. 2020;26(4):551–555. doi:10.1089/tmj.2020.0009
2. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040. *Ophthalmology*. 2014;121(11):2081–2090. doi:10.1016/j.ophtha.2014.05.013
3. Rein DB. The economic burden of major adult visual disorders in the United States. *Arch Ophthalmol*. 2006;124(12):1754. doi:10.1001/archophth.124.12.1754

4. Butler CR, Wong SPY, Wightman AG, O'Hare AM. US Clinicians' Experiences and Perspectives on Resource Limitation and Patient Care During the COVID-19 Pandemic. *JAMA Netw Open*. 2020;3(11):e2027315. doi:10.1001/jamanetworkopen.2020.27315
5. Romano MR, Montericcio A, Montalbano C, et al. Facing COVID-19 in Ophthalmology Department. *Curr Eye Res*. 2020;45(6):653–658. doi:10.1080/02713683.2020.1752737
6. Chodosh CGNH, Yeh S. Important coronavirus updates for ophthalmologists. AAO, CDC, WHO. Available from: <https://www.aao.org/headline/alert-important-coronavirus-context>. Accessed July 11, 2023.
7. Powell T, Chuang E. COVID in NYC: what we could do better. *Am J Bioeth*. 2020;20(7):62–66. doi:10.1080/15265161.2020.1764146
8. Eldaly MA. Goldmann versus Disposable Applanation Tonometer Tips in Glaucoma Patients and Normal Subjects. *Curr Eye Res*. 2015;1–5. doi:10.3109/02713683.2015.1015144
9. Bhartiya S. Current Glaucoma Practice: the Covid-19 Impact. *J Curr Glaucoma Pract*. 2020;14(1):1–2. doi:10.5005/jp-journals-10078-1275
10. Walsh L, Hong SC, Chalakkal RJ, Ogbuehi KC. A Systematic Review of Current Teleophthalmology Services in New Zealand Compared to the Four Comparable Countries of the United Kingdom, Australia, United States of America (USA) and Canada. *Clin Ophthalmol Auckl NZ*. 2021;15:4015–4027. doi:10.2147/OPTH.S294428
11. Aguwa UT, Aguwa CJ, Repka M, et al. Teleophthalmology in the Era of COVID-19: characteristics of Early Adopters at a Large Academic Institution. *Telemed J E-Health off J Am Telemed Assoc*. 2021;27(7):739–746. doi:10.1089/tmj.2020.0372
12. Brandão-de-Resende C, Alcântara L. Glaucoma and Telemedicine. *J Glaucoma*. 2023;32(5):327–332. doi:10.1097/IJG.0000000000002200
13. Thomas SM, Jeyaraman MM, Hodge WG, Hutnik C, Costella J, Malvankar-Mehta MS. The effectiveness of teleglaucoma versus in-patient examination for glaucoma screening: a systematic review and meta-analysis. *PLoS One*. 2014;9(12):e113779. doi:10.1371/journal.pone.0113779
14. Creswell JW. *Qualitative Inquiry & Research Design: Choosing Among Five Approaches*. 2nd ed. Sage Publications; 2007.
15. Get your clinic ready for coronavirus disease 2019 (COVID-19). Centers for Disease Control and Prevention. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinic-preparedness.html>. Accessed July 11, 2023.
16. Siwicki B. Telemedicine during COVID-19: benefits, limitations, burdens, adaptation. Healthcare IT News. Available from: <https://www.healthcareitnews.com/news/telemedicine-during-covid-19-benefits-limitations-burdens-adaptation>. Accessed July 11, 2023.
17. Brodwin E, Ross C. Surge in patients overwhelms telehealth services amid coronavirus pandemic. STAT News. Available from: <https://www.statnews.com/2020/03/17/telehealth-services-overwhelmed-amid-coronavirus-pandemic/>. Accessed July 11, 2023.
18. Rosenbaum L. The Coronavirus Has Created A Surge Of Telemedicine Demand. GoodRx Now Lets Consumers Compare Services. Forbes. Available from: <https://www.forbes.com/sites/leahrosenbaum/2020/03/26/the-coronavirus-has-created-a-surge-of-telemedicine-demand-goodrx-now-lets-consumers-compare-services/?sh=749c90dc47f5>. Accessed July 11, 2023.
19. Caffery LJ, Taylor M, Gole G, Smith AC. Models of care in tele-ophthalmology: a scoping review. *J Telemed Telecare*. 2019;25(2):106–122. doi:10.1177/1357633X17742182
20. Lam PY, Chow SC, Lai JSM, Choy BNK. A review on the use of telemedicine in glaucoma and possible roles in COVID-19 outbreak. *Surv Ophthalmol*. 2021;66(6):999–1008. doi:10.1016/j.survophthal.2021.03.008
21. Naveed H, Leung V, Zarei-Ghanavati M, Leak C, Liu C. Ophthalmic Workplace Modifications for the Post-COVID Era. *J Ophthalmic Vis Res*. 2020;15(3):400–407. doi:10.18502/jovr.v15i3.7458
22. Xia J, Tong J, Liu M, Shen Y, Guo D. Evaluation of coronavirus in tears and conjunctival secretions of patients with SARS-CoV-2 infection. *J Med Virol*. 2020;92(6):589–594. doi:10.1002/jmv.25725
23. Zhou L, Xu Z, Castiglione GM, Soiberman US, Eberhart CG, Duh EJ. ACE2 and TMPRSS2 are expressed on the human ocular surface, suggesting susceptibility to SARS-CoV-2 infection. *Ocul Surf*. 2020;18(4):537–544. doi:10.1016/j.jtos.2020.06.007
24. Seah IYJ, Anderson DE, Kang AEZ, et al. Assessing Viral Shedding and Infectivity of Tears in Coronavirus Disease 2019 (COVID-19) Patients. *Ophthalmology*. 2020;127(7):977–979. doi:10.1016/j.ophtha.2020.03.026
25. Cleaning and Disinfecting ZEISS Ophthalmic Devices. Zeiss Medical Technology. Available from: <https://www.zeiss.com/meditec/int/med-support-now/disinfecting-ophthalmic-devices.html#faq>. Accessed July 11, 2023.
26. Interim Infection Prevention and Control Recommendations for Healthcare Personnel During the Coronavirus Disease 2019 (COVID-19) Pandemic. Centers for Disease Control and Prevention. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html>. Accessed July 11, 2023.
27. Shabto JM, De Moraes CG, Cioffi GA, Liebmann JM. Review of Hygiene and Disinfection Recommendations for Outpatient Glaucoma Care: a COVID Era Update. *J Glaucoma*. 2020;29(6):409–416. doi:10.1097/IJG.0000000000001540
28. Patel SY, Mehrotra A, Huskamp HA, Uscher-Pines L, Ganguli I, Barnett ML. Variation In Telemedicine Use And Outpatient Care During The COVID-19 Pandemic In The United States: study examines variation in total US outpatient visits and telemedicine use across patient demographics, specialties, and conditions during the COVID-19 pandemic. *Health Aff*. 2021;40(2):349–358. doi:10.1377/hlthaff.2020.01786
29. Koonin LM, Hoots B, Tsang CA, et al. Trends in the Use of Telehealth During the Emergence of the COVID-19 Pandemic — United States, January–March 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(43):1595–1599. doi:10.15585/mmwr.mm6943a3
30. Vinod K, Sidoti PA. How glaucoma care changed for the better after the pandemic. *Curr Opin Ophthalmol*. 2022;33(2):59–66. doi:10.1097/ICU.0000000000000812
31. Jones PR, Campbell P, Callaghan T, et al. Glaucoma Home Monitoring Using a Tablet-Based Visual Field Test (Eyecatcher): an Assessment of Accuracy and Adherence Over 6 Months. *Am J Ophthalmol*. 2021;223:42–52. doi:10.1016/j.ajo.2020.08.039
32. Prea SM, Kong YXG, Mehta A, et al. Six-month Longitudinal Comparison of a Portable Tablet Perimeter With the Humphrey Field Analyzer. *Am J Ophthalmol*. 2018;190:9–16. doi:10.1016/j.ajo.2018.03.009
33. Final Policy, Payment, and Quality Provisions Changes to the Medicare Physician Fee Schedule for Calendar Year 2019. Centers for Medicare & Medicaid Services. Available from: <https://www.cms.gov/newsroom/fact-sheets/final-policy-payment-and-quality-provisions-changes-medicare-physician-fee-schedule-calendar-year>. Accessed July 11, 2023.
34. Zwingelberg SB, Mercieca K, Elksne E, Scheffler S, Prokosch V. Einstellung von Patienten zu möglicher Telemedizin in der Ophthalmologie: erhebung mittels Fragebogen bei Glaukompatienten. *Ophthalmol*. 2022;119(4):374–380. doi:10.1007/s00347-021-01501-6
35. Baughman BD, Hansemann BK, Shah MM, Weizer JS. Drive-through Intraocular Pressure Checks During the COVID-19 Pandemic. *J Glaucoma*. 2021;30(3):223–226. doi:10.1097/IJG.0000000000001748

Clinical Ophthalmology

Dovepress

Publish your work in this journal

Clinical Ophthalmology is an international, peer-reviewed journal covering all subspecialties within ophthalmology. Key topics include: Optometry; Visual science; Pharmacology and drug therapy in eye diseases; Basic Sciences; Primary and Secondary eye care; Patient Safety and Quality of Care Improvements. This journal is indexed on PubMed Central and CAS, and is the official journal of The Society of Clinical Ophthalmology (SCO). The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/clinical-ophthalmology-journal>