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Emergency and Eye Care Providers' Perspectives on the Acceptance of Interprofessional Teleophthalmology.

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Abstract

Background

Teleophthalmology is well established for screening conditions such as retinal diseases, yet its use for synchronous interprofessional consultation in emergency departments (EDs) remains limited. This study examines how U.S. emergency and eye-care professionals viewed the challenges, opportunities, and overall acceptability of teleophthalmology for ED consultations.

Methods

We conducted a national cross-sectional web-based survey of emergency and eye-care providers across the United States in mid-2020. The survey assessed respondent demographics and organizational context, technology-acceptance constructs including perceived usefulness (PU) and intention to use (IU), perceived barriers and facilitators, and an open-ended item on implementation considerations. Analysis integrated descriptive statistics, subgroup comparisons, and inductive thematic analysis of free-text responses.

Results

Among 244 respondents, 35.2% reported prior experience with video-based telemedicine and 66.4% believed the COVID-19 pandemic would accelerate telemedicine adoption. The most frequently cited barriers were privacy and security concerns (61.9%), initial technology costs (60.6%), and resistance to workflow change (57.4%). Commonly identified facilitators included advancing technologies (59.4%), integration of telemedicine into medical and nursing education (59.0%), and easing of regulatory barriers (58.6%). Qualitative responses regarding teleophthalmology implementation in EDs reflected four sentiment profiles: positive (45.5%), cautiously optimistic (35.6%), and skeptical or negative (18.9%), with more favorable views associated with higher PU and IU scores.

Conclusions

Emergency and eye-care clinicians demonstrated clear readiness to adopt synchronous teleophthalmology for inter-provider consultations. Findings suggest that acceptance is shaped less by technical limitations than by persistent concerns about privacy, cost, and workflow integration. Pandemic-era policy shifts and growing telemedicine experience may facilitate broader adoption.

INTRODUCTION

Telehealth has moved from peripheral experimentation to a durable feature of modern care, driven by advances in networks and mobile devices, alongside policy attention to access and cost (Tuckson,

Edmunds, & Hodgkins, 2017; van Dyk, 2014). Across clinical specialties, remote consultation has been associated with shorter time to decision making, fewer avoidable patient transfers, and a more equitable distribution of specialist expertise (Ekeland, Bowes, & Flottorp, 2012; Ackerman, Filart, Burgess, Lee, & Poropatich, 2010). Ophthalmology offers a particularly informative use case, as high resolution imaging is essential, yet on call specialist coverage remains uneven. This mismatch creates a gap that interprofessional teleconsultation can help address (Host, Turner, & Muir, 2018; Tan, Dobson, Bartnik, Muir, & Turner, 2017). While teleophthalmology is well established for retinal disease screening, its use for real time emergency department (ED) consultations between providers remains limited.

Existing teleophthalmology research has focused largely on technical feasibility and the success of asynchronous care models. Most large scale implementations involve store and forward screening programs, such as diabetic retinopathy screening, where image interpretation can be efficiently centralized (Prathiba & Rema, 2011). In contrast, live teleophthalmology for ED consultation remains underused, despite its clear relevance to time sensitive conditions such as ocular trauma or suspected retinal detachment. In emergency settings, real time consultation allows ophthalmologists to guide the examination, support clinical decision making, and influence disposition without delay (Host et al., 2018; Tan et al., 2017). Hybrid models that combine store and forward imaging with live consultation have also shown promise (Prathiba & Rema, 2011; Tan et al., 2017). Given demonstrated diagnostic concordance and operational value for urgent eye complaints, the feasibility of live teleophthalmology is no longer the primary concern.

Less well understood are the non-technical factors that limit routine adoption in emergency care. In ED settings, barriers commonly include workflow friction, such as responsibility for image acquisition and integration into triage, alongside medico legal concerns, cost, and professional culture (LeRouge & Garfield, 2013; van Dyk, 2014). The ED operates under high cognitive load and throughput pressure, conditions that amplify even minor disruptions in workflow. As a result, clinicians' beliefs about usefulness and fit within existing processes often determine whether a pilot program becomes standard practice (Ekeland et al., 2012; LeRouge & Garfield, 2013). The policy shifts of 2020 temporarily lowered external barriers and increased awareness of telemedicine across care settings (Saleem et al., 2020; Sharma et al., 2020; Zachrison et al., 2020), but it remains unclear how clinicians interpreted this period and whether it translated into durable readiness for change (Tuckson et al., 2017). Directly examining provider perspectives helps distinguish short term adaptation from longer term acceptance and highlights implementation barriers that health system leaders can realistically address.

The objective of this study was to characterize U.S. emergency and eye care professionals' perceptions and overall acceptance of live teleophthalmology for interprofessional ED consultations. Specifically, the study aimed to identify commonly endorsed barriers and facilitators, describe individual and contextual factors associated with technology acceptance, and synthesize qualitative themes relevant to practical implementation.

METHODS

This study was a complementary part of a larger dissertation project evaluating the impact of transformational leadership constructs on the acceptance of teleophthalmology by emergency department professionals. The present report focuses on the descriptive and qualitative findings from the providers' perspectives.

Design and Participants. We conducted a national, cross-sectional, web-based survey (May–June 2020) targeting U.S. clinicians involved in emergency eye-care workflows. Eligible respondents included emergency physicians (EP); advanced practice providers (APPs, including nurse practitioners (NP) and physician assistants (PA)); emergency nurses (RN), technicians (TEC); and ophthalmologists (MD) and Doctor of Optometry (OD) who provide or receive ED teleconsultations. These roles were included because live ED teleophthalmology requires coordinated input from both ED teams and consulting specialists (Host, Turner, & Muir, 2018; Tan, Dobson, Bartnik, Muir, & Turner, 2017). A pragmatic, nonprobability approach was used as it aligns with telehealth evaluation guidance that emphasizes context and implementation in early-stage studies (Ekeland, Bowes, & Flottorp, 2012; van Dyk, 2014).

Sampling and Recruitment. A purposive, nonprobability sampling strategy with quota controls was applied to include a diverse mix of providers. However, initial recruitment through email invitations, social media outreach, professional networks, and snowball referrals yielded limited participation as the COVID-19 pandemic constrained emergency providers' availability. Consequently, a population of health professionals registered with a polling firm that conducts online and mobile surveys (Pollfish; https://www.pollfish.com) was used as a proxy sampling frame. This pragmatic approach prioritized heterogeneity across roles and U.S. regions to reflect adoption barriers and facilitators under real-world conditions where formal sampling frames for interprofessional telehealth do not exist.

Data Collection and Instruments. The self-administered questionnaire is provided as Supplementary Material (A-1: Survey Questionnaire). It comprised four parts: (1) demographics, individual factors, and organizational context; (2) technology-acceptance and transformational leadership constructs; (3) checklist items on perceived challenges and opportunities for live ED teleophthalmology; and (4) an open-ended prompt on how the technology should be introduced into ED workflow.

Technology-acceptance items for perceived usefulness (PU) and intention to use (IU) were adapted from established theoretical models (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Taylor & Todd, 1995; Venkatesh & Davis, 2000; Venkatesh et al., 2003; Thompson et al., 1991). Wording and examples were grounded in prior real-time teleophthalmology programs to ensure face validity for emergency use-cases (Host et al., 2018; Tan et al., 2017) and guided by telehealth adoption frameworks relevant to workflow and governance (LeRouge & Garfield, 2013; van Dyk, 2014).

The core items addressing the study aims (Q16–Q20: prior telemedicine exposure; challenge checklist; opportunity checklist; perceived COVID-19 influence; and the open-ended implementation question) are included verbatim in this manuscript. Platform safeguards and manual review procedures minimized inattentive or fraudulent responses (e.g., short completion time, inconsistent answers).

Key Terms. For this study, acceptance refers to individual-level attitudes toward teleophthalmology, measured as PU and IU following TAM/UTAUT frameworks (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh et al., 2003). Adoption denotes organizational-level integration into ED workflows, influenced by factors like infrastructure, reimbursement, and staff readiness (Tuckson et al., 2017; van Dyk, 2014). Live teleophthalmology is defined as real-time, synchronous video consultation between ED teams and eye-care specialists, in contrast to store-and-forward models. Advanced practice providers (APPs) include nurse practitioners (NPs) and physician assistants (PAs), grouped together in analyses.

Analysis. Primary outcomes were the frequencies of challenge and opportunity endorsements and the distributions of PU and IU. Secondary descriptors included individual factors (role, years in practice, prior video-based telemedicine experience) and organizational context (on-call availability, site type, ED volume, and telehealth infrastructure). These variables were selected for their relevance to perceived usefulness, normative pressures, and practical feasibility in clinical technology adoption (Davis, 1989; Venkatesh et al., 2003; LeRouge & Garfield, 2013).

Closed-ended items were summarized descriptively (frequencies, percentages), with exploratory cross-tabulations by role, prior video experience, on-call availability, and site type. For the open-ended item, we conducted an inductive, constant-comparative thematic analysis to derive implementation-relevant themes (value/timeliness; quality/safety; workflow; equity; training; policy), consistent with pragmatic telehealth evaluation guidance (van Dyk, 2014).

Ethical Considerations. The protocol received approval from the Institutional Review Board of Georgia Southern University. No personally identifiable information was collected. Participation was voluntary. Electronic informed consent preceded the survey launch.

RESULTS

A total of 244 clinicians completed the survey. The sample included emergency physicians (31.1%), emergency nurses/technicians (21.1%), nurse practitioners (18.4%), physician assistants (11.1%), and optometrists (19.3%). This role distribution approximated national workforce proportions and was consistent with the quota targets set at study design.

Individual Factors. Roughly one-third of respondents (35.2%) reported prior experience with video-based telemedicine (Table 1). Additional patterns of exposure included telephone-only use before 2020 (17.6%), telephone or video visits first initiated during 2020 (27.4%), and no prior telemedicine exposure (19.7%). Clinicians with prior video-based telemedicine experience had higher mean scores for perceived usefulness (PU) and intention to use (IU) teleophthalmology than those without prior video experience. Differences by professional role were present but modest. Consultant-side clinicians, including ophthalmologists and optometrists, and some emergency physicians reported higher IU scores, while supporting staff, including nurses and technicians, reported lower mean IU scores. No meaningful differences were observed by age group or gender.

Table 1
Individual characteristics and intention to use (IU) teleophthalmology among emergency eye-care providers, USA, 2020 (N = 244).

Characteristics	Group/Measure	#	%	Usefulness (PU) Mean (SD)	Intention (IU) Mean (SD)
Gender	Female	126	51.6%	3.45 (1.0)	3.66 (.99)
	Male	118	48.4%	3.56 (.93)	3.80 (.89)
Generation	20–40 (Millennials, Gen-Y)	95	38.9%	3.58 (.85)	3.73 (.79)
	40–54 (Gen-X)	107	43.9%	3.60 (1.04)	3.84 (1.01)
	55+ (Baby-Boomers)	42	17.2%	3.20 (1.09)	3.52 (1.09)
Race/Ethnicity	Minorities	94	38.5%	3.56 (.99)	3.78 (.95)
	Whites	150	61.5%	3.50 (.96)	3.72 (.95)
Consultation Side*	Consulted (Eye Doctors)	47	19.3%	**3.78 (.98) ***	**3.93 (.98) ***
	Consulting (ED providers)	148	60.6%	3.58 (.91)	3.78 (.94)
	Supporting (Nurses & Techs)	49	20.1%	3.09 (1.04)	3.45 (1.07)
Leadership Role*	Medical Practice Only	122	50.0%	3.36 (1.01)	3.55 (.96)
	Directing / Managing Too	122	50.0%	**3.69 (.91) ***	**3.93 (.90) ***
Video Telemedicine Experience*	No	158	64.8%	3.43 (.99)	3.65 (.99)
	Yes	86	35.2%	**3.67 (.91) ***	**3.91 (.84) ***
Qualitative Opinion *	Positive	111	45.49%	**3.72 (.90) ***	**3.91 (.80) ****
	Optimistic	87	35.66%	3.44 (1.1)	3.75 (1.04)
	Skeptical	28	11.48%	3.21 (1.1)	3.36 (1.00)
	Negative	18	7.38%	3.21 (.79)	3.28 (1.06)

Note: *Significant difference among subgroups * $p < 0.05$, ** $p < 0.01$ (t-test for 2 means, one way ANOVA for multiple groups, equal variance) PU= Perceived Usefulness, IU= Intention To Use.*

Organizational Context. Most respondents practiced in urban hospitals, although on-site ophthalmology coverage was not universal. Higher PU and IU scores were observed in settings with on-call ophthalmology coverage, higher ocular emergency caseloads, and existing telemedicine systems in the

ED (Table 2). Exploratory analyses did not indicate meaningful PU or IU differences by state policy environment, hospital location, or patient transfer rates.

Table 2
Organizational context (on-call availability, site type, ED volume, telehealth infrastructure) and perceived usefulness/intention to use, USA, 2020 (N = 244).

Characteristics	Group/Measure	#	%	Usefulness (PU) Mean (SD)	Intention (IU) Mean (SD)
State Policy on Telemedicine	Restrictive	73	29.9%	3.44 (.99)	3.76 (.90)
	Moderate	49	20.1%	3.51 (1.06)	3.74 (.97)
	Progressive	122	50.0%	3.57 (.93)	3.74 (.97)
Hospital Location	Urban	162	66.4%	3.53 (.96)	3.81 (.91)
	Rural	82	33.6%	3.50 (1.0)	3.65 (1.00)
Having On-Call Ophthalmologist*	None	45	18.4%	3.10 (.94)	3.50 (1.20)
	Remote	112	45.9%	3.53 (.97)	3.66 (.98)
	On-site	88	35.7%	**3.73 (.94)***	**3.98 (.82) ***
Caseload ** (of ocular emergencies)	Low (< 5 / month)	135	55.3%	3.27 (.97)	3.56 (.93)
	High (5+ /month)	109	44.7%	**3.83 (.89)****	**3.74 (.95)****
Transfer Rate (cases/5 encounters)	Low (< 3)	154	63.1%	3.47 (.95)	3.70 (.91)
	High (3+)	90	36.9%	3.60 (1.01)	3.82 (1.00)
Telemedicine System in ED**	None	58	23.8%	2.97 (1.0)	3.26 (1.00)
	Available	186	76.2%	**3.69 (.90)****	**3.90 (.88)****

Note: * p < 0.05 ** p < 0.001 (t-test for 2 means, one way ANOVA for multiple groups, equal variance) PU= Perceived Usefulness, IU= Intention To Use

Perceived Challenges and Opportunities. When asked about barriers to adopting live teleophthalmology in emergency departments, respondents most frequently cited privacy and security concerns (61.9%), the initial cost of technology (60.6%), and staff resistance to new workflows (57.4%). Other commonly noted challenges included medico-legal ambiguity, limitations in image quality, and uncertainty around consent and documentation procedures. Conversely, the leading opportunities reflected optimism about external and internal drivers of change. Advancing technologies were endorsed by 59.4% of respondents, incorporation of telemedicine into medical and nursing education by 59.0% and easing of regulatory restrictions by 58.6% (Fig. 1).

Privacy and security issues ($p = 0.35$) and the technology's cost ($p = 0.026$) were more critical challenges for physicians and doctors than other participants. Also, most doctors (64%) agreed that telemedicine education is one of the solutions. Otherwise, there was no difference among doctors and other health professionals in identifying opportunities and challenges. Compared to those from urban areas (43.2%), responders from rural hospitals (57%) were more likely to perceive limited acceptance by staff as a hindrance to telemedicine acceptance ($p = 0.037$). No significant difference emerged in the pattern of selected opportunities and challenges among those exercising leadership roles compared without management responsibilities.

Pandemic Impact on Telemedicine Use. More than one quarter of respondents (27.5%) reported initiating telemedicine use for virtual patient visits during the COVID-19 pandemic. When asked about the pandemic's impact on telemedicine adoption, two-thirds of respondents (66.4%) reported that COVID-19 had "a great deal" or "a lot" of impact. An additional 26.0% reported a moderate impact, while 8.0% reported little or no impact.

Provider Attitudes and Sentiment Profiles. Sentiment coding of open-ended responses to Q20 ("In general, what do you think about introducing teleophthalmology to emergency departments?") identified four attitudinal categories: positive (45.5%), cautiously optimistic (35.6%), skeptical (11.5%), and negative (7.5%). These distributions were consistent with checklist findings, with more favorable sentiment associated with higher mean scores for perceived usefulness (PU) and intention to use (IU) (PU: $F = 3.35$, $p = 0.02$; IU: $F = 4.2$, $p = 0.006$; $r = 0.19–0.22$).

Clinicians in the positive and cautiously optimistic groups emphasized teleophthalmology's potential to improve timeliness and access, describing it as "a great idea… quick and easy, preventing unnecessary admissions" (Emergency Physician) and "a cost-saving tool that ensures 24/7 specialist access" (Nurse Practitioner). Others expressed conditional support, noting that teleophthalmology "helps decide whether to transfer or not" or "is better than no coverage at all." Skeptical respondents raised concerns about diagnostic adequacy and reimbursement feasibility, including that "it would be difficult to perform a fundoscopic exam over a webcam" or that "insurers may not reimburse at parity." Negative views, though infrequent, cited technical and medico-legal risks, such as "increased chance of misdiagnoses" and "the need for in-person exams in trauma cases."

Implementation Themes From Open-Ended Responses. Thematic analysis of open-ended responses identified six recurring implementation themes: value and timeliness, quality and safety, workflow design, equity and coverage, training and confidence, and policy or reimbursement considerations. Representative excerpts across the four sentiment categories are presented in Table 3.

Table 3
Attitudes Of Emergency and Eye Care Providers Towards Introducing Teleophthalmology Technology To Emergency Departments In The USA, 2020

Theme	Excerpts	Responder
Positive (45.5%)	"I think it would be a generally useful move that would increase efficiency.'	PA
	"Great idea - very efficient and effective. Plan to expand usage in the future."	EP
	"It is a great solution during COVID-19 and during normal times."	EP
	"It is a great idea and cost-saving for the patient."	NP
	"I think [it] is important because it can help with emergency procedures."	EP
	"I think in the long run, it is beneficial and may reduce wait times as well as triage headaches."	OPH
	"I think it would be useful and that all hospitals would need to use it. I like it, and some of my colleagues would like to try it someday."	OD
Cautiously optimistic (conditional) (35.6%)	"Depends on how many I can help."	PA
	"I think it can be useful in some situations, but it is never as good as an in-person visit."	NP
	"It is a tool and only a tool, but it adds flexibility to treatment."	EP
	"Very helpful, especially in rural areas!"	OD
	"I think it is a great tool to have available in emergency rooms that may otherwise not have access to this type of service."	RN
	"It is good but needs much work to be used at its fullest potential."	RN
Skeptical (11.5%)	"I think it would make some improvements, but in our place, it might be more efficient to ship the patient."	NP
	"I am skeptical of how it will work."	EP
	"Pros and cons. Cannot examine the eye properly."	N.P
	"Impracticable but nice to have"	RN
Negative (7.5%)	"It could increase misdiagnoses."	PA
	"It is difficult to do the eye exams, unfortunately."	EP

Abbreviations: *EP = Emergency Physician; PA = Physician Assistant; NP = Nurse Practitioner; RN = Registered Nurse; NM = Nurse Manager; OPH = Ophthalmologist; OD = Optometrist;*

Theme	Excerpts	Responder
	“Better to see the injury in person.”	NM

Abbreviations: *EP = Emergency Physician; PA = Physician Assistant; NP = Nurse Practitioner; RN = Registered Nurse; NM = Nurse Manager; OPH = Ophthalmologist; OD = Optometrist;*

DISCUSSION

Our national snapshot of clinicians involved in emergency eye care in 2020 showed broad support for live teleophthalmology, with respondents anticipating benefits such as faster triage, fewer avoidable transfers, and more reliable after-hours coverage. At the same time, commonly cited barriers included privacy and security concerns, start-up costs, and staff resistance to workflow change. Acceptance varied by experience and context. Clinicians with prior video-based telemedicine experience reported higher perceived usefulness (PU) and intention to use (IU), consistent with the “experience effect” described in technology acceptance research (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh et al., 2003; Taylor & Todd, 1995; Thompson, Higgins, & Howell, 1991). Qualitative responses highlighted recurring implementation themes related to clinical value, quality and safety, workflow fit, training, and governance, aligning with established telehealth adoption frameworks (Tuckson, Edmunds, & Hodgkins, 2017; van Dyk, 2014; LeRouge & Garfield, 2013; Ekeland, Bowes, & Flottorp, 2012).

These findings reinforce evidence from the broader telehealth literature that adoption depends less on technological capability and more on implementation mechanics, including workflow integration, governance, and organizational support (Tuckson et al., 2017; van Dyk, 2014; Ekeland et al., 2012). Although prior ophthalmology studies have demonstrated diagnostic concordance for remote consultation, routine use in emergency settings remains uneven. Live teleophthalmology must perform under time pressure, where even minor workflow disruptions can undermine uptake (Host et al., 2018; Tan et al., 2017; Prathiba & Rema, 2011; LeRouge & Garfield, 2013). The observed experience effect suggests that brief, well-supported pilot implementations that allow ED teams to complete end-to-end consultations may be an effective strategy for building confidence and normalizing use.

Implementation efforts should therefore prioritize workflow design, including clear consultation triggers and standardized order sets, alongside reliable connectivity to reduce failed or delayed consultations (Ackerman et al., 2010; LeRouge & Garfield, 2013). Clear governance structures, such as defined consent language, standard operating procedures for image storage, and liability guidance, may further reduce professional uncertainty that is often perceived as resistance. While policy changes during the COVID-19 pandemic lowered external barriers and increased familiarity with telemedicine (Saleem et al., 2020; Sharma et al., 2020; Zachrison et al., 2020), sustained adoption will depend on translating temporary regulatory flexibility into durable organizational and financing arrangements (van Dyk, 2014; LeRouge & Garfield, 2013). Attention to equity is also important to ensure that devices, training, and support are available across shifts and sites, minimizing access gaps (Tuckson et al., 2017; Ekeland et al., 2012).

Limitations. This study benefits from a mixed sample of emergency and consulting eye-care clinicians and the integration of quantitative and qualitative data. Limitations include nonprobability sampling, reliance on self-reported measures, and a cross-sectional design reflecting a U.S. snapshot from 2020. Local variation in readiness and potential common-method bias should be considered when interpreting the findings. Nonetheless, convergence between quantitative patterns and qualitative themes supports the relevance of the implementation priorities identified.

Conclusions. Clinicians in emergency eye care demonstrated cautious but clear readiness for live teleophthalmology. This optimism suggests that technical feasibility has largely been established and that remaining barriers are primarily organizational. Progress toward routine use is likely to depend on reducing workflow and governance friction rather than overcoming skepticism about the technology itself. Pandemic-era policy shifts and growing user experience provide momentum for health systems to move from pilot projects to broader integration. Future studies should examine real-world utilization and outcomes, including time to decision making, avoided transfers, user satisfaction, and the role of leadership in sustaining adoption.

Declarations

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Author Contributions:

A. Roba conceptualized and led the study, including survey design, data analysis, and manuscript drafting. Drs. Mase, Apenteng, and Shah contributed to the study design, methodology, interpretation of findings, and critical revision of the manuscript. Dr. Shah provided overall guidance and oversight.

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Figures

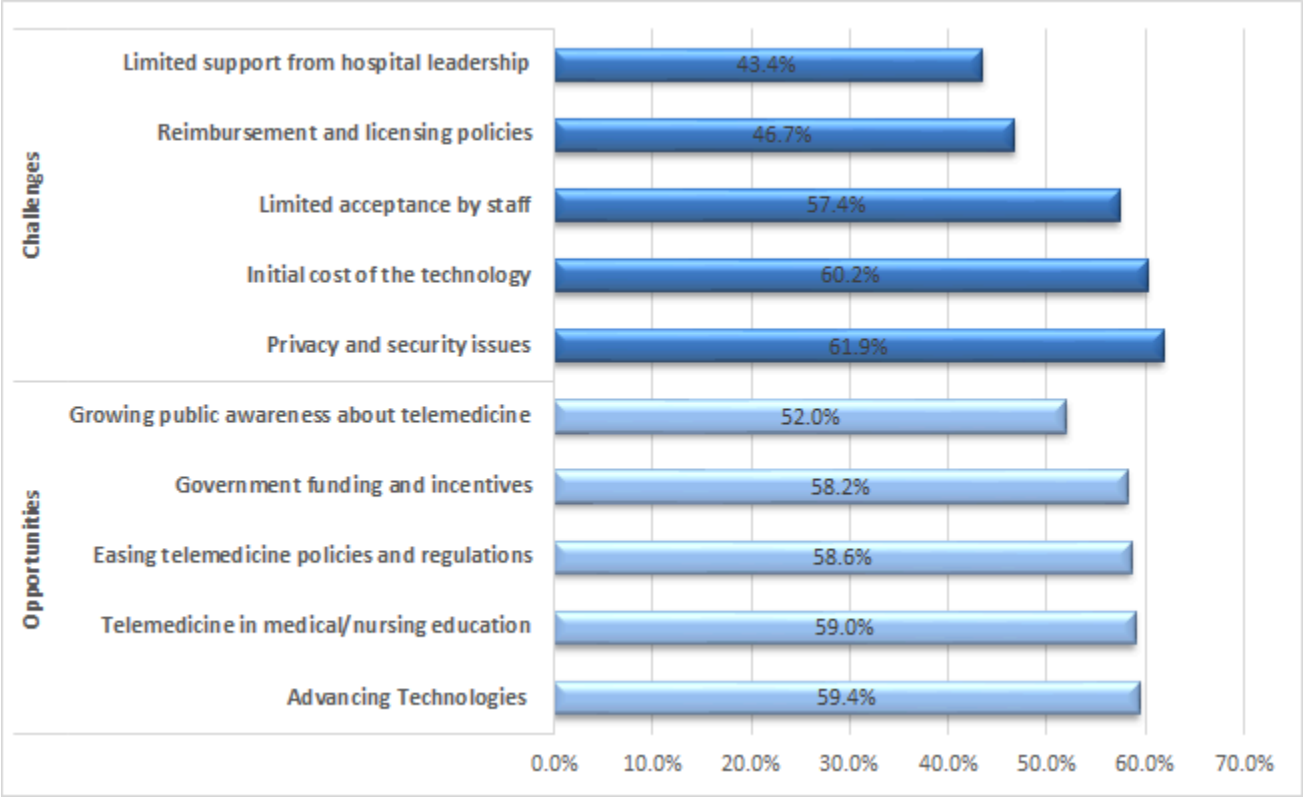


Figure 1

Percent endorsement of perceived challenges and opportunities for adopting live emergency teleophthalmology among emergency and eye-care providers, USA, 2020 (N = 244).

Supplementary Files

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