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Telemedicine Curriculum in an Ophthalmology Residency Program

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Abstract

Background The COVID-19 pandemic has accelerated the adoption of telemedicine in the field of ophthalmology. Despite the increasing utilization of telemedicine, there is a lack of formal training in ophthalmology residency programs to ensure ophthalmologists are prepared to conduct virtual eye exams.

Objective This article aims to assess the impact of an ophthalmic telemedicine curriculum on ophthalmology residents' self-reported knowledge acquisition in conducting telemedicine eye exams, perceived ability to diagnose, manage, and triage common eye diseases, and evaluate their attitudes toward the current and future use of teleophthalmology.

Methods This single-center study at Massachusetts Eye and Ear used a nonvalidated pre- and postcurriculum survey conducted during the 2020 to 2021 academic year among ophthalmology residents. Participants engaged in an ophthalmic telemedicine curriculum that consisted of interactive didactic lectures and electronic postdidactic assessments.

Results Twenty-four residents (100%) completed a precurriculum survey, while 23 of 24 (95.8%) residents completed both the telemedicine curriculum and a postcurriculum survey. On a five-point Likert scale, the median interquartile range (IQR) scores for confidence with setup/logistics, history taking, examination, documentation, and education increased from 2.5 (2.0–4.0) to 4.0 (3.5–4.5) ($p = 0.001$), 3.0 (3.0–4.0) to 5.0 (4.0–5.0) ($p < 0.001$), 2.0 (1.8–2.0) to 4.0 (3.5–4.0) ($p < 0.001$), 2.0 (1.0–2.0) to 4.0 (3.0–4.0) ($p < 0.001$), and 2.5 (2.0–3.0) to 4.0 (4.0–4.0) ($p < 0.001$), respectively. The median (IQR) scores for comfort with ethics/professionalism, disparities and conducting patient triage, diagnosis, and management increased from 2.0 (2.0–2.3) to 4.0 (3.0–4.0) ($p < 0.001$), 2.0 (2.0–2.0) to 3.0 (3.0–4.0) ($p < 0.001$) and 3.0 (2.0–3.0)

Keywords
- resident education
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- telemedicine
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to 4.0 (3.0–4.0) ($p = 0.001$), 2.0 (2.0–3.0) to 3.0 (3.0–4.0) ($p < 0.001$), and 3.0 (2.0–3.0) to 3.0 (3.0–4.0) ($p = 0.008$), respectively.

Conclusion The implementation of an ophthalmic telemedicine curriculum increased resident confidence and self-reported knowledge across all logistical and clinical components of virtual ophthalmic care. Formal telehealth curricula can address an unmet educational need of resident trainees in an era of rapid uptake and utilization of telehealth services.

Teleophthalmology is the provision of ophthalmic care to patients remotely through the use of technology.[1] Various models of ophthalmic telemedical care have been successfully implemented in the past decade with the goal of improving patient access to eye care, improving health equity, reducing health system costs, and improving public health outcomes.[1,2] The COVID-19 pandemic accelerated the demand for and expansion of telemedicine services, with 17% of ophthalmology visits in Michigan taking place via telemedicine in March 2020, and by September 2020, 37.4% of ophthalmologists in Michigan had used telemedicine.[3] The necessity of telehealth during this period required providers to expedite the establishment of virtual services or expand existing virtual infrastructures.[4–7] As a result, both medical and surgical specialties, including ophthalmology, have a new imperative to equip providers and trainees with the necessary clinical tools to successfully conduct telemedicine examinations.[8–10]

One of the biggest barriers to the adoption of telemedicine is a lack of provider training both in navigating online consultation systems and performing virtual exams.[11–13] Telehealth requires specific training because it calls for a nuanced skillset distinct from standard in-person clinical instruction. Providers must be able to guide the patient through necessary physical exams, establish meaningful rapport through virtual interfaces, and perform reliable and appropriate clinical assessments.[12,14–16] Providers must also know the appropriate use cases and limitations of telemedicine. To date, a limited number of studies describe formal telemedicine curricula at the resident trainee level, including in family medicine, internal medicine, pediatrics, and neurology residency programs.[16–21] This effort is growing in importance as professional organizations, including the American Medical Association and the Association of American Medical Colleges, begin to incorporate telehealth into trainees' core competencies.[22,23] While the ability to screen for and triage various ocular diseases through virtual visits has been validated, formalized training on these processes has yet to be developed or disseminated in the field of ophthalmology.[24–28] As the crisis response to the pandemic abates and advances in telemedicine are anticipated to remain an integral component of health care systems, it becomes imperative to reflect on provider attitudes and preparedness toward teleconsultation.[29]

In this study, we assess the impact of a teleophthalmology curriculum created for the Massachusetts Eye and Ear (MEE) Ophthalmology Residency Program on resident perceived confidence and skill completing a telemedicine eye exam. This study also characterizes residents' exposure to and participation in telemedicine and attitudes toward telehealth in its current and future state. This study is the first to examine a telehealth curriculum in ophthalmology.

Methods and Materials

Study Design

This single-center study used a nonvalidated pre- and posttest survey design administered to MEE ophthalmology residents during the 2020 to 2021 academic year. Participation was voluntary and all residents received access to the curriculum regardless of survey participation. Surveys were anonymous and data were not linked to individual residents. The study protocol was reviewed and approved by the Massachusetts General Brigham Institutional Review Board.

Teleophthalmology Curriculum

The teleophthalmology curriculum consisted of three 1-hour didactic lectures (►**Table 1**) as well as postlecture survey assessments to evaluate research study outcomes and direct internal improvement efforts in future years. The lecture series was administered to ophthalmology trainees through integration into existing weekly resident learning didactics. Each lecture was presented live and was recorded and subsequently made available to residents after each teaching session. The curriculum initially incorporated a component of resident observation and participation in real-world teleophthalmology encounters; however, not every resident was able to take part in this component of the curriculum due to implementation of the curriculum mid-year, scheduling conflicts, and sporadic availability of telemedical encounters. Consequently, data on real-world clinical encounters was excluded from the current study.

Surveys

A nonvalidated 25-item survey was designed to assess the impact of a structured teleophthalmology curriculum for resident trainees (►**Supplementary Material**). Surveys were administered to residents prior to and immediately after completion of the teleophthalmology curriculum via REDCap, a secure Web-based survey platform, and were available to residents for 1 week. The following six domains were assessed in the survey: (1) prior exposure to ophthalmic

Table 1 Teleophthalmology curriculum lecture topics

Lecture 1: Introduction to Foundational Topics in Ophthalmic Telemedicine	- A global perspective on the presence and utilization of teleophthalmology worldwide - Models of telemedicine: Synchronous, asynchronous, hybrid, and remote monitoring (i.e., gathering remote patient data for telemedical use) - Appropriate clinical uses of teleophthalmology: triage, screening, diagnosing, and long-term management of ophthalmic disease - Televisit workflow, logistics, and previsit patient preparation - Professionalism, including decorum, appropriate surroundings, and dress - Documentation, insurance-compliant billing, and trainee supervision - Telemedical technology and future directions
Lecture 2: Special Considerations in Ophthalmic Telemedicine	- Validated telemedicine screenings for ophthalmic diseases - Subjective and objective components of virtual eye exam - Best practices in ophthalmic telemedicine - Clinical efficacy and cost-effectiveness of teleophthalmology - The role of patient factors, clinical diagnoses, and ophthalmologic subspecialty in determining the suitability, safety, and success of telehealth encounters - Digitization of eye exams and the future of remote testing centers
Lecture 3: Advantages, Drawbacks, and Ongoing Evolution of Ophthalmic Telemedicine	- The impact of COVID-19 on the growth and uptake of teleophthalmology services - Future directions and drivers of teleophthalmology: the role of aging populations and ophthalmologist shortages - The limitations of telemedicine in ophthalmology: difficulty with the clinical exam and ophthalmic procedures - Ethical implications (patient privacy, identification of the number and nature of participants on the call, consideration of the location of the patient and potential privacy issues, disclosure of sensitive diagnoses, ensuring appropriate follow-up for urgent diagnoses) and impact on health disparities

telemedicine, (2) engagement in ophthalmic telehealth encounters, (3) confidence in conducting objective components of a telemedicine eye exam, (4) level of comfort and perceived appropriateness of diagnosing and managing ocular diseases virtually, (5) the future of telemedicine in ophthalmology and throughout clinical training, and (6) confidence in applying telemedical solutions to issues of professionalism, ethics, and health disparities. Survey questions regarding the triage, diagnosis, and management of specific diagnoses using ophthalmic telemedicine were eliminated from final analysis as residents anecdotally expressed high variability about their interpretation of these questions, making the interpretation of the data unreliable. Demographic data including age, race, sex, intended subspecialty, and year of training were also collected. Race was self-reported by participants from a list of categories defined by the researchers, including a "prefer not to answer" option. The groupings included were based on racial categories in the institution's electronic medical record system. Survey items consisted of a combination of five-point Likert scale items, multiple choice questions, and qualitative freeform responses. Likert scale responses were converted into an ordinal 1 through 5 grading scheme.

Statistical Analyses

The primary outcome measured was the impact of a telehealth curriculum on residents' attitudes and beliefs toward teleophthalmology and their self-reported knowledge acquisition in conducting a telemedicine eye exam. Continuous variables that were normally distributed were reported as means with standard deviations. Numeric variables that were not normally distributed were reported as medians with interquartile ranges (IQRs). Categorical variables were reported as frequency counts and percentages. Descriptive statistics and Wilcoxon rank sum tests were executed using R version 4.1.0 (R Foundation for Statistical Computing). Unpaired *t*-tests and Fisher's exact tests were executed using the GraphPad QuickCalcs Web site.[30] A two-tailed *p*-value of $\alpha < 0.05$ was considered to be statistically significant.

Results

A total of 24 (100%) ophthalmology residents participated in the study, with all 24 completing the pretest. Participant demographics are summarized in ►**Table 2**. Twenty-three (95.8%) residents took part in the telemedical curriculum and completed the posttest. Residents reported a high degree of satisfaction with the curriculum with a median (IQR) score of 5.0 (4.3–5.0) on a five-point scale. Before participation in the curriculum, the median (IQR) score for comfort addressing issues of ethics and professionalism within telemedical care was 2.0 (2.0–2.3) increasing to 4.0 (3.0–4.0) ($p < 0.001$) after its completion. The median (IQR) score for comfort with utilizing real-world technological solutions to address health disparities in telemedicine increased from 2.0 (2.0–2.0) to 3.0 (3.0–4.0) ($p < 0.001$). Prior to the curriculum, 17 (70.8%) participants reported that they intend to use telemedicine in their future practice. After completion of the curriculum, 18 (78.3%) participants reported that they intend to use telemedicine in their future practice ($p = 0.740$). The median

Table 2 Results of pre- and postophthalmic telemedicine curriculum survey by MEE residents

Characteristic	Precurriculum, *n* (%)	Postcurriculum, *n* (%)	*p*-Value
Age, mean (SD) y	30.4 (2.3)	30.7 (2.4)	0.664
Gender			
Male	11 (45.8%)	9 (39.1%)	–
Female	13 (54.2%)	13 (56.5%)	–
Prefer not to say	–	1 (4.3%)	–
Postgraduate year			
1	0 (0.0%)	0 (0.0%)	–
2	8 (33.3%)	8 (34.8%)	–
3	8 (33.3%)	8 (34.8%)	–
4	8 (33.3%)	7 (30.4%)	–
Race			
American Indian or Alaskan Native	0 (0.0%)	0 (0.0%)	-
Asian or Asian Indian	7 (29.2%)	6 (26.1%)	-
Black or African American	0 (0.0%)	0 (0.0%)	-
Hispanic, Latino, or Spanish	3 (12.5%)	3 (13.0%)	-
Middle Eastern or Northern African	1 (4.2%)	1 (4.3%)	-
Native Hawaiian or Other Pacific Islander	0 (0.0%)	0 (0.0%)	-
White	10 (41.7%)	11 (47.8%)	-
Prefer not to say	3 (12.5%)	2 (8.7%)	-
Planned subspecialty of practice			
Comprehensive	1 (4.2%)	1 (4.3%)	-
Cornea	4 (16.7%)	4 (17.4%)	-
Retina	7 (29.2%)	8 (34.8%)	-
Glaucoma	1 (4.2%)	1 (4.3%)	-
Pediatrics	1 (4.2%)	2 (8.7%)	-
Oculoplastics	4 (16.7%)	3 (13.0%)	-
Neuro-ophthalmology	0 (0.0%)	0 (0.0%)	-
Uveitis	0 (0.0%)	0 (0.0%)	-
Industry/Nonclinical	1 (4.2%)	0 (0.0%)	-
Undecided	5 (20.8%)	4 (17.4%)	-
Participation in a formal telemedicine curriculum during residency			
Yes	1 (4.2%)	23 (100.0%)	< 0.001
No	23 (95.8%)	0 (0.0%)	
Satisfaction with current telemedical curriculum			
1	0 (0.0%)	0 (0.0%)	–
2	0 (0.0%)	0 (0.0%)	–
3	0 (0.0%)	1 (4.2%)	–
4	1 (4.2%)	5 (20.8%)	–
5	0 (0.0%)	16 (66.7%)	–
Median (IQR) score	4.0 (4.0–4.0)	5.0 (4.3–5.0)	0.189
Confidence with setup/logistics			
1	4 (16.7%)	0 (0.0%)	–
2	8 (33.3%)	2 (8.7%)	–

Table 2 (*Continued*)

Characteristic	Precurriculum, *n* (%)	Postcurriculum, *n* (%)	*p*-Value
3	5 (20.8%)	4 (17.4%)	–
4	5 (20.8%)	11 (47.8%)	–
5	2 (8.3%)	6 (26.1%)	–
Median (IQR) score	2.5 (2.0–4.0)	4.0 (3.5–4.5)	0.001
Confidence with history taking			
1	0 (0.0%)	0 (0.0%)	–
2	5 (20.8%)	1 (4.3%)	–
3	8 (33.3%)	2 (8.7%)	–
4	10 (41.7%)	6 (26.1%)	–
5	1 (4.2%)	14 (60.9%)	–
Median (IQR) score	3.0 (3.0–4.0)	5.0 (4.0–5.0)	< 0.001
Confidence with examination			
1	6 (25.0%)	0 (0.0%)	–
2	17 (70.8%)	3 (13.0%)	–
3	1 (4.2%)	3 (13.0%)	–
4	0 (0.0%)	12 (52.2%)	–
5	0 (0.0%)	5 (21.7%)	–
Median (IQR) score	2.0 (1.8–2.0)	4.0 (3.5–4.0)	< 0.001
Confidence with documentation			
1	8 (33.3%)	0 (0.0%)	–
2	12 (50.0%)	1 (4.3%)	–
3	2 (8.3%)	6 (26.1%)	–
4	2 (8.3%)	15 (65.2%)	–
5	0 (0.0%)	1 (4.3%)	–
Median (IQR) score	2.0 (1.0–2.0)	4.0 (3.0–4.0)	< 0.001
Confidence in ability to meet educational objectives of performing telemedicine (e.g., ensuring attending oversight, learning how to conduct telemedicine exams)			
1	2 (8.3%)	0 (0.0%)	–
2	10 (41.7%)	1 (4.3%)	–
3	9 (37.5%)	3 (13.0%)	–
4	2 (8.3%)	14 (60.9%)	–
5	1 (4.2%)	5 (21.7)	–
Median (IQR) score	2.5 (2.0–3.0)	4.0 (4.0–4.0)	< 0.001
Comfort in addressing issues of ethics and professionalism in telemedical care			
1	4 (16.7%)	0 (0.0%)	–
2	14 (58.3%)	1 (4.3%)	–
3	5 (20.8%)	9 (39.1%)	–
4	1 (4.2%)	13 (56.5%)	–
5	0 (0.0%)	0 (0.0%)	–
Median (IQR) score	2.0 (2.0–2.3)	4.0 (3.0–4.0)	< 0.001
Comfort in addressing issues of health disparities in telemedical care			
1	5 (20.8%)	0 (0.0%)	–
2	15 (62.5%)	3 (13.0%)	–
3	4 (16.7%)	9 (39.1%)	–

(*Continued*)

Table 2 (*Continued*)

Characteristic	Precurriculum, *n* (%)	Postcurriculum, *n* (%)	*p*-Value
4	0 (0.0%)	11 (47.8%)	–
5	0 (0.0%)	0 (0.0%)	–
Median (IQR) score	2.0 (2.0–2.0)	3.0 (3.0–4.0)	< 0.001
Personal involvement in clinical care of a patient			
Yes	5 (20.8%)	11 (47.8%)	0.068
No	19 (79.2%)	12 (54.2%)	
If yes, approximate no. of telemedicine visits with involvement, *n* (%)			
1–3	3 (60.0%)	10 (90.1%)	0.214
4–6	1 (20.0%)	0 (0.0%)	0.313
7–9	1 (20.0%)	1 (9.1%)	1.00
10 or more	0 (0.0%)	0 (0.0%)	1.00
If yes, type of involvement			
Direct patient care	2 (40.0%)	0 (0.0%)	0.083
Shadowing	3 (60.0%)	7 (63.6%)	1.00
Both	0 (0.0%)	4 (36.4%)	0.245
If yes, type of telemedicine model			
Synchronous	2 (40.0%)	7 (63.6%)	–
Asynchronous	2 (40.0%)	1 (9.1%)	–
Hybrid	1 (20.0%)	6 (54.6%)	–
Remote monitoring	1 (20.0%)	0 (0.0%)	–
Future use of telemedicine			
Yes	17 (70.8%)	18 (78.3%)	0.740
No	1 (4.2%)	0 (0.0%)	1.00
Unsure	6 (25.0%)	5 (21.7%)	1.00
Future importance of telemedicine			
1	0 (0.0%)	0 (0.0%)	–
2	1 (4.2%)	0 (0.0%)	–
3	9 (37.5%)	8 (34.8%)	–
4	4 (16.7%)	4 (17.4%)	–
5	10 (41.7%)	11 (47.8%)	–
Median (IQR) score	4.0 (3.0–5.0)	4.0 (3.0–5.0)	0.574
Importance of telemedicine education			
1	0 (0.0%)	0 (0.0%)	–
2	1 (4.2%)	0 (0.0%)	–
3	11 (45.8%)	7 (30.4%)	–
4	7 (29.2%)	7 (30.4%)	–
5	5 (20.8%)	9 (39.1%)	–
Median (IQR) score	3.5 (3.0–4.0)	4.0 (3.0–5.0)	0.110
Comfort with triaging			
1	0 (0.0%)	0 (0.0%)	–
2	9 (37.5%)	1 (4.3%)	–
3	11 (45.8%)	9 (39.1%)	–
4	4 (16.7%)	8 (34.8%)	–

Table 2 (*Continued*)

Characteristic	Precurriculum, *n* (%)	Postcurriculum, *n* (%)	*p*-Value
5	0 (0.0%)	5 (21.7%)	–
Median (IQR) score	3.0 (2.0–3.0)	4.0 (3.0–4.0)	0.001
Comfort with diagnosis			
1	5 (20.8%)	0 (0.0%)	–
2	12 (50.0%)	1 (4.3%)	–
3	7 (29.2%)	15 (65.2%)	–
4	0 (0.0%)	6 (26.1%)	–
5	0 (0.0%)	1 (4.3%)	–
Median (IQR) score	2.0 (2.0–3.0)	3.0 (3.0–4.0)	< 0.001
Comfort with management			
1	2 (8.3%)	0 (0.0%)	–
2	7 (29.2%)	2 (8.7%)	–
3	11 (45.8%)	10 (43.5%)	–
4	3 (12.5%)	10 (43.5%)	–
5	1 (4.2%)	1 (4.3%)	–
Median (IQR) score	3.0 (2.0–3.0)	3.0 (3.0–4.0)	0.008
Preferred educational modalities			
Lecture based/didactics	13 (54.2%)	7 (30.4%)	–
Online modules	6 (25.0%)	4 (17.4%)	–
Simulated telemedicine encounters with directed feedback	13 (54.2%)	10 (43.5%)	–
Real patient telemedicine encounters with directed feedback	20 (83.3%)	19 (82.6%)	–

Abbreviations: IQR, interquartile range; MEE, Massachusetts Eye and Ear; SD, standard deviation.

(IQR) score for future importance of telemedicine was 4.0 (3.0–5.0) prior to the curriculum, and remained 4.0 (3.0–5.0) after its completion ($p = 0.574$). Prior to the curriculum, the median (IQR) score for importance of telemedicine education was 3.5 (3.0–4.0), which changed to 4.0 (3.0–5.0) after its completion ($p = 0.110$).

Discussion

We present a study assessing the impact of an ophthalmic telemedicine curriculum on the attitudes and self-perceived knowledge and skill of conducting telemedicine encounters of ophthalmology residents at a single academic institution. This curriculum included instruction on navigating logistics of online consultation systems, gathering patient histories, performing virtual eye exams, and diagnosing, managing, and triaging common acute and chronic eye diseases. We found that residents believe that teleophthalmology will be an important aspect of future ophthalmic practice, and that engagement in the curriculum resulted in increased confidence across all components of a teleophthalmology encounter.

These findings suggest that structured teleophthalmology curricula can meaningfully prepare ophthalmologists to adequately provide care to patients in a virtual setting. We demonstrate that targeted telehealth education can increase physician confidence and thus help reduce barriers to telehealth use. Graduate medical education programs can use similar curricula to incorporate formal telehealth education and prepare trainees to provide telemedical care.

Much like studies performed in the fields of internal medicine, family medicine, neurology, and pediatrics, this study confirms residents' desire to be clinically competent in the telehealth setting.[16–21] One of the primary similarities across studies of telehealth incorporation into graduate medical education is the universal need for formalized training and the capacity for this training to improve resident attitudes and confidence in completing telemedical exams. Prior studies also found a need for developing comprehensive virtual exam techniques.[16–21] The recommended practices derived from these studies, namely incorporating residents at all training levels in telehealth didactics, were critical in the formulation of our educational curriculum.

The unique elements of our educational curriculum are the incorporation of teachings on ethics, professionalism, and health disparities in telemedicine. In regard to ethics, residents were presented with issues of patient privacy, including identification of the number and nature of participants on the call, consideration of the location of the patient and potential privacy issues, and the disclosure of sensitive diagnoses. Additionally, ensuring that patients in need of urgent evaluation and treatment can be connected to a local

provider is critical, requiring the physician to have an understanding of local practices and practitioners near the patient. In regard to professionalism, trainees were provided with examples of best practices of decorum, surroundings, and dress during telehealth visits. After completion of the curriculum, participants reported increased confidence in addressing issues of ethics and professionalism in telemedicine with an increase in the median score from 2.0 to 4.0 ($p < 0.001$) on a Likert scale.

The curriculum also focused on the impact of ophthalmic telemedicine on health disparities. There is evidence in the literature that telemedicine has the potential to either close the gap in health disparities or widen it, both within ophthalmology as well as other fields.[2,31–33] This curriculum contextualized the rise in telemedicine uptake within the realities of (1) technological inequalities including access to resources (smart phones, computers, broadband access) and digital literacy, (2) health care inequities including health literacy, and (3) disparities in communication including securing interpreter services for virtual visits and optimizing visits for patients whose physical health, such as low vision or reduced hearing, may affect the successful use of technology. After completion of the curriculum, participants in the curriculum had improved confidence in addressing issues of health disparities in telemedicine. When assessed on a Likert scale, comfort with navigating issues of disparities increased from a median score of 2.0 to 3.0 ($p < 0.001$). Notably, no residents reported feeling entirely confident addressing issues of professionalism, ethics, or health disparities in either the pre- or post-participation surveys, identifying a topic area for further attention and resident training.

One of the leading challenges in teleophthalmology is obtaining a reliable eye exam.[34,35] As the clinical setting shifts into patients' homes and conducting the clinical exam moves into the patients' hands, providers must identify creative and practical ways to guide patients through each aspect of the ophthalmic exam. While a video call with a patient may not be sufficient to capture all ophthalmic clinical details, store-and-forward imaging and testing modalities can be used to provide more detail to ophthalmologists during virtual encounters. As part of the curriculum, various options for capturing all aspects of the eye exam for use in telemedicine were discussed, including capturing patient visual acuity, pupillary illumination and examination, intraocular pressure, cover testing, anterior and posterior segment examination, visual fields, and other exam techniques, while also navigating environmental factors such as lighting, camera positioning, and patient assistance through family members or friends. Interestingly, resident confidence in obtaining a patient history through telemedicine increased after partaking in the curriculum. While this skillset may seem familiar and similar to in-person care, we believe that there may have been initial apprehension and unfamiliarity with which details of a clinical history are specifically needed during telemedical exams. Furthermore, improvement in this domain may result from the explicit advice on gathering clinical history through various technological modalities, such as a video visit or a phone call. The importance of identifying ways to perform meaningful ophthalmic examination through telemedicine is highlighted by the fact that, at baseline, there was a high rate of residents who intended to use telemedicine in their future practice (70.8%) and perceived the future use of teleophthalmology to be important (41.7%). After the implementation of the curriculum, each of these numbers increased further (78.3 and 47.8%, respectively) (►**Table 2**). Although no statistically significant difference in the perceived importance of and future intent to use teleophthalmology prior to and after the implementation of the curriculum was observed, this finding may be a reflection of the current climate and existing presence of technology's role in health care delivery. These findings are consistent with the results of other telehealth curricula implemented in other specialties.[16–21]

The implemented curriculum includes integrated didactic lectures, opportunities for patient interactions, and assessments. The choice of multimodal teaching instruction followed evidence that supports the utilization of such hybrid teaching methods to increase knowledge retention and learner confidence.[36–38] Residents were surveyed on their preferred educational modalities, with the majority preferring simulated telemedicine encounters, followed by lecture-based didactics, and online modules both pre- and post-participation. Approximately 67% of respondents were satisfied with the telemedicine curriculum. As the demands of medical education and residency training continually increase, it becomes imperative to not only ensure protected learning time for telemedicine but to also create educational content that will maximize retention.[39,40] Formalized curricula are a means to proactively prepare physicians for and anticipate the future of medicine, to ensure standardized delivery of quality care, expand the reach of specialty care, and help ensure that medical education and training advance in parallel with technological developments.

While this study evaluated self-perceived knowledge and confidence about ophthalmic telemedicine, future studies should assess the impact of the curriculum on clinical performance. By expanding telemedicine curricula to incorporate real-world opportunities to shadow and lead teleophthalmology visits, trainees will have the opportunity to observe firsthand the techniques associated with routine virtual eye exams, identify strategies for optimizing the clinical encounter in real time, and distinguish patients who can be managed virtually from those who would be better served by an in-person visit. Future curricula should also incorporate objective assessments of resident skill conducting telemedical visits. This will provide important information on where to focus additional teaching efforts and maximize physician readiness. Additionally, the use of standardized practical telemedical patient encounters may further aid in both the training and assessment of ophthalmology residents conducting telehealth encounters. The use of a telehealth objective structured clinical examination may be one tool to achieve this, and has been shown to identify strengths and weaknesses of trainees' telehealth exams.[41,42] Furthermore, as professional organizations continue to define telemedicine competencies for training

physicians, telehealth curricula should be refined to align with these recommendations. As uptake of teleophthalmology training will require educator buy-in and support, future studies should also assess attending and supervising physicians' perspectives. These physicians are in a unique position to train future ophthalmologists while also integrating telemedicine into their clinical practice for the first time.

The present curriculum, assessment, and study were implemented at a single academic center, limiting the external validity. The results of this study may not be generalizable to other residency programs with different clinical curricula, telehealth capabilities, and staffing support to deliver these lectures. While exposure to lectures and other didactic educational resources is an important first step to better prepare residents to engage in teleophthalmic care, supervised direct patient care is a standard educational approach in residency programs. Although the initial design of the curriculum included resident participation in real-world telemedical patient encounters, not all residents engaged firsthand in telehealth visits or received evaluation and feedback by attending physicians. This hinders the study's ability to assess the impact of the curriculum on residents' application of teleophthalmology principles and examination skills in a virtual care setting. Furthermore, this study reported subjective outcomes, thus limiting our ability to objectively comment on knowledge and skill acquisition. Self-reported responses are subject to social desirability bias and limit the interpretation of our findings. The survey used in this study was created in-house due to a lack of validated questionnaires that could be applied for the evaluation of telehealth curricula. As a nonvalidated tool, the survey administered in this study is vulnerable to measurement error and reduced content and face validity. Furthermore, although the surveys were voluntary and anonymized, there is a potential that residents felt coercion as the surveys were administered by attending physicians at their training institution. Another limitation is that this study was conducted over a 4-month period and limited the ability to assess the long-term impact of this training. Lastly, this study survey employed Likert scale items which can be subject to acquiescence bias.

Conclusion

Formal telehealth training in ophthalmology residency programs is necessary to ensure ophthalmologists are prepared to conduct virtual eye exams and provide high quality care to patients. In our study, the implementation of an ophthalmic telemedicine curriculum increased resident confidence and self-reported knowledge across the spectrum of activities that accompany virtual patient care. Our results suggest that formal telehealth curricula can meet the educational needs of resident trainees. Future studies should objectively assess resident knowledge of and clinical skills in teleophthalmology encounters and build toward establishing best practices in teleophthalmology.

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Conflict of Interest
None declared.

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